7.0 SOIL MANAGEMENT

This section provides useful information on the characteristics of soil and important soil management practices.

What Is Soil?

The four main components of soil are mineral and organic matter, air and water. A well structured soil will have as its components approximately 45% mineral matter, 25% air, 25% water and 5% organic matter.

Mineral Matter

Mineral matter refers to the proportions of sand, silt and clay particles which make up the mineral component of soil. Soil texture is described by terms such as sand, sandy loam, clay loam and clay. Approximately 95% of all soils in this province are sandy loam meaning high in silt and sand but low in clay.

Soil structure refers to how well soil particles are organized and held together as soil crumbs or clods. Soil structure is important in that it influences:

- water movement through the soil;
- the resistance of soil to erosion, crusting and compaction;
- aeration; and,
- development of a good root system and nutrient up-take.

Organic Matter

Organic matter is a mixture of naturally occurring materials such as roots, leaves, decayed plant parts and microorganisms. It is important to soil fertility and ultimately, good yields. Humus, the relatively stable component comprising about 80% of all soil organic matter helps the soil store water and nutrients and reduces erosion.

The optimum amount of organic matter in the soil is a difficult question because of the variability of soil systems. It accounts for less than 5% of soils in other agricultural areas. Undisturbed soils in Newfoundland contain, on average, 11-19% organic matter (duff layer incorporated). Cultivated soils range from 4% in the central region to 5% (Western) and 7% in the Eastern region. (Source: Soil Organic Matter, J.B. Whalen, Soils Specialist, Agrifoods Branch, Newfoundland and Labrador Forest Resources and Agrifoods.)

Air and Water

The amount of air and water in the soil is referred to as soil porosity. Since large particles such as sand create larger pores than do smaller particles (such as in clay soils), water erosion is not as major a problem as in other provinces.

Maintaining Soil Structure

Many production practices can have a negative impact on soil structure. Excessive tillage and harvesting operations can cause soil compaction problems, reduced water infiltration rates and erosion.

Soil Compaction

Many soils in the province have naturally occurring compacted layers usually at depths of about 50-60 cm (20-24 in). It is difficult to break up these compacted layers. Tillage and cultivation tend to break down soil clods and organic matter. At the same time, production of high-quality horticultural crops requires careful attention to the timing of various crop management procedures. Sometimes, this means tilling, spraying or harvesting on soils that are too wet. Running heavy equipment in wet conditions may cause soil compaction, where the soil has become compressed and pore spaces reduced. This limits the soil's ability to hold air and water. This problem is more pronounced in shallow soil conditions.

You can reduce soil compaction by the following practices:

- avoid working on wet soils;
- never use deep tilling or subsoiling without first consulting with a soils specialist;
- reduce the number of trips over a field;
- limit traffic to certain areas or rows and use the same travel lanes each year;
- use four wheel drive tractors;
- keep the weight on an individual axle to below 5 tonnes;
- where and when possible, use trailers with tandem wheels;
- use radial tires where extra traction is needed; and,
- practice good crop rotations using deep-rooted crops or cover

crops.

While tillage and crop roots usually break up shallow or surface compaction, deep compaction requires special consideration. A combination of natural and production processes can help in combating this problem. These include:

- Frost. Research in other areas shows that frost takes at least three winters to reduce soil compaction, assuming that no further compaction has taken place.
- Using deep-rooted crops.
- Deep tillage or subsoiling can be used for the worst areas. Please note, that subsoiling is only a temporary solution and does not remove what caused the compaction in the first place. Consult with a soil specialist before subsoiling.

Potato production is particularly hard on soil structure. To counteract this, try to rotate out of potatoes for at least one year and use cover crops to protect the soil. This is important since compaction can lead to soil crusting, reduced plant emergence and the occurrence of misshapen potatoes.

Reduced Water Infiltration Rates

Generally, water infiltration (the penetration of water into the soil) is good in this province. Infiltration rates can be increased in problem areas by increasing the organic matter in the soil and reducing compaction.

7.1 MAINTAINING SOIL ORGANIC MATTER

Organic matter is a small but very important portion of the soil. Cool and wet climates reduce the amount of oxidation in the soil thereby maintaining high levels of organic matter in the soil. Maintaining adequate soil organic matter levels is crucial to consistent production of horticultural crops. Excessive tillage, soil erosion and poor crop rotation speeds up the loss of organic soil matter. Good practices for maintaining and improving organic matter include:

- practicing good crop rotations that return a variety of residues to the soil;
- underseeding rotational cereal crops (cereal crops are grain crops used for food such as rye and wheat) with either clover or alfalfa if vegetable crops are to be planted after the cereal;
- using winter cover and green manure crops to add plant material to the soil;

- reducing tillage where possible;
- keeping tillage shallow to prevent organic matter dilution;
- adding organic material such as manure, compost, peat, etc.;
- maintaining proper soil pH; and,
- reducing erosion losses.

