VEGETABLES

Cereal crops like wheat make a good break in a crop rotation, helping to build and maintain soil organic matter and soil structure.

FIELD-SEEDED AND TRANSPLANTED VEGETABLES

Economic and environmental pressures are challenging Ontario vegetable producers. Growers need to produce a high-quality product efficiently to remain competitive, however, soil and water resources must also be preserved. Healthy, productive plants require healthy soil and clean water.

SOIL AND WATER MANAGEMENT

Intensive vegetable production, whether for processing or fresh market, returns little organic matter to the soil. Tillage used to prepare the seedbed increases the loss of organic matter.

To maintain or increase organic matter levels:

- Use cover crops within the rotation. Following short-season vegetables, establish a cover crop as soon as possible. This green manure crop increases organic matter levels and also breaks some pest life cycles.
- For long-season vegetables, annual or cereal rye is usually the best cover crop. It grows well in cooler weather such as late autumn and early spring. Rye's large, fibrous roots help hold the soil together, preventing erosion. Tillage or herbicides will kill the rye prior to spring planting.
- When a cereal crop precedes vegetables, underseed the cereal with either clover or alfalfa to improve soil structure and reduce compaction. Legumes produce nitrogen, so make allowances in your nutrient applications.
- Reduce tillage and add manure, mushroom compost (a permit is required by Ministry of the Environment for the application of organic off-farm waste) and other plant waste. Take care not to increase soil compaction. Adjust the following year's nutrient application depending on the content of these materials.

Soil Compaction

Soil compaction is a growing concern for vegetable producers. Increased mechanization has led to larger and heavier equipment to ensure planting and harvesting are handled on time.

Seedbed preparation and harvest operations under wet soil conditions are the major causes of soil compaction. Perishability and maturity of the vegetable crop are important to quality. Because staying out of wet fields is often not an option, research continues into solutions.

WEIGHTS OF SOME HARVEST EQUIPMENT

EQUIPMENT	WEIGHT (TONNES)
PEA COMBINE	≈ 17
TOMATO HARVESTER	11 - 14
TRANSPORT WAGONS	3 - 16
SWEET CORN HARVESTER	11
SELF-DUMPING CARTS	3 - 8

Crop Rotation

Crop rotation is a best management practice for vegetable growers. It will address loss of organic matter, disease, weed and insect pressures, soil nutrition, compaction and erosion. Two rules of thumb:

The longer the rotation, the better.

Rotate between different families of crops.

In designing a rotation, ask yourself the following questions:

- ▸Is the rotation profitable?
- ▸Are the yields sustainable?
- ▸Does the sequence allow the use of cover crops?
- ▸Does it make use of nitrogen produced by an earlier crop?
- ▸Does it allow for timely planting and harvest?
- ▸Are harmful herbicide residues left?

Recent tomato research shows that yields improve with good crop rotations. Building and maintaining soil resources should produce similar results for all vegetable crops.

Processing peas can be particularly hard on soil structure. Tightly scheduled planting and harvest seasons mean soil moisture levels may not be optimum when machinery, such as pea combines, are running over the soil.

Early or short season crops such as melons allow the use of cover crops and green manure crops to build and maintain soil organic matter.

FAMILIES OF CROPS

FAMILY (COMMON NAME)	EXAMPLES
CRUCIFERAE (MUSTARD)	Cabbage, Cauliflower, Broccoli, Rutabaga, Brussels Sprouts, Rapeseed, Canola, Oilseed Radish
GRAMINEAE (GRASS)	Wheat, Rye, Barley, Oats, Corn
LEGUMINOSAE (PEA)	Snap Bean, Pea, Alfalfa, Clover, Soybeans
SOLANACEAE (NIGHTSHADE)	Tomato, Potato, Eggplant, Pepper
CUCURBITACEAE (MELON)	Pumpkin, Squash, Cucumber, Melons
LILIACEAE (LILY)	Asparagus
UMBELLIFERAE (PARSLEY)	Carrot, Parsnip, Celery
CHENOPODIACEAE (GOOSEFOOT)	Beet, Spinach, Chard
AMARYLLIDACEAE (AMARYLLIS)	Leeks, Onion, Garlic, Chives, Shallots

"Fall broadcasting of rye followed by bedding for my tomato crop is my definition of 'lazy man's wind control'. It's easily accomplished and does the trick in preventing early season sandblasting."

