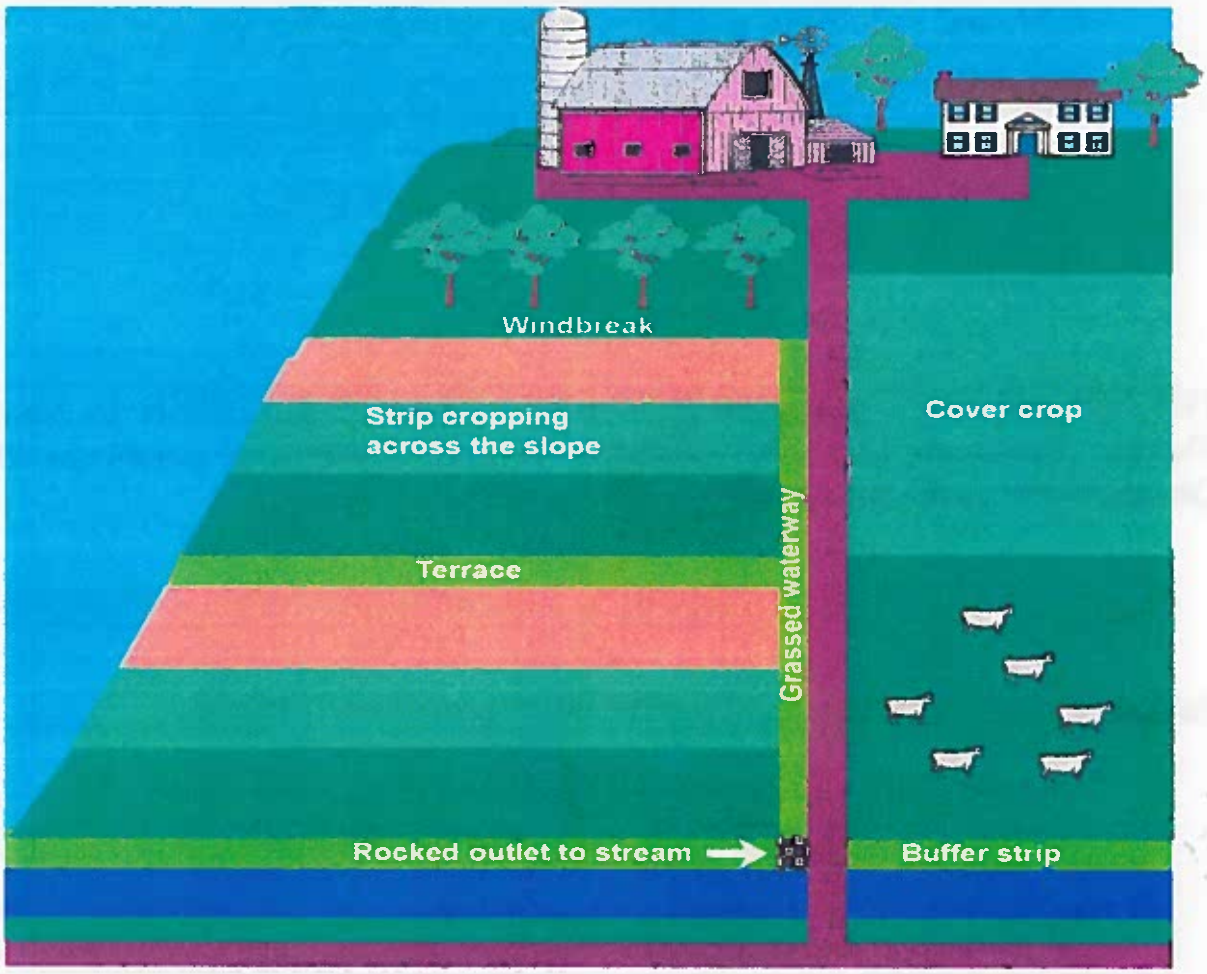
Soil Conservation in Nova Scotia

Problems, solutions and innovative practices for the farmer



Prepared by the Nova Scotia Soils Institute

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Problems, solutions and innovative practices for the farmer

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INTRODUCTION

Soil is the most important resource on which agriculture is based. Proper management of this valuable resource is vital to sustain long-term agricultural productivity. The Canada/Nova Scotia Soil Conservation Program was initiated in 1991 to encourage the implementation of sustainable soil resource management. In 1993, a soil conservation specialist was contracted for a two-year period to promote soil conservation and coordinate appropriate on-farm demonstration projects under the guidance of the Nova Scotia Soils Institute. Initially, an inventory was conducted of on-farm soil degradation problems encountered throughout the province by farmers and agricultural specialists. After identifying the problems, a program of proven soil conservation practices suitable for Nova Scotia was designed. These practices were promoted through reports, articles, presentations, tours, farm visits and on-farm demonstration projects.

