Best Management Practices

COVER CROPS AND MANURE APPLICATION

Most cropland soils in Ontario need additional organic matter. Manure and composted manure are good for soil health. However, finding a window for adding these organic amendments, including washwaters, is a challenge.

Spring is busy, and spring soil conditions can make additional field operations less feasible. Late summer and fall offer much more suitable soil and weather conditions – especially after the harvest of shorter-season crops. The problem with adding manure post-harvest is that there is no crop in place to feed. The risk of losing much of the nutrient value of the added materials due to runoff, denitrification, leaching or volatilization is high. Planting cover crops with manure application can keep organic amendments in place and help build soil health.

This factsheet outlines the benefits, techniques, options and tips for including a cover crop with manure application.

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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The risks of post-harvest manure application without cover crops

RUNOFF OF SURFACE-APPLIED MANURE – Applying manure when fields are bare and there is no growing crop to use the nutrients will make some crop nutrients, especially phosphorus, susceptible to loss from erosion and runoff.

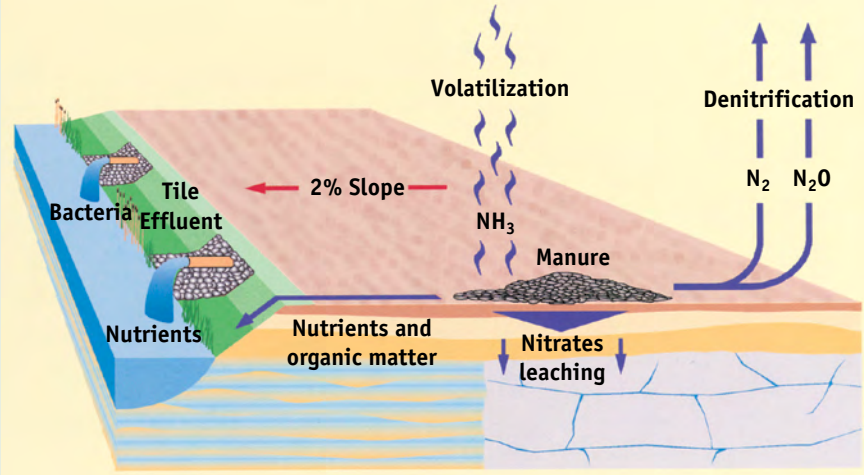
COMPACTION OF SOIL IN LATE FALL – Cropland soils are most often wet in late fall following corn harvest. In this condition, field traffic – especially heavy loads – will compact surface and subsurface soil layers.

LOSS OF MANURE NUTRIENTS TO LEACHING – Following application, part of the organic nitrogen in manure can mineralize into plant-available forms such as nitrate-nitrogen (NO_3-). This form of nitrogen is prone to leaching in sandy soils – especially if there is no living crop to feed on before it is lost.

LOSS OF MANURE NUTRIENTS TO WEEDS – In the absence of established cover crops, nutrients in manure will feed weeds.

VOLATILIZATION – Up to 80% of the ammonia from liquid manure can be lost during warm dry weather if left on the cropland soil surface for five or more days. The dosimeter tube shown below measures ammonia loss due to volatilization.

Unincorporated manure left on the soil surface is at risk of runoff with storm events and volatilization (loss of ammonia). There is a BMP to address this risk: summer- and fall-seeded cover crops, which are good for soil health, too.



GREENHOUSE GAS EMISSIONS – NITROUS OXIDE (N_2O) – Nitrate-nitrogen in cropland topsoil can be converted to nitrogen gas (N_2) following temporary in-field storage or manure application in saturated conditions – or to nitrous oxide (N_2O), if conditions are very moist. N_2O is a potent greenhouse gas.

Types of manure application using cover crops

Slurry/side-dress. Cover crop seed can be added at the time of a side-dressed manure application and lightly worked in with tillage implements attached to the tanker.