P. Brunato, Tri-B Farms Ltd., Leamington, Ontario

Wind and Water Erosion

Level sandy soils are at the highest risk of wind erosion while hilly fields are also subject to water erosion. Windbreaks, grassed waterways and other structures address problems in the long-term. Increased residue on the soil surface and use of cover crops will help in the short-term.

For precision-seeded crops, choose a field sheltered by a windbreak, woodlot or other means. Strip cropping with another crop will also cut down wind. If a field is particularly prone to wind erosion, broadcast oats or barley prior to planting the vegetable. The cereal will shelter the seedlings. A timely application of contact grass herbicide will kill the cover crop before it competes with the vegetable.

In some transplanted vegetable production systems, ground beds roughen the soil surface which slows water, wind and soil movement. Some growers are also managing cover crops on ground beds to control wind. Another alternative is the use of narrow grass strips spaced across a field to reduce the speed and soil-carrying ability of wind.

A rye cover crop on beds can be managed with a timed application of herbicides to provide short-term wind protection in the spring. This system also minimizes the number of passes over the field in spring.

Irrigation

Average rainfall is irregular and sometimes is inadequate for vegetables. Irrigation can be profitable with high-value vegetable crops. Both overhead and sprinkler irrigation systems are being used in Ontario. Overall costs are comparable. Drip irrigation has two advantages: reduced water needs and uniform soil moisture; but, overhead irrigation is adaptable to any crop and can be used for frost protection.

Irrigation is important after planting until seedlings emerge and during fruit development. Most vegetables have periods where a lack of water can affect yield and quality. Use a scheduling method such as the tensiometer or the evapotranspiration model to assist in irrigation timing.

DRIP VS. OVERHEAD IRRIGATION

DRIP IRRIGATION	OVERHEAD IRRIGATION
Requires up to 50% less water than overhead irrigation.	Requires more water because of evaporation and run-off.
Provides a more uniform availability of water through season.	Larger fluctuations in soil moisture levels.
Higher fixed costs if irrigation not required because of adequate rainfall. Lower variable costs when irrigation is required.	Decision to irrigate not made until required; therefore, lower carrying costs on fixed portion. High variable costs when irrigating because larger water volumes pumped and more labour intensive.
Easier to irrigate through harvest since only growing area wet.	Must schedule irrigation around harvesting operations.
More efficient use of fertilizer.	Requires more fertilizer.
Certain crops are not adaptable to drip irrigation.	Any crop can be sprinkler irrigated.
Fixed location.	Mobile which facilitates land rental and crop rotation. Some frost control.
Relatively new technique, grower must develop skill.	Many growers already have sprinkler systems.

CRITICAL GROWTH STAGES FOR MOISTURE STRESS

CROP	CRITICAL GROWTH STAGE
SNAP BEAN	Flowering and pod setting
BROCCOLI	Head formation and enlargement
CABBAGE	Head formation and enlargement
CARROT	Root enlargement
CAULIFLOWER	Planting to harvesting
SWEET CORN	Tasselling, silking and ear filling
CUCUMBER	Flowering and fruit enlargement
MUSKMELON	Flowering and fruit enlargement
PEAS	Flowering and pod formation
PEPPER	Transplanting, fruit set and development
PUMPKIN, SQUASH	Flowering and fruit development
TOMATO	Flowering, fruit set and enlargement
WATERMELON	Blossom to harvesting

Pepper production on plastic with drip irrigation. The plastic has been cut away to show the irrigation line slightly buried and one of the emitters.

Plasticulture

This practice combines plastic mulches with row covers and drip irrigation. The practice is costly and is only practical with fresh market vegetables. Benefits include: early harvest, increased early season yield, improved quality and reduced soil movement due to erosion. Removing and disposing of plastic materials in land fills after harvest is a drawback.

NUTRIENT MANAGEMENT

The most important aspect of nutrient management is to soil test before applying anything. Applying too much fertilizer is expensive and also may affect surface and groundwater. Too little fertilizer may affect yields.

Each vegetable crop requires a different fertilizer program. Start by considering the base fertility of your soil. When taking soil samples, be sure to take samples that are representative of the whole field. Good record keeping can help you track a field's fertility over time and assist in making decisions.

"The money spent on soil tests is one of my best investments. Every tomato field gets soil-tested every year. By following fertilizer recommendations, I feel we have saved money and improved our yields."

P. Richards, Dresden, Ontario

PEST MANAGEMENT

Integrated Pest Management helps reduce pesticide use while maintaining yield and quality. See the section on Pest Management in Understanding the Basics for more information.