Crop rotation provides several other benefits:

- it limits the build-up of disease organisms in the soil;
- crop rotation interrupts the life cycle of insects and diseases; and,
- it provides the opportunity to apply a broader range of herbicides to a parcel of land which will prevent the build-up of specific weeds or resistant strains of weeds.

7.2 PREVENTING SOIL POLLUTION

Applying pesticides, manures, and inorganic fertilizers to horticulture crops can potentially pollute soils. It is important to understand how these practices can lead to soil pollution and to minimize this potential by using accepted farm practices.

Pesticides

It is important to follow the manufacturer's recommendations for all pesticide products. Most pesticides are organic compounds which are broken down in the soil by physical, chemical and biological processes and by micro-organisms. Regularly using certain pesticides (such as some herbicides) may leave residues which take several years to break down. Under Newfoundland and Labrador's climate soil conditions, most pesticides take longer to break down than in the rest of Canada. This is important for crop rotation strategies.

Manure

Over-application of manure to soils can result in the build up of nutrients such as phosphorous, potassium, nitrates, nitrites and ammonia. High concentrations of manure are toxic to plants. A prolonged over-application of manure can lead to an imbalance in the soil chemistry which will result in reduced crop yields. When concentrations become too high, groundwater can be affected. After one year of manure application, grasses, root crops or some type of flora must be planted to take up the nutrients applied to the soil. The level of manure application can be determined through analyzing

the soil and manure and then matching these results with the requirements of the crops to be grown (see the documents, Farm Practice Guidelines for Livestock Producers in Newfoundland and Labrador" or " Farm Practice Guidelines for Poultry Producers in Newfoundland and Labrador" , for a method to calculate manure application rates).

The timing of manure spreading throughout the year is important. Manure will gradually decompose in the soil zone. As decomposition occurs, nutrients from the manure become available for use by the plant. These nutrients, however, also become susceptible to losses through leaching or runoff depending on the weather and soil conditions.

Spring may be the best time to apply manure, since the crop will be able to use the nutrients as they become available. Soil compaction can be a problem in spring, however, since the land is often too wet to handle the heavy wheel loads involved with certain types of spreading methods.

Winter is the least desirable time for manure application, since nutrient loss can be high and the potential for runoff is the greatest. Currently, producers are advised not to spread manure on frozen or snow covered ground.

Inorganic Fertilizers

Increasing amounts of inorganic fertilizers (chemical fertilizers that are either mixed or manufactured) are being used in the production of horticulture crops in Newfoundland and Labrador. The benefits of using inorganic fertilizers include consistent analysis and ease of handling.

You must ensure that elements found in commercial fertilizers do not accumulate in the soil to high concentration levels. Base the amount of inorganic fertilizer used in your operation on soil analysis and follow recommendations for fertilizer use.

7.3 PEATLAND FARMING (For further information, see Management and Conservation Practices for Vegetable Production on Peat Soils, Eastern Canada Soil and Water Conservation Centre, May 1997.)

Bog farming is increasing in Newfoundland and Labrador partly because of limited mineral land base. Peat soils are used to grow a variety of vegetables, cranberries, forage crops, sod or used as pasture land across Newfoundland and Labrador. Peat soils are very high in organic matter (from 30% to 98%) and require extensive drainage when used for agricultural purposes. Careful attention must also be paid to loss of organic matter and the possibility for the accumulation of contaminants from production practices. As a grower you must be aware of specific conditions that may affect both production and potential environmental problems on peatland. For specific information on production practices or drainage requirements contact the Soil Drainage Specialist.

Many herbicides are not effective when used on peat soils because of the high organic matter content. The organic matter acts as an absorptive surface whereby the herbicide is bound up and unable to kill the weed.

7.4 EROSION CONTROL

Highly productive land is valuable in Newfoundland and Labrador. In many areas, the supply is limited. While water and wind erosion are not major concerns in most areas of this province, it is important for growers to understand that erosion can remove nutrients, other crop inputs, soil and organic matter from the land. Crops may be damaged or stressed by erosion, increasing the possibility of disease.