Consultation between farmer and extension specialist on the best solution to the erosion problem.

This booklet gives a description of the soil conservation practices suitable for Nova Scotia. It also gives a summary of the demonstration projects initiated, the location of the projects for parties interested in seeing the soil conservation practices working on the farm, and gives sources of reference material and contacts for those interested in acquiring additional information or wanting to implement a soil conservation practice on their farm.

SOIL DEGRADATION IN NOVA SCOTIA: Problems and Causes

Soil degradation has been said to be non-existent in Nova Scotia, and for the 60 to 70 % of agricultural land in forage production, this may be true. But for those areas of the province under intensive row crop production, the potential for soil degradation is high. Soil degradation occurs when the soil begins to lose its productivity, whether through erosion, soil structure deterioration or other causes, which will be addressed in this manual.

Soil Erosion

Rill erosion between rows of strawberries.

There are three types of soil erosion: water, wind and tillage erosion. Water erosion can occur uniformly in a field due to the beating action of raindrops on bare soil (it is called sheet erosion), but is most commonly seen as rill erosion. Gully erosion is the extreme form of water erosion, and usually produces a channel too deep for machinery to cross. The tolerable limits of soil erosion vary from 2 to 10 t/ha/yr, depending on the site. Beyond these limits, soil is being lost at a greater rate than can be regenerated through the slow natural processes of soil genesis. This means an irretrievable loss of topsoil. For example, some fields in New Brunswick and Prince Edward Island have been abandoned because they have lost all their soil, and are down to the bedrock. A good rule of thumb is, if there is rill erosion in a field, soil loss is occurring at a rate greater than the tolerable limit. It is then time to intervene with a soil conservation plan.

Gully erosion through a potato field. Hay bales are not very effective at stopping erosion.

Wind erosion is a major problem in the prairies, and everybody has heard of the "dust bowl" of the 1930's. In a less spectacular way, wind erosion does occur in Nova Scotia when wind meets poorly structured bare soils. This process has been aggravated in general by the removal of hedgerows and the consolidation of small fields into bigger ones.

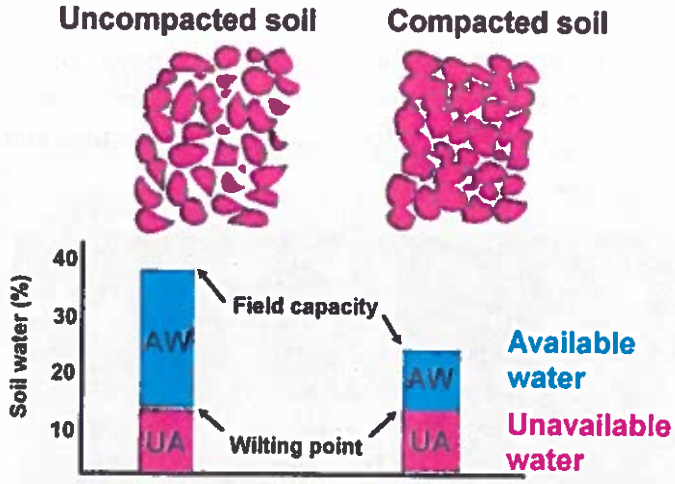
Wind erosion in progress on a bare field in the winter time.

Tillage erosion is the most insidious type of soil erosion, and it occurs when soil particles are moved by machinery on a slope. Gravity pulls these particles down the slope, and much more so when tillage is performed up and down a slope. One symptom of it is lowered productivity on knolls in the field.

Soil loss is not only a problem for the farmer, with the loss of organic matter and clay particles (the most fertile part of the soil), it is also an environmental problem. Siltation of streams causing loss of habitat for fish spawning is a common consequence of soil erosion, and there are many others. Soil erosion is then a double-edged sword, causing loss of productivity in the field and siltation of ditches, waterways and reservoirs.

Deterioration of Soil Structure

Ideally, the soil should have a good proportion of macropores and micropores. The macropores provide rapid internal drainage and good aeration to plant roots. Micropores retain moisture which remains available to the crop after excess water has drained away. The best type of soil structure for good porosity is granular. But this type of structure is not common in soils under row crop



Uncompacted soil has more pore space and available water for crop use than compacted soil.

production. Degradation of soil structure is due to repetitive tillage, loss of organic matter and lack of biological activity, which both act as binding and stabilizing agents in soil aggregate formation. The problems that can follow deterioration of soil structure are: crusting, compaction and waterlogging, depending on the type of soil. These problems are common in areas of the province where intensive row cropping is done, as was seen in the Great Village soil profile studies in 1993, which are described in the section "Soil Degradation Observed in Nova Scotia in Various Productions". Deterioration of soil structure makes the soil more susceptible to erosion. In Ontario, most of the compaction in the fields occurs during the first pass by machinery in the spring, when the surface might be dry but the soil underneath is not dry enough. There is certainly a lot of

Harvesting corn during wet field conditions can lead to rutting and soil compaction.

pressure on farmers to get their field operations started early, but this should be resisted for preservation of the soil structure in Nova Scotia especially, because of our higher rainfall.