Cultural Control

- ▸Select the most resistant variety of your crop.
- ▸Select a site that reduces problems.
- ▸Reduce stress and injury to crops. These allow pests to get started.
- ▸Use good sanitation practices. Till under or bury culls.
- ▸Control weeds that may harbour pests.

Chemical Control

When choosing a pesticide, always refer to the pesticide label and consider:

- ▸The days to harvest interval.
- ▸The impact on beneficial insects. For example, consider when honey bees are most active. *Bacillus thuringiensis* (Bt) is least likely to harm beneficials because it is specific for each type of insect. Synthetic pyrethroids are not persistent but they do affect a broad spectrum of species.
- ▸Use strategies to reduce the chances of pests becoming resistant. Rotate chemical families.

Weather conditions - some pesticides work better under specific environmental conditions. For example, synthetic pyrethroids are most effective in cool temperatures while others such as carbamates and organophosphates work best in warm conditions.

The life cycle of the pest - adult insects are more difficult to control than immature forms. Larger, mature weeds are more difficult to kill.

Cole Crops

The development of an IPM program for cole crops is underway at the Simcoe Research Station. Special attention is being paid to the identification of insect tolerant cultivars. Cultural practices such as trap cropping are being evaluated.

MONITORING FOR INSECTS ON COLE CROPS

INSECT PEST	VISUALLY MONITOR BY	YELLOW PAN TRAPS	PHEROMONE TRAPS (INDICATES PRESENCE ONLY)
CABBAGE MAGGOT	Observe eggs in soil at plant base	Adults	–
FLEA BEETLE	Count on leaves and observe chewing damage	–	–
THRIPS	On or between leaves	–	–
CABBAGE LOOPER	Count larvae on leaves	–	X
APHIDS	On or between leaves Observe damage to leaves	–	–
DIAMONDBACK MOTH	Count larvae on leaves	–	X
IMPORTED CABBAGE WORM	Count larvae on leaves	–	–

X = Suitable **– = Not Applicable**

While very limited insect damage may be tolerated on cabbages, consumers will not tolerate any insects on broccoli, cauliflower or brussels sprouts. Particular care must be taken when monitoring these crops for insects.

Cabbage looper larvae.

CULTURAL PRACTICES TO CONTROL DISEASE IN COLE CROPS

CONTROL PRACTICE	ALTERNARIA DISEASES	BLACK ROT BLACK LEG	CLUB ROOT	DOWNY MILDEW	SCLEROTINIA	VIRAL DISEASES
Tolerant or resistant varieties	–	X	–	X	–	–
Disease-free seed and transplants	X	X	X	X	–	–
Clean seedbed	X	X	X	X	X	–
Good air circulation	X	X	–	X	X	–
Proper pH	–	–	X	–	–	–
Avoid overwatering	X	X	–	X	X	–
Eliminate weeds	X	–	X	–	X	X
Don't work when foliage is wet	–	X	–	–	–	–
Don't bruise head at harvest	X	–	–	–	X	–
Incorporate crop residues immediately	X	X	X	X	X	–
Clean all equipment	–	X	X	–	–	–
Rotate crops	X	X	X	X	X	X

X = Suitable Control Practice

Alternaria black spot on cauliflower head and leaves.

Tomatoes

Disease control - TOM-CAST is a weather-monitoring program used to time fungicide spray for field tomatoes. A daily disease severity value is determined by the average temperature during hours when foliage is wet. Once the value reaches a certain level, growers should apply fungicide. About 80% of processing tomato growers use TOM-CAST to time their first spray and 50% continue to use the system through the growing season. By following the system throughout the season, growers can usually save between one and three sprays. Further research is underway.

Insect control - the Colorado Potato Beetle can do great damage to tomatoes, particularly when emerging adult beetles attack young plug transplants. While a number of insecticides are available, the beetle is resistant to several of them. This is a particular problem in areas with large acreages of both tomatoes and potatoes. Field rotation can help to reduce CPB pressure.

Trap cropping can help to reduce pesticide use. Plant strips of potatoes or eggplant, which the insects prefer, at the edges of tomato fields to trap adult beetles. When the beetles are concentrated on the trap crops, apply insecticides to them. The results are fewer sprays on a more concentrated area.

"In 1991, I planted one row of potatoes at the edge of my tomato field and one row down the middle of the field. I had to spray the potatoes three times for Colorado Potato Beetle but I only sprayed the tomatoes once."