Rye planted at side-dress time provides soil coverage in the inter-row spaces during the growing season to protect against erosion.

Post-harvest/pre-application planting. Suitable cover crop species or mixes can be established after crop harvest and before the manure is applied.

Approximately 3,000 gal/acre liquid manure is applied after winter wheat harvest to a stand of red clover that was spring-seeded into the winter wheat.

Post-harvest slurry seeding. Cover crop seed can be added to manure at the time of a post-harvest application, and lightly worked in with tillage implements attached to the tanker.

Cereals and mixes of cereals and other non-legumes can be added at the time of manure application so that the seed is applied with the manure (emerged seedlings, left photo). The photo on the right was taken 10 weeks after planting.

Planting cover crop after manure application. Cover crops can be established in late summer following harvest and manure application.

Cover crops established following manure application (left photo) are able to trap (transfer to the plant) manure nutrients before the end of the growing season (right photo), and release them in the following spring.

Why cover crops are a good fit with manure application

MULCH EFFECT AND OVERWINTER COVERAGE

As the late-summer or fall-planted cover crop grows and the canopy closes, the soil is protected from the erosive power of the wind and rain.

Cover crops slow wind energy to prevent soil erosion. The aboveground plant matter intercepts spring precipitation and reduces the impact of the raindrops on the soil, which helps to keep the soil in place. Additionally, plant stems intercept and slow runoff, which reduces the energy available to transport nutrient-rich soil particles off cropland and into surface water.

NITROGEN-TRAP CROPS + REDUCED N_2O EMISSIONS

Nitrogen from applied manure will continue to mineralize whether or not a crop has been established. Residual nitrate-nitrogen in the soil or nitrate from fall-applied manure or fertilizer is susceptible to leaching through the soil to the groundwater – especially during the spring before the next crop is planted.

Trap crops such as cereals and brassicas will lower soil nitrate levels and reduce the risk of nitrous oxide (N_2O) emissions. N_2O is the most powerful greenhouse gas emitted from cropland.

REDUCED COMPACTION

Deep-rooted cover crops have enough root pressure to penetrate compacted layers and lower the overall density of surface and subsurface soil layers.

Deep-rooting post-harvest cover crops such as tillage radish have taproots that will penetrate and break up plow pans.

BETTER WEED CONTROL

Cover crops and their residues can act as mulches or physical barriers by smothering weeds and/or suppressing weed seed germination and growth.

Some cover crops have very aggressive root and top-growth patterns, making them competitive with late-season weeds.

INCREASED SOIL ORGANIC MATTER AND IMPROVED SEEDBED STRUCTURE

Cropping and tillage practices associated with intensive crop production wear down seedbed structure and soil organic matter (SOM) content. Cover crops help to reverse this trend – especially when combined with additions of organic amendments.

ORGANIC AMENDMENT	STABLE CARBON (lbs/ac)	% in SOM* (aboveground only)	YEARS to INCREASE SOM by 1% (aboveground only)	YEARS to INCREASE SOM by 1% + ROOT BIOMASS (estimate)
DIGESTATE ONLY	101	0.005	200	200
CC OAT	422	0.02	47	26
DIGESTATE + CC OAT	823	0.04	24	15

* Soil organic matter

The cover crop's root system and aboveground biomass add to the soil organic carbon pool.

Planting cover crops at or around the time of manure application helps to trap and later release manure nitrogen, improve overall soil fertility, and protect the investment of adding the organic material provided by the manure application.

In an Ontario study, it was projected that it would take as few as 15 years to reach a 1% soil organic matter level increase, when annual organic amendment applications were combined with cover crops and all of the biomass was returned to the soil. Conversely, it would take 200 years to do this with digestate applications alone!

INCREASED WATER INFILTRATION

Deep-rooted cover crops such as radish or cover crops with fibrous rooting systems such as grasses can have multiple benefits. They can increase the number of macropores, reduce soil density near the surface which will reduce ponding and runoff, by increasing the movement of water into the soil (infiltration rate).

