Best Management Practices

PERENNIAL SYSTEMS

"The soil is tired."

You've heard it before. You may have seen it firsthand – where the seedbed is too light in colour, doesn't hold its tilth, dries out too quickly after you work it, puddles after a light rain and washes out after a heavy one.

It wasn't always this way. Years ago – when you (or your parents) fed hay and pastured a few head – the soils seemed to be more forgiving, more alive, when worked after forage or pasture crops.

The reason is quite simple: perennial crops rehabilitate the soil. The living roots of perennial forages help to create soil habitats where beneficial microbes, fungal mycelium and invertebrates such as earthworms and beetles process organic matter and rebuild root zone structure.

This factsheet provides an overview of the benefits of perennial crops, types of systems, what to consider, and guidelines for establishing and maintaining them.

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 perennial systems are good for soil health

During the green revolution (1940s–1960s), mixed operations and some livestock farms shifted to row-crop agriculture and stopped rotating with forages and applying manure. Within a decade, soil health declined. Soil organic matter levels dropped and seedbeds began to deteriorate. With continuous row cropping, runoff and erosion were evident.

There were exceptions to this trend. Some farm operations did not experience a drop in productivity or a decrease in soil quality. These were the farms that fed forages and used straw bedding, cereals, grasses and legumes to protect their soil overwinter. In other words, these farms continued to practise crop rotation.

Perennial cropping systems include crops that have a life cycle of more than two years and are harvested multiple times before being replaced.

Following several years of perennial crops, tilth improves, seedbed structure is more resilient, moisture is more available, erosion and runoff are reduced, and crops thrive. The effect is most noticeable on soils that were in the poorest condition.

There are improvements to soil health from other BMPs – such as reducing tillage, managing residue, growing cover crops and adding manure – but it is hard to top perennial systems for all of the advantages to soil health.

In some cases, soils are so degraded that the only choices are rehabilitation with perennial systems or retirement to trees, shrubs and other non-agricultural plants. See the BMPs for Soil Health Factsheet *Cropland Retirement*.

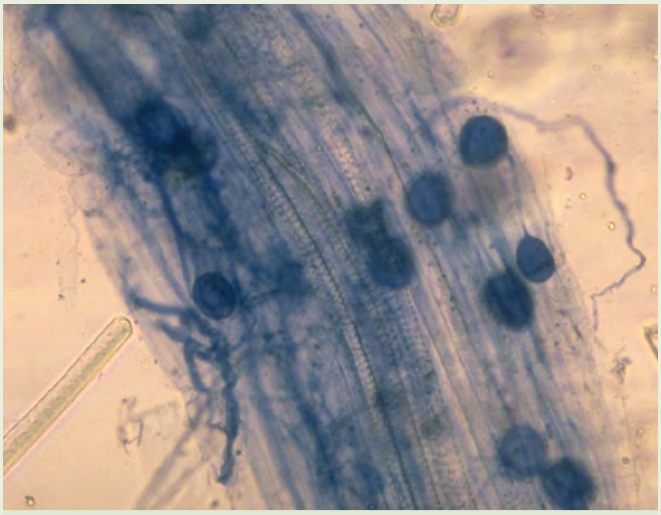
PERENNIAL COVER – Top-growth, thatch from grass species, and forage crop roots combine to provide a complete cover for cropland soils, protecting them from rainfall impact, wind and water erosion, and runoff.

PERENNIAL ROOTS – Roots of perennial legume, grass and woody crops improve the soil – especially soil structure and density. Large taproots will penetrate deeply into the soil profile and break up near plow pans and subsurface compaction. The fibrous root systems of legumes and grasses will aggregate soil particles and form granular structures in the seedbed.

MINIMAL DISTURBANCE – Compared with annual row crop production, perennial cropland is relatively undisturbed. Most of the disturbance is at time of establishment (e.g., tillage, seeding) or during harvest (haying or grazing). Less disturbance supports a diversity of soil life, which in turn builds more resilient soils – allowing soil structure and organic matter levels to stabilize.

ANNUAL ADDITIONS – Perennial crops add organic material to soils. Leaves and stems from top-growth are deposited on the soil, processed by soil fauna, and incorporated into the soil. Plant roots grow, exploit the soil, secrete organic exudates, die off and decompose. One of the net results of these activities is an annual addition of organic carbon and an increase in soil organic matter.