Loss of Organic Matter

Organic matter plays an essential role in soil structure, the soil's ability to withstand traffic and its fertility. It is also the primary source of energy for soil organisms. Tillage causes oxidation of organic matter by mixing soil with air, therefore it is a major cause for loss of organic matter. Organic matter must be replenished by regular additions, and rotations with forage plants. The worst cases of depletion of organic matter occur in tobacco and vegetable production in the Annapolis Valley. This is due to intensive tillage, lack of organic matter and rotations lacking forages. Loss of organic matter results in weaker soil structure.

"Erosion" of Biological Activity

Soil erosion, loss of organic matter and structure deterioration contribute to a reduction of biological activity in the soil as well as the diversity of soil organisms. This diversity is necessary to maintain a balance between the pest soil organisms and the beneficial organisms. There is a lot to gain in avoiding erosion of biological activity. For example, very active earthworm populations may increase the rate of water infiltration three to four times through their channels and burrows. Secretions from earthworms and other soil organisms act like glue to hold soil particles together. Many soil micro-arthropods and fungi destroy harmful nematodes. Good organic matter management is necessary to ensure better diversity of soil life. Many pesticides are harmful to soil life. Without the soil organisms, there would be no recycling of nutrients from plant residues and organic matter, and the availability of macro and micronutrients essential to plant growth would be drastically reduced.

Symptoms of Soil Degradation

Field symptoms which may indicate soil degradation problems are:

- water ponding on the surface of the soil
- soil erosion (rills and gullies)
- poor or uneven crop growth
- increased fertilizer requirements
- increased tillage requirements because of a "hard soil"
- crops not tolerant to common temperature and water regime stresses
- hedgerows higher than the bordering field, silt filled ditches, muddy water running into streams

The most difficult symptoms to recognize are sheet and rill erosion. By the time a gully forms, there has been a lot of undetected erosion already taking place.

Generally, most fields which receive several passes of secondary tillage each year, are tilled when wet, do not receive organic matter additions such as manure or lack cover crops in the rotation, will

The soil profile on the left has good soil structure with no compacted layer. The soil profile on the right has a plow pan below the dark topsoil, a waterlogged B horizon (light brown soil) and a compacted subsoil (greyish with smooth shovel marks).

Blueberry production

There is no tillage in blueberry production, but a network of bare ground patches on very hilly land which leads to water erosion. The use of herbicides has removed the vegetative cover needed to reduce erosion and the layer of humus that is conducive to the growth of blueberry rhizomes. A survey in the summer of 1993 showed that most fields in Colchester and Cumberland counties showed serious soil erosion, well above tolerable limits threatened the spread of blueberry plants in the field. Providing more soil cover is the only way to reduce the erosion problem, and a factsheet entitled "The Control of Soil Erosion in Blueberry Fields" is available at the Plant Industry Branch, N.S.D.A.M. located in Truro.

Apple and small fruit production

In the establishment years, when clean cultivation is done between the rows, rill erosion is common where rows run up and down the slope. Compaction occurs also, especially when erosion has occurred and machinery operations are performed when the soil and subsoil are too wet. Both compaction and erosion problems lead to more compaction and erosion, and must be prevented with a soil conservation plan.

Soil degradation has always existed, but it has been accelerated by large field mechanization and continuous row-cropping. Farmers in Nova Scotia may know about their particular soil degradation problems, and how it increases the soil's requirements for tillage and fertilization, but they may not know that these problems also reduce the productivity of their land, and its potential monetary value for agricultural purposes.

Conservation Tillage

Conservation tillage is "any tillage system that reduces loss of soil or water relative to conventional tillage" (Carter, M.R., 1994). The range of conservation tillage practices is enormous and can go from just changing the timing of tillage (eg. fall to spring plowing) to the use of a chisel plow, to no-till practices. But the goals remain the same: to reduce soil erosion and prevent contaminated water and sediments from making their way into the waterways.

Chisel plows with sweeps, when used when the soil is dry, will shatter the entire soil profile and leave most of the crop residue on the soil surface.