In this photo, dye was added to water and the solution poured on the soil surface. Afterwards the soil was vertically excavated to demonstrate how previous cover crops had improved soil porosity. Note how far the solution had infiltrated into the soil through continuous macropores formed by cover crop roots and earthworm activity.

Some challenges with cover crops and manure application

SEQUENCING SEEDING AND MANURE APPLICATION

Timing manure application with the required planting date of the cover crop may be difficult. If the cover crop is planted before manure application, timing and cover crop choices may be less of an issue. But if manure is not applied until later in the season, fewer cover crop planting options remain.

COVER CROP TIMING

Planting the cover crop too late (after corn) can lead to a poor stand and reduced benefits. Planting too early (after winter wheat) can lead to a robust stand and a heavy residue cover that may be a challenge for the next crop. The planting date of cover crop species may not coincide with the date when manure needs to be applied or vice versa.

WEATHER CONDITIONS

Drought conditions and cold temperatures later in the fall will limit the germination of cover crop seed.

EQUIPMENT COMPATIBILITY

Planting cover crops with manure application can require modified tankers. If the seed is being put directly into the tanker, the tanker must have a good agitator to keep the seeds suspended and as evenly distributed through the manure as possible. Salt content in manure (e.g., sodium, ammonium, calcium) could affect germination of some cover crops.

CROP SPECIES

It's important to choose the cover crop species (see page 9) that will release plant-available N when the next crop needs it during the following growing season.

CUTWORM PRESSURE

Overwintering cover crops can attract cutworms. This is an undesirable pest pressure for grains and oilseeds.

Planting late in the fall after corn harvest and manure application may leave insufficient time for cover crops to establish before freezing, and may hinder the intended functions of nutrient trapping and soil protection over winter.

Cover crops and manure application: making it work

ESTABLISHMENT

✓ Aerial-seed cereals like rye into the stand of the existing crop prior to harvest.

✓ Consider slurry seeding if the tanker has a proven agitator that will keep the seeds suspended and as evenly distributed through the manure as possible.

✓ If broadcasting with or after manure application, ensure to incorporate (shallow will suffice) to increase seed-to-soil contact.

✓ If applying solid manure, try to avoid large clumps that will prevent seedlings from germinating.

✓ If applying liquid manure, keep application rates constant to achieve uniform germination.

Check planting depth during manure application and planting operation for best stand results.

Solid manure has more carbon than liquid manure. The bedding and feed in solid manure is high in organic carbon which adds to the organic matter pools in the soil.

MANAGEMENT

✓ For manure applied after cover crop establishment, apply no more than 7,000 gal/acre.

✓ If suitable for your operation, consider a split application of manure – one in summer and one the following spring – to minimize nutrient loss and feed the cover crop.

✓ In late fall or early spring, harvest the cover crop as forage or graze livestock.

TERMINATION

✓ Know what rates and levels of manure nutrients are being applied so fertilizer application rates can be reduced accordingly.

✓ Terminate overwintered cover crops. There are a number of options:

- prior to planting – e.g., rye, kill with tillage or with a herbicide treatment in the spring prior to planting
- at or after planting – cover crops can be terminated with herbicides or roller-crimper at or after planting

✓ To protect transplants of wide-spaced, high-value vegetable crops such as tomatoes, leave strips of overwintering cover crops (e.g., rye cereal) as wind strips.

SELECTION OF COVER CROP SPECIES

Candidate species for compatibility with manure application should be able to trap nitrogen, outcompete weeds, grow quickly, and be tolerant of dry conditions. Further, they should pose minimal pest management concerns for the crop that follows.