IMPROVED SOIL MOISTURE PROPERTIES – Perennial roots add organic material, improve soil structures and penetrate compacted layers. As a direct result, porosity is increased and macropores are created. Rainfall can infiltrate better, excess water can drain faster, and available soil moisture to plants is increased. In other words, soil moisture conditions are improved with a perennial cover.



IMPROVED SOIL FERTILITY – Perennial crops can improve soil fertility in at least two ways. First, they improve nutrient cycling: a portion of the nutrients (e.g., potassium, calcium, magnesium) taken from less accessible (i.e., deeper) sites in the soil are returned to the topsoil in the fall. Secondly, less plant-available P compounds can be made available from the presence of VAM (vesicular arbuscular mycorrhizae). VAM is a symbiotic microbe that thrives in undisturbed soils.

FLOURISHING SOIL LIFE – The mechanical action of tillage can kill individual organisms and tends to temporarily reduce populations of fungi, earthworms, nematodes and arthropods. Over the long term with repeated tillage, these populations may decline as a result of lack of food (i.e., surface residue), rather than the mechanical action of tillage. Soil flora and fauna thrive in the undisturbed ecosystem of soils covered by perennial forages.

BIODIVERSITY – Perennial crops provide more cover and food, and require less intrusive management practices than row crops. Flowering plants in pastured perennial forages provide forage for pollinating species such as honeybees.

LOWER GREENHOUSE GAS (GHG) EMISSIONS – Perennial crops such as forages are climate-friendly in several ways. Soil carbon is fixed and not lost to the atmosphere as carbon dioxide (CO_2); soil nitrogen (N) is better used by the crops; and, with better aeration normally associated with perennial crops, emissions of nitrous oxide (N_2O) and methane (CH_4) are reduced.

Types of perennial systems

Perennial cropping systems include crops that have a life cycle of more than two years and are harvested multiple times throughout that period.

FORAGES/HAY CROPS – Forage (hay) crops are perennial agricultural crops consisting of mixtures of solid stand grasses, legumes and grass–legume mixes. Forages are harvested a few times each year as haylage or dried hay, and are fed to ruminant livestock or horses.

BIOMASS PERENNIAL GRASS CROPS – Cool-season and warm-season native and introduced grasses can be suitable biomass energy crops. Some of these grasses (such as switchgrass) can be harvested for up to 10 years before replanting.

PASTURE – Pastures are a population of herbaceous plants, usually bounded by a fence, considered as a functional unit for grazing. Species composition is most often similar to forage crops. Crop can consist of perennial or self-seeding annual plants and are maintained through several years for grazing.

Considerations when establishing perennial crops

Are perennials a good fit?

- Will perennials fit the enterprise mix for your operation? Is it economically viable to include them?
- Do you have the proper expertise and equipment? Or could a custom operator do some of the work?

Can you use the products on farm? Is there a market for the product(s)?

- Hay and pasture may be ideal for soil rehabilitation – but can you sell the hay or feed livestock yourself? Or can you make an arrangement with a neighbour to grow them on your land?

Are your soils suitable for the perennial crops being considered?

- Soil type – certain species have exacting soil and site requirements (e.g., pH, drainage, texture), so matching crop to soil and site features is essential. Offsite plantings can be disappointing and even disastrous.
- Soil condition – ensure that drainage improvements and fertility applications have been done to support a successful establishment of the perennial crop.

Will growing this crop present pest problems for the next crop?

- Will the perennial crop become a pest for the next row crop?
- Is this perennial crop a host for troublesome pests for next crop?

Match perennial crops to local soil and site conditions. Alfalfa will not thrive in the excessively moist conditions found on poorly drained soils. Consider planting trefoil or a forage grass mix that is more tolerant of higher soil moisture.

Fitting hay into your rotation will take some effort, but the soil conditioning benefits are worth it.

Perennial crops can be a host for pests of oilseed and grain crops, such as cutworm in corn.

How to establish perennial systems

GENERAL GUIDELINES

Soil Type

✓ Know what soils you have and match perennial crops to local soil and site conditions. Refer to OMAFRA publications (e.g., *Forage Production,* Publication 30) to learn about species tolerances and preferences regarding natural soil properties.

Soils are classified into series (or types) according to soil material (e.g., origin, texture, pH), depth, water table activity and slope.

Some perennial species such as orchard grass tolerate a wide range of soil characteristics), whereas others have limited tolerance. Some species are intolerant of pH extremes: alfalfa does not do well on acidic soils.