There are a variety of water and wind erosion control measures that can be used in horticulture operations facing erosion problems:

- the use of cover crops to protect the soil surface and maintain soil structure;
- tillage and residue management where some crop residues are left to protect the soils;
- strip cropping involving planting strips or sections of a field with crops having different growth habits to better protect the soils surface; and,
- the use of structures such as earthen berms or terraces (water control), windbreaks and wind barriers (offer wind control by reducing the speed of the wind and reducing its ability to carry soil).

Cover Crops

When soil is left bare, the potential for soil erosion, nutrient leaching and run-off is increased. Undesirable environmental effects such as siltation of water ways and fertilizer (nutrient) contamination of water bodies can occur. Nutrient contamination of water bodies increases the growth of aquatic plants and algae which lowers the oxygen levels in the water. This is in turn harmful to fish and other aquatic organisms. High nitrates in drinking water can cause potential health problems, especially in children.

Cover crops can be used to help control erosion, especially where vegetable or other row crops are grown for long periods of time. Cover crops also help tie up excess nutrients, add organic matter and improve soil tilth. A variety of cover crops are available. Some are suited for specific uses and therefore you must know what you want from a cover crop when making a selection.

Good cover crops for Newfoundland and Labrador include oats, annual ryegrass and fall rye.

1) Oats. This crop can be planted during spring to early summer at a seeding rate of 136 kg/ha (120 lb/ac) and in soil with a pH of about 6.0. (If potatoes are to be grown in rotation, the pH should not be raised above 5.8.) A general fertilizer recommendation is 340 kg/ha (300 lb/ac) of 17-17-17. Please note, a representative soil sample should be tested and the recommended fertilizer treatment followed. Oats can then be ploughed into the soil the following spring. This cover crop can also be used for animal feed or mulch for strawberries.

2) Annual Ryegrass. Spring and early summer is the best time to seed annual ryegrass as a cover crop. Annual ryegrass can be seeded until early August for erosion control but successful establishment may be hampered by lack of moisture after seeding. Annual or cereal rye is usually the best cover crop used in conjunction with long-season vegetables since they grow well in cooler weather.

   Generally, ryegrass requires about 340 kg/ha (300 lb/ac) of 17-17-17. The pH of the soil should be at least 6.0. Since ryegrass is a heavy feeder, topdressing with nitrogen during the growing season may be required.

   Italian ryegrasses and the leafy Westerwolds ryegrass Promenade produce a large root mass which averages about almost 12 tonnes/ha (5 tons/ac) of dry matter in the seeding year. Aubade, Barspectra and Marshall Westerwold ryegrasses produce about 7 tonnes/ha (3 tons/acre). Seeding rates for diploid ryegrass such as Marshall are about 23 -28 kg/ha (20 to 25 lb/ac). Tetraploids such as the Promenade, Barspectra and Aubade varieties require about 28 - 40 kg/ha (25 to 35 lb/ac).

3) Fall Rye. This grain crop makes an excellent cover crop and can be plowed down as a source of organic matter. It can be grazed late in the fall or early spring, or left to mature and be harvested as a grain crop the following year. The straw can also be used to mulch strawberries. Fall rye can also be seeded in late August and early September at a rate of about 125 kg/ha (110 lb/ac).

   A general fertilizer recommendation would be about 565 kg/ha (500 lb/ac) of 10-20-20 at seeding and then topdressing the following May when growth starts with about 280 kg/ha (250 lb/ac) of 34-0-0. The soil pH should be 6.0.

Contact a crop specialist for more information about using cover crops in your horticulture operation.

Tillage and Residue Management

Crop residues left in the field are beneficial in that they:

- protect the soil from impact of raindrops and the resulting movement of soil particles and crusting; and,

- act as small dams or windbreaks slowing the movement of wind and water across a field and reducing their ability to carry soil.

To protect soils, leave at least 20% residue cover in the field.

Strip Cropping

Strip cropping involves planting alternate strips of early vegetables with late-seeded vegetables to provide better soil protection. Although management may increase, the soil surface is better

protected.

If a field is particularly prone to wind erosion, broadcast oats or barley prior to planting vegetables. This will help to shelter the seedlings and can later be controlled with a timely application of contact grass herbicide before the cover crop competes with the vegetable.

Erosion Control Structures

These structures are often used in field crop production. They include earthen berms and terraces for water control, and a variety of wind barriers to control erosion such as tree windbreaks, grass strips or fence-like materials to protect vegetables. The area protected by a tree barrier is usually about 10 times its height. The amount of protection offered by other structures depend on their height and flexibility. For example, grass wind barriers are more flexible and can be pushed down by high winds, reducing the protection distance to about five to seven times the barrier height.