E. Gyori, Harrow, Ontario

A potato trap crop for Colorado Potato Beetle control in processing tomatoes allows growers to reduce the number of overall sprays.

Promising research continues into encouraging natural predators, mulching and barrier crops.

Other tomato pests include:

- ►Flea beetles.
- ►Tarnished plant bugs.
- ►Fruit flies.
- ►Grasshoppers.
- ►Cabbage loopers.
- ►Aphids.
- ►Hornworms.
- ►Crickets.
- ►Variegated cutworms (monitored regionally by OMAF and processors).

These pests rarely require treatment. Check OMAF Publication 363 for control measures.

Soil pathogens - high levels of plant parasitic nematodes and *Verticillium dahliae* cause stunted, wilted, low-yielding tomato plants, especially on sandy soils. To control the problem:

- ►Rotate crops to avoid pest build-up.
- ►Plant cover crops such as annual and perennial ryegrass, alfalfa, non-flowering marigolds or work in green material from oilseed radish or mustard to reduce populations. Oats and winter wheat have little effect on populations. Nematode populations increase under clover, corn and many vegetable crops.
- ►Improve organic matter, drainage and soil structure to promote good root growth.
- ►Test your fields. Ensure that the samples are representative.
- ►If threshold levels have been reached, fumigate. Then, concentrate on the other control measures to prevent repeated build-up.

High levels of plant parasitic nematodes, such as the root lesion nematode, combined with *Verticillium dahliae* can cause significant yield reductions in tomatoes.

Peppers

European Corn Borer is the major insect pest. Pheromone traps capture males. Traps are monitored regionally and adult flight patterns collected as part of the OMAF Pest Alert program. Check the Agriphone for details. Growers can also put out traps to monitor their own fields. Pests such as aphids and pepper maggots rarely require control, but tarnished plant bugs are becoming more of a problem.

Bacterial spot is the major disease threat. Fixed Copper may reduce the spread of this disease if weather conditions are not too favourable.

Field-Seeded Vegetables

Includes peas, sweet corn, snap beans, cucumbers, carrots, beets, pumpkins, squash, spinach, radish and rutabaga.

Primary pests attacking these vegetables are root-rot organisms and maggots. To reduce the problems:

►Maintain and increase soil organic matter levels.

►Use crop rotation.

►Make sure all seed is treated with fungicide.

►Ensure adequate fertility.

►Improve drainage.

►Ensure good soil structure. Reduce or avoid compaction.

Summary

There is a saying, "A chain is only as strong as its weakest link." Success in the management of vegetable production is like that chain. Each decision reflects two considerations: short-term viability and long-term sustainability.

With the trend towards growing supersweet sweet corn for freshmarket, creating good conditions for germination and early growth is critical.

POTATOES

Any practice considered for potato production must be cost-effective. But sustainability is more than just an economic issue, it also considers environmental factors. Best management practices bring together concerns for the environment and the need for efficient production of a high-quality product.

Potato harvest is highly mechanized, involving numerous trips over the field. Good soil management should be practiced to reduce the effects of soil compaction.

SOIL MANAGEMENT

Potato production is hard on soil structure. Crop rotations can help. Try to rotate out of potatoes for at least a year. Avoid continuous potatoes. Use cover crops.

Compaction and poor soil structure can cause several problems:

- ►Soil crusting and reduced plant emergence.
- ►Poor aeration reduces crop vigour and leads to inconsistent yields.
- ►More misshapen tubers.
- ►Increased soil erosion by water.

SAMPLE ROTATIONS FOR PRACTICAL SITUATIONS

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Where cash cropping is the only option:	Potatoes Winter wheat –	Winter wheat Short fallow period Rye cover crop	Potatoes Winter wheat –	– – –	– – –
For short-term, leased land agreements:	Potatoes Cover crop	Potatoes Cover crop	– –	– –	– –
For long-term "soil investment":	Alfalfa – –	Alfalfa – –	Potatoes Winter wheat –	Winter wheat Short fallow Rye cover crop	Potatoes Rye –

Ask yourself the following questions about your water management practices:

- **Do you have a rain gauge in every field and keep records of rainfall?**
- **Do you know the pH level of your water for consideration in irrigation and spraying?**
- **Do you regularly test your well for chemicals, bacteria and nitrates?**

Hard pans can develop on sandy soils, particularly when there is heavy traffic on wet soil. Increasing potassium levels near the roots may help overcome some of the effect. Building organic matter levels will produce longer-term benefits. Use crop rotations, cover crops and manure. Good production depends on healthy, vigorous roots. Improving soil structure can improve yields.