Several forage species (e.g., alfalfa) are not tolerant of poorly drained conditions (high water table). You may have to improve subsurface drainage or choose alternative species to plant.

Some perennials have narrow tolerances of soil properties such as drainage, texture, pH and micro-climate. Match species to site: an improper match can be a costly mistake.

Soil Condition

✓ Account for soil health or condition as well as natural soil properties. Address concerns such as ph and drainage before planting.

Check out the condition of your soil before seeding down to forages or other perennial crops. Improve soil health to ensure better perennial crop performance.

The soil to be planted may be in bad shape from past management and may have been subjected to soil health challenges such as erosion, compaction and structural degradation. If remediation is the reason to plant to perennials, the type of soil degradation should be considered before planting. Otherwise, these challenges may hinder plant establishment and the effectiveness of the remedial function of the perennial crop.

In other words, you may need to get the soil in shape before planting the perennial crop:

- soil remediation – topsoil may need to be returned to eroded slope positions (BMPs for Soil Health Factsheet *Soil Remediation*)
- compaction – grow alfalfa or sweet clover before planting preferred perennial crops to improve subsoil structure and internal drainage
- low organic matter – add organic amendments (e.g., manure, compost, biosolids) before planting to increase soil organic matter
- soil fertility – soil test and then adjust pH and fertility levels of P+K before planting perennial crop.

SOIL HEALTH IN HORTICULTURAL CROPS – Orchard, Vineyards, Small Fruit Plantings and Perennial Vegetables

Horticultural crops can pose some unique challenges for building better soil health. Many perennial systems may make use of extensive inter-row tillage, particularly early in establishment for weed control.

Growing cover crops or perennial sod cover can help to build better soil health and resilience in these intensive perennial cropping systems. Good water infiltration and compaction prevention are important to ensure adequate available soil moisture.

✓ Grow cover crops. Cover crops use nutrients and moisture late in the season to help trees or vines prepare for winter. They also prevent leaching losses by tying up nutrients in organic form over winter.

✓ Grow perennial sod crops. Grass cover helps to reduce the risk of erosion. Orchards or vineyards are frequently subject to water erosion because of slopes needed for good air movement. Wind erosion can be a problem with bare, coarse-textured soils.

Winter cover crops can be used in vineyards to protect the soil from erosion and to prevent the loss of valuable nutrients.

Pasture and forage species require high levels of P+K to maintain production and to outcompete weeds.

Applying locally sourced organic amendments such as solid manure will increase early performance of perennial crops by adding soil organic matter and improving seedbed conditions.

Growing sod or cover crops between orchard rows reduces the risk of erosion. A grass cover also supports implements, thereby reducing compaction, which enables tile systems to drain more effectively.

Managing Sod in Perennial Fruit Areas

Design

✓ Establish the permanent grass cover before planting the orchard or in the third or fourth year after planting, as the trees reach cropping age. If the grass is established the year before planting, use a wide 1.5 m (5 ft) herbicide strip in the tree rows in the fall before planting.

Fertility

✓ If the grass is seeded after the orchard is established, apply sufficient nitrogen fertilizer for both the trees and the grass in the spring before seeding. Soil test and broadcast the fertilizer needed by the sod. If the soil test indicates a need, apply lime before seeding when the lime can be cultivated into the soil.

Seeding

✓ Seed the grass as shallow as possible, preferably in early September or alternatively in the spring. Keep the seed out of the tree row.

Maintenance

✓ Once the grass is established, keep it mowed to minimize competition with the trees or vines for moisture and nutrients. In vineyards, planting a permanent grass in every other row may be a viable alternative to a complete sod system, which may be too competitive.

It is easier to work in the orchard with a grass cover and easier to mow than to cultivate.

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,* Publication 811
- *Forage Production,* Publication 30
- *Guide to Fruit Production,* Publication 360
- *Pasture Production,* Publication 19
- *Soil Management for Orchards and Vineyards,* Factsheet 92-120

Best Management Practices Series

- *Buffer Strips*
- *Soil Management*
- *Streamside Grazing*

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

- #15, *Soil Management*
- #16, *Nutrient Management*
- #17, *Use and Management of Manure*
- #18, *Horticultural Production*
- #19, *Field Crop Management*

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

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Research and Writing: Ann Huber, Don King, Margaret Ribey, Soil Research Group (SRG)

Technical Coordinators: H.J. Smith, Ted Taylor

Editorial Coordinator: Alison Lane

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