SPECIES	NITROGEN SCAVENGER spring	NITROGEN SCAVENGING fall	FAST-GROWING	WEED CONTROL	DROUGHT TOLERANCE	RISK OF INSECTS/ NEMATODES
RYE	Excellent	Very good	Excellent	Excellent	Very good	Moderate risk
OATS/ BARLEY	N/A	Very good	Excellent	Excellent	Fair	Moderate risk
RADISH	N/A	Excellent	Very good	Excellent	Fair	Very low risk
OTHER BRASSICAS	N/A	Good	Very good	Very good	Very good	Very low risk
RED CLOVER	Good	Good	Fair	Very good	Good	Moderate risk

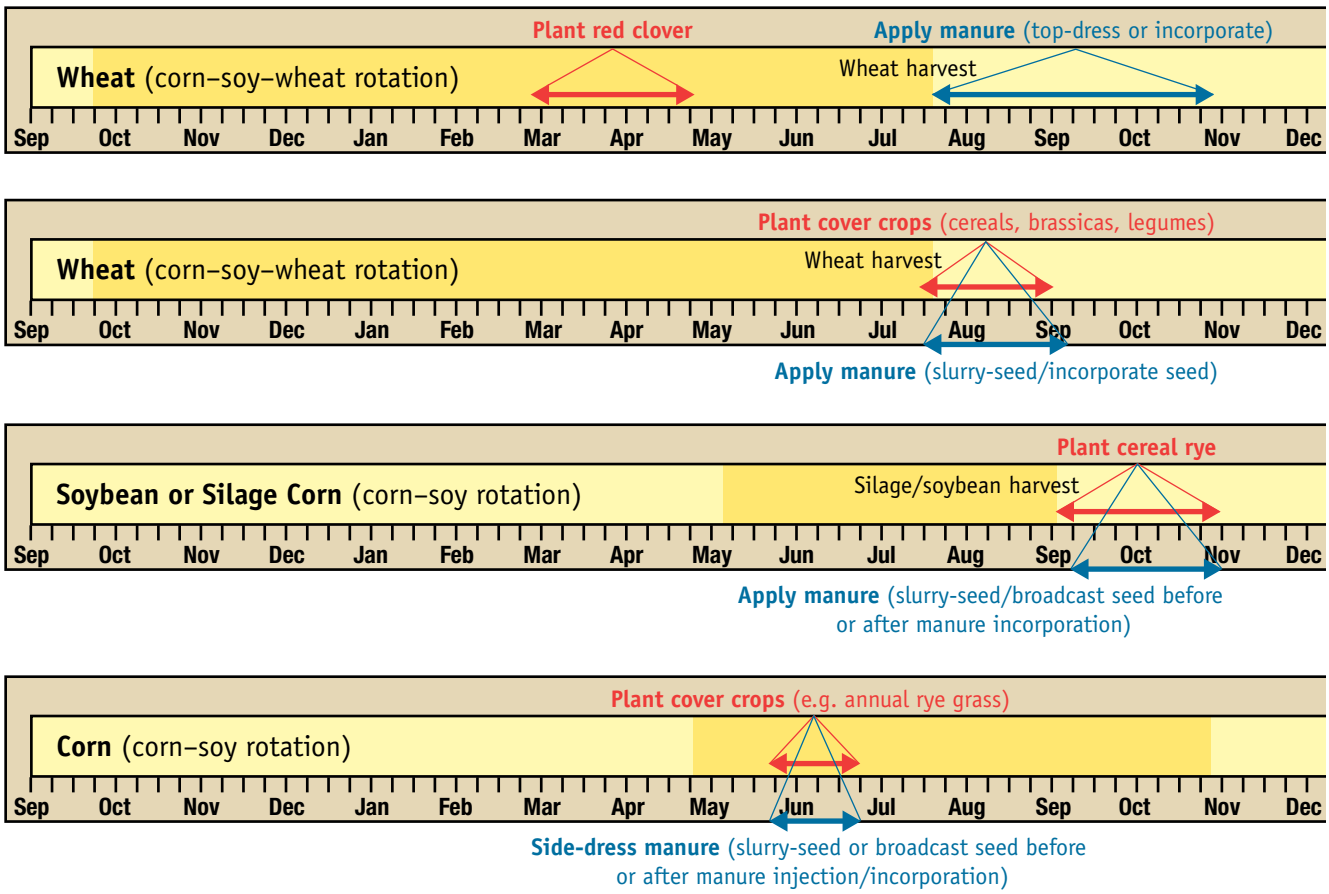
For more information on cover crop selection and management, see these titles from the BMPs for Soil Health series: *Winter Cover Crops* and *Inter-Seeding Cover Crops*.