A good practice is to plant a cereal crop in September or October and subsoil or chisel plow in late October or November when the ground is dry. This will break up hard layers but leave enough cover to prevent erosion.

WATER MANAGEMENT

Many of the decisions a farmer makes to improve soil will also improve water quality. Water quality is important for spraying, irrigation and personal use.

Irrigation

More and more farmers are turning to irrigation to provide relief from droughts. Properly used, irrigation can help plants stay healthy and vigorous; however, leaching of nutrients and increased disease may result from over-irrigation. Consider the following when managing irrigation:

- Know your soil type and its capacity to hold water.
- Know how your crops store water. Demands change as crops develop.
- Use an irrigation scheduling method such as a tensiometer or the evapotranspiration model.
- Know the weather forecast.

As long as the soil is dry, subsoiling or chisel plowing a cover crop in mid-fall can help to break up plow layers. Take care to leave enough cover to prevent erosion.

- Monitor irrigation and use a rain gauge to measure the quantity applied.
- Watch for blight.
- On level fields with small hollows, use a "dammer diker". This machine makes small holes between the rows that trap the water where it is applied — preventing water flow to low spots.

Irrigate when available moisture is below 50% of field capacity, wind speeds are less than 20 kilometres per hour, during evenings or calm, cloudy days. Irrigation can also be used to reduce soil blowing.

NUTRIENT MANAGEMENT

A healthy, well-nourished crop can withstand stress from drought, insects and weeds. Growers should supply the particular nutrients needed on a field by field basis. This prevents waste of fertilizer and lost yields.

Take soil tests - take samples carefully and map the field properly. Sample trouble areas separately.

- ▶ Establish yield goals based on your previous records; fertilize for a realistic yield goal and to improve your soil. Your own experience and the variety of potato will affect decisions.
- ▶ Leaf tissue test before bloom, particularly in poor areas.

Tuber test - take two weeks before harvest or at harvest to gauge storability of crop. Optimum levels of tuber calcium improve storability.

Keep good records - record all samples taken and make careful maps. Use records to correct problems and to refine programs.

R.J. Mackenzie, Alliston, finds, "Placement and timing of fertilizer applications are critical for the production of a quality crop." Providing the required nutrients at each stage of growth, in the most effective way, is a challenge for all growers.

SAMPLE FERTILITY PROGRAM*

FALL	Broadcast 50% of potassium requirement.
SPRING	Broadcast, or band in planter, the remaining potassium. Split nitrogen 25% ppi (urea), 50% in the planter mix (ammonium sulfate/ammonium nitrate), 25% at second hilling (urea, calcium nitrate).
PLANTER MIX	Band on either side of seed piece. Include phosphorus, magnesium, sulphur, zinc and calcium if needed.
FOLIAR APPLICATION	If boron or zinc levels are low, apply in irrigation or sprayer. Manganese is most effective if applied this way.
SOIL APPLIED	Boron can be applied in a sprayer with pre-emergent herbicides at levels not higher than 9 kilograms per hectare. Lime may be spread in the fall at a rate of 2.5 tonnes per hectare.

*** Example only.**

The importance of secondary nutrients and micronutrients is often overlooked. Calcium is essential for internal quality and storability. If calcium levels test low, add a gypsum source to the planter mix to ensure that levels are adequate in the immediate vicinity of the tuber. Application of excess nitrogen, phosphorous or potassium will not correct problems with micronutrients.

Newly hatched Colorado Potato Beetle larvae with eggs.

Defoliation by Colorado Potato Beetle.

PEST MANAGEMENT

Modern pest management uses both cultural and chemical controls to produce a quality product. A number of non-chemical controls are in use and others are being examined.

Cultural Control

Scout fields during the crop season, walk your whole field every two or three days. Keep records of weather, pests present, numbers and stage of development and crop condition. Use OMAF programs and information lines for pest updates.

Use a good crop rotation to break pest cycles.

Use a short fallow period to reduce weed pressure and reduce some soil-borne pests but beware of soil erosion.

Use good sanitation practices. Control weedy areas. Clean and disinfect storage and equipment. Bury or dispose of culls.

Chemical Control

Manage your sprayer - calibrate the sprayer regularly. Regularly clean nozzles and components of sprayer. Use recommended rates of pesticides when applying. Mix spray as required. Be careful when working with chemicals.

Monitor water quality - be aware of pH levels and test water regularly.

Colorado Potato Beetle

Colorado Potato Beetle is probably the most frequent and serious pest. Good management is essential because this pest quickly becomes resistant to chemicals. The beetle's life cycle is:

- ►Adults emerge and lay eggs, approximately 300 per female.
- ►Eggs hatch in 5 to 10 days.
- ►Larvae 4 instars in 13 to 15 days.
- ►Larvae - enter the soil for 8 to 10 days. Emerge as adults.

Colorado Potato Beetle adult.

Resistance Management

Time spray when larvae are small, (their most vulnerable stage.) For best control, apply spray to first generation before third to fourth instar.

Use dip tests before spraying. These tests help to avoid applying ineffective materials.

Rotate chemical families to vary the mode of action against the insect. Use each chemical only once or twice a season.

For more information, refer to the "Understanding the Basics" section of this booklet.

Alternative Tactics

Rotation and isolation - to reduce the movement of Colorado Potato Beetle, isolation by streams or bush is necessary.

Microbial - it is effective on small larvae only.

Mechanical treatments - suction, flamers, ditches and traps.

Botanicals - a natural insecticide (e.g. Rotenone).

Trap cropping - plant some of the rows in the field to a crop preferred by the beetles so that control efforts can be concentrated on smaller areas.

Summary

Field scouting and good record keeping are important. To responsibly manage your crop, you must know soil type, fertility levels, weed pressures, cropping history, insect pressures, drainage patterns, pH levels, etc. Take notes and get advice.

Effective managers question all aspects of production, seek information and try innovative practices. A good crop rotation is important. Keep up with practices and developments in other areas that may assist you. Remember that a change in one part of your management system will affect the other parts. Plan ahead.

Pesticide dip tests will help you to determine resistance and avoid applying ineffective materials.

Aphids

Aphids can reduce yields and transmit viruses. Scout fields and use aphicides responsibly. Resistance has already been recorded.

Subsidence or decreasing soil level is a problem with organic soil. The stake on the right with the cross pieces marking different levels, illustrates the rate of subsidence on the Bradford Marsh.

MUCK CROPS

Organic soil is a valuable resource but must be protected to maintain good yields of high-quality vegetables. These soils are very susceptible to wind erosion. As water is drained, organic matter is "eaten up" by microorganisms and soil gradually disappears in a process called subsidence.

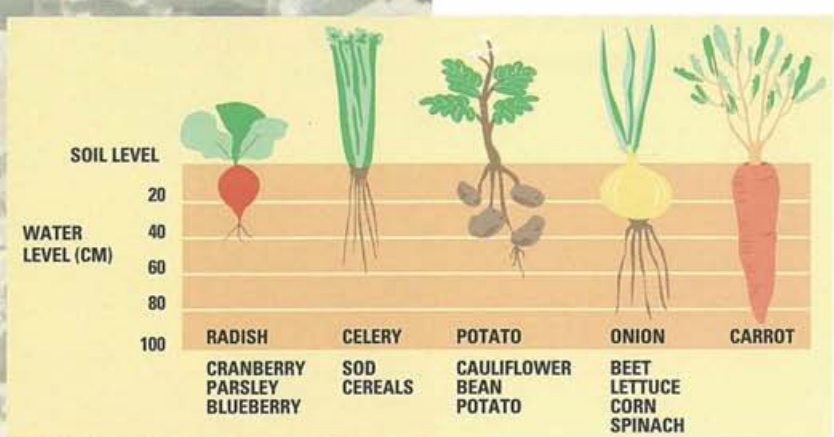
Pesticides are necessary to produce the vegetables that consumers demand. Yet, a number of steps will help reduce the use of chemical pesticides. These materials are expensive so reduced usage is also cost-effective. Best management practices must make economic sense, be practical and fit present farm operations.

SOIL MANAGEMENT

Subsidence - Organic soils such as muck or peat are very high in organic matter content — from 30 to 98%. The organic matter begins to disappear as soon as soils are exposed to air. When organic soil is drained and farmed, soil levels decrease. To slow the rate of loss, two possibilities are:

- **Copper application** - Copper is required by crops such as onions and lettuce and also helps reduce subsidence by slowing the growth of microorganisms. Apply copper to new muck at a rate of 14 kilograms per hectare (56 kilograms/hectare copper sulphate) each year for three years. Afterwards, apply five kilograms per hectare (20 kilograms of copper sulphate) to the soil with broadcast fertilizer every second or third year.