Proven combinations

Corn–Soybeans–Winter Wheat or Corn–Soybeans with Oats and/or Rye with Oilseed Radish Mixture

- Manure carries the seed into the soil fissures and gives it a quick start.
- The growing plants capture manure nutrients, hold the soil in place over winter, improve water infiltration and soil structure, and reduce manure runoff.
- Next spring, the nutrients are available for the cash crop.

TIMING OPPORTUNITIES FOR COVER CROPS WITH MANURE



Field trial work on Ontario farms have helped to specify the best windows for staging cover crops and manure applications in a range of cropping systems – including wheat in a corn–soybean–winter wheat rotation, silage corn and soybean in a corn–soybean rotation.

Silage Corn

- Unlike a compacted, recently harvested silage field, one with a cover crop (like rye or a rye mix) will:
  - improve seedbed structure with its dense rooting system
  - prevent erosion and runoff of soil and manure with its dense top growth
  - hold manure nutrients over winter.
- Cereal rye is the best cool-season grass for capturing excess N after silage harvest. It is cold-tolerant and germinates at near-freezing temperatures. It will grow later in the fall and begin growth earlier in the spring than wheat. It will also provide excellent pasture in the spring.
- Harvested silage fields will benefit from spreading rye with a bulk spreader – either just before or just after the manure is applied – and then using a shallow tillage tool to incorporate both the manure and cover crop seed. Rye has a flexible seeding depth.

Overwintering rye makes a good spring forage for livestock.

Potatoes + Solid Manure

- Manure application following potato harvest is one way of adding organic amendments and improving soil fertility – provided food safety guidelines are adhered to. Establishing a cover crop will help to protect the investment of this operation.
- Cover crops like rye can stay in place over winter to protect soil and nutrients in the soil until termination in the spring. Rye is a good cover crop choice after a late potato harvest and manure application. Rye has an unmatched ability to grow in the low fall temperatures. In northern regions of the province, rye should ideally be sown by mid-September, while farther south, it can be sown well into October. If sown later, higher seeding rates should be used to ensure good overwinter coverage.
- An alternative to drilling rye after the potato harvest is to broadcast it before digging the potatoes and prior to manure application. If the rye cover crop is going to be harvested the following year, it is recommended to chop the straw after harvest and incorporate it well. Rye seeds left behind will germinate and make a nice cover crop.

Cover crop mixes with rye grow quickly and are well-established before winter. This means the manure nutrients are removed from the soil quickly, leaving less in the soil to be lost to erosion, runoff and leaching over winter.

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
- *Cover Crops: Adaptation and Use of Cover Crops* **omafra.gov.on.ca/english/crops/facts/cover_crops01/cover.htm**
- *Cover Crops Following Cereals and Late-Summer Harvested Crops* omafra.gov.on.ca/english/crops/field/news/croptalk/2014/ct-0614a5.htm
- *Soil Erosion – Causes and Effects*, OMAFRA Factsheet 12-053 **omafra.gov.on.ca/english/engineer/facts/12-053.htm**

Best Management Practices Series

- *Controlling Soil Erosion on the Farm*
- *Cropland Drainage*
- *Field Crop Production*
- *Soil Management*

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

- #15, *Soil Management*
- #16, *Nutrient Management*

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