- **Water table control** - Draining organic soils exposes soil to the air and increases loss. By keeping as much of the soil profile as possible under water, subsidence decreases. Recommended water table levels are shown in the diagram/chart (below). The water table can be controlled by keeping water in drainage tiles or filling ditches and storage tanks and allowing water to flow back into tile drains as shown in the diagram. This also provides water to the roots of the crop which is cheaper than overhead irrigation and reduces the risk of spreading certain diseases (e.g. Septoria late blight of celery).



Control the water table at the right level for each crop.
(NOTE: Diagrams of vegetables are not to scale).

Wind Erosion

Erosion also increases soil loss. Blowing soil can bury seed too deeply, cut young seedlings and fill ditches. High winds may even blow away seed with the soil. To reduce erosion, seed barley, or another cereal crop, on the same day as the crop is planted.

A broadcast seeding of barley provides the best wind protection. Make sure to kill the barley before it competes with the crop. Row seeding works well if the wind usually blows in one direction. The rows should be at right angles to the prevailing winds. Plant one row of barley per four to eight rows of onions.

BARLEY INTERSEEDING TO REDUCE WIND DAMAGE

	BROADCAST	ROWS
Seeding rate*	50 - 75 kilograms/hectare (1 ½ bushels/acre)	60 seeds/metre row
Height to spray herbicide	10 centimetres	15 centimetres

*** Seeding rate will depend on seed quality. Lower rates may be used if germination rate is high.**

Seeding on ridges also reduces wind erosion. It works especially well for carrots but can work with lettuce and onions if the soil is not too dry. Growers use bed shapers to form the ridges. Ridges are 66 to 88 cm wide and 20 cm in height. Equipment is also available to form ridges when the crop is transplanted.

Winter cover crops reduce wind and water erosion as well. Ideal cover crop choices for muck soils die out completely over the winter and do not leave tough roots or leaves to get tangled in the seeder. Possibilities include oilseed radish, spring barley and annual ryegrass. Seed the cover crop between August 15 and September 15. Be prepared to mow or chop oilseed radish, if it starts to flower, to prevent seed set.

Row seeding of a cereal crop provides good protection if damaging winds usually come from one direction. Broadcast seeding provides better wind protection.

SOME SEEDING RATES FOR COVER CROPS

COVER CROP	RATE TO BROADCAST	RATE TO DRILL
OILSEED RADISH	20 kilograms/hectare	12 kilograms/hectare
BARLEY	65 kilograms/hectare	60 kilograms/hectare
ANNUAL RYEGRASS	12 kilograms/hectare	10 kilograms/hectare

Tillage

It is important not to over-cultivate muck soils.

- ►In the spring, disk the soil to mix in fertilizer then deep cultivate to a depth of 20 to 30 centimetres.
- ►Leave the land as rough as possible while making sure there are no clumps that will interfere with the seeder.
- ►Conserve as much moisture as possible.
- ►Try not to overdrain the land. However, it may be necessary to cultivate low spots or wet fields twice, to dry land enough for seeding.
- ►After seeding, do not disturb the soil until the crop is established. The thin crust formed will help to resist wind erosion.
- ►Only plow once every two or three years in the fall, particularly after growing carrots. This turns carrot tops under and exposes a small amount of peat soil.
- ►If there is a drainage problem, use a subsoiler in the fall every second year.

Seeding on ridges works especially well for carrots and does provide some wind protection.

WATER MANAGEMENT

As stated previously, water table control is particularly important. Subirrigation from below roots is good in most cases although it can increase the concentration of salts in the soil. Overhead irrigation increases the risk of some diseases and should be done at night if possible.

Avoid water erosion on flooded fields. In the spring, drain water through soil and into drainage tiles. Don't let water run off the surface. Replacing drainage ditches with header tiles also helps. Watch the natural flow of water before installing header tile.

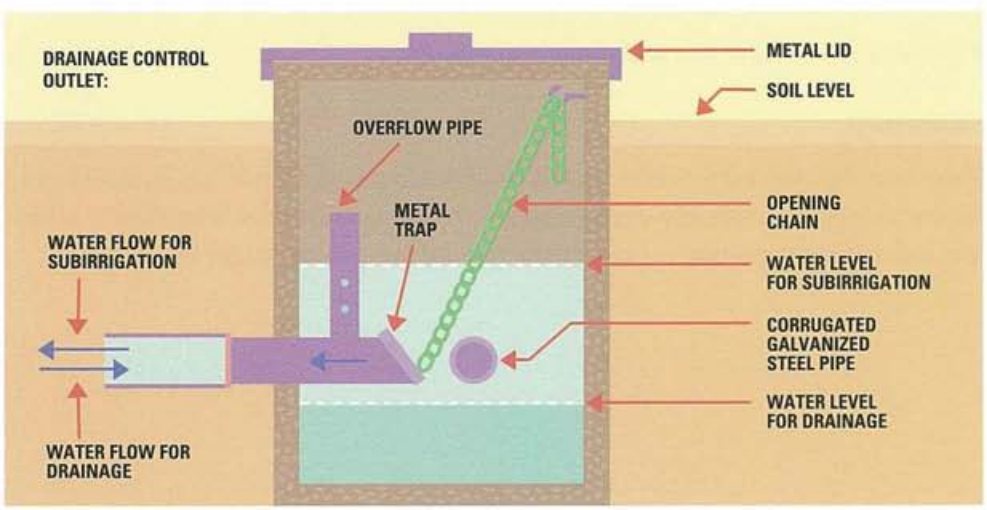
NUTRIENT MANAGEMENT

Annual soil tests are important. Newly-developed muck soils tend to be low in most plant nutrients except nitrogen. After muck soils have been farmed for many years, levels of potassium and phosphorus can increase and may become excessive.

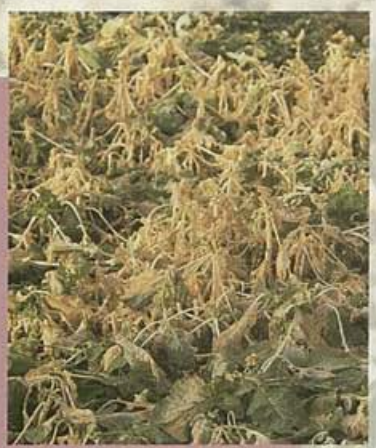
Muck soils usually lack micronutrients. A complete soil analysis is a good investment. Add any required micronutrients to spring fertilizer or as a foliar spray. Check the OMAF Vegetable Production Recommendations Publication 363 for the correct timing and application method for each micronutrient and crop.

Keep good records of soil tests each year to see if changes are occurring in either nutrient or pH levels. The best pH level for vegetables on organic soils is 5.5 to 6.5 but onions will produce well at a range of 5.1 to 7.0.

Applying the correct amount of fertilizer according to a soil test is the best approach. Too much fertilizer reduces yield and quality and costs money.



To drain land, the square metal trap is removed and water flows out drainage pipe. If necessary, excess water may be pumped out this way if water rises to the height of the tile. For subirrigation, metal cover is closed, causing cistern to be filled above the level of the tile. Excess subirrigation water flows into top pipe and into drainage tile.



Oilseed radish shows promise as a cover crop for muck soils; it does not overwinter, it is inexpensive and it may help to suppress nematodes.

PEST MANAGEMENT

Growers can reduce the use of pesticides by taking the following steps:

- ►Use varieties of vegetables that resist pests. This is the only possibility for diseases such as Fusarium yellows in celery or pink root in onions.
- ►Rotate crops. Onions and carrots are a good combination. Avoid growing carrots after lettuce or potatoes because soil-borne diseases such as Sclerotinia and Rhizoctonia will be worse.

Make full use of alternative control methods such as:

- ►Root-knot nematode is the most significant problem nematode on muck crops. Grains and grasses are not hosts of this nematode. Cover cropping with grasses can help to control the population.
- ►Oilseed radish may suppress nematodes. (Till under at green pod stage.)
- ►Late plowing when there's a crust of frost to reduce nematode populations.
- ►Winter flooding with a thin layer of water to reduce Onion white rot, Sclerotinia white mold on carrots, possibly even carrot weevil and nematodes.
- ►Removing cull piles off the field.

Schedule sprays to be most effective by:

- ►Walking your fields regularly or hiring a pest management scout.
- ►Ensuring your sprayer is calibrated to operate efficiently.
- ►Listening to the local Agriphone for recommendations.
- ►Spraying according to pest management thresholds.

Summary

These best management practices provide solutions to everyday problems. In most cases, the cost is minimal, especially when compared to long-term benefits. When BMP's are in use, soil and water essential to crop production are being protected for the future.