The aim of most conservation tillage practices is to leave as much residue from the harvested crops on the soil surface as possible to reduce erosion. Research has shown that spring tillage that leaves residue coverage of 35 % can reduce erosion by 19 times compared to fall plowed land with less than 3 % residue. The type of tillage equipment and how it is used (operational speed, depth and timing) determine the amount of residue cover remaining on the soil surface. For instance, moldboard plows bury almost all of the residue left from the previous crop while chisel plows may leave 50 % or more of the residue on the soil surface depending on whether the plow is equipped with sweeps, points or twisted shovels.

There are a few farmers in Nova Scotia that have experimented with conservation tillage. Bidolosy Farms and Baybend Farm in Old Barns, Colchester County have used reduced tillage with corn production for the past several years.

In barley production on Upland Soils

In 1994, Baybend Farm tried four tillage operations before seeding barley into the different residue levels left by the various tillage practices. The field has a Truro soil (sandy loam) on slopes ranging from 4 to 15 %. Silage corn was grown on the field the two previous years. The four tillage methods were:

- mulch tilled, disked once, then seeded

- disked once then seeded
- one pass with the coulter cart, then seeded on the second pass with the coulter cart-seeder tandem
- one pass with the coulter cart-seeder tandem.

The mulch tillage consisted of one pass with a chisel plow equipped with twisted shovels and coulters mounted in front. The coulter cart tillage equipment consists of a series of fluted coulters attached to a bar. This is mounted to the back of the tractor and in front of the seeder. The coulters disturb a slit of residue and soil in front of the grain drill to a uniform planting depth.

Residue counts and plant counts were collected to determine how the various tillage methods affected residue cover, and if this affected seed germination. Residue counts were taken with a line-transect cord method in each area of the field that had a different tillage system. This method consists of stretching a 50 foot cord with beads every six inches (a measuring tape can be used) diagonally to the direction of tillage and counting beads which have residue located beneath them. Plant counts were taken along individual rows for a distance of 50 cm.

Coulter cart with staggered fluted coulters that can be adjusted to provide narrow tillage of the right depth in front of the planter.

Residue levels and plant counts for the four tillage systems.

Tillage system	Residue levels (%)	Plant counts
Mulch tilled	24	18
Disked once	46	19
Coulter cart twice	50	24
Coulter cart once	54	21

As expected, the areas of the field that received the least amount of tillage had more residue on the soil surface. The section of the field that was mulch tilled had half the residue cover of the other tillage methods.

Residue levels left on the soil surface after one pass with the coulter cart (on the left) and after mulch tillage (on the right).

The high residue levels left by the disked and coulter cart treatments had no detrimental effect on plant counts or barley yields. It appeared that the coulters cut the residue and disturbed the soil to a uniform depth that was appropriate for planting. Soil conditions at the time of planting may affect the ability of the coulters to cut residue and soil. It should be noted that conservation tillage usually reduces soil moisture losses compared to conventional tillage and may increase yields in dry growing seasons such as 1994.

In barley production on Marshland Soil

Phillarik Acres Ltd., Amherst, tried several reduced tillage operations in 1994 on fields with winter wheat stubble. The goal is to seed 100 acres of grain on their formed marshland each year. But the cool, wet springs and slow natural drainage of marshland soils in this area produce very few workdays in which to prepare a seedbed and plant crops. Marshland soils are susceptible to soil clumping or rutting if tillage is not performed at the correct time. The three tillage methods used were:

- one pass with the Conser-tine harrow and seeded with the Great Plains drill
- no-tillage and seeded with the Great Plains drill
- one pass with the Conser-tine harrow and one pass of the coulter cart with the International disc opener seeder.

The Conser-tine harrow was designed for a minimum tillage application with a standard tine spacing of 10 cm and working at depths of 5 to 15 cm. It is designed to mix the residue from the previous crop with the coarse layer of top soil.

The barley was harvested on September 21 and there was little difference in yields among the three tillage methods. Phillarik Acres Ltd. was aiming for yields of 1500 kg/ha or greater from the minimum tillage and more than achieved that goal. The owners also reported that other fields which had no tillage and were seeded with the Great Plains drill looked better than the fields that were tilled before seeding. This may be due to the higher soil moisture associated with conservation tillage compared to conventional tillage which is important in a dry growing season such as 1994.

Barley yields for different tillage methods in 1994.

Treatment	Yield (kg/ha)
Conser-tine and GP drill	1958
No-till and GP drill	1839
Conser-tine and coulter cart with Int. seeder	1899

The reduced labour, increased soil organic matter content, improved soil structure and erosion protection provided by the extra residue associated with conservation tillage make it a very appealing alternative in seedbed preparation in Nova Scotia. More information on conservation tillage can be obtained by contacting Eric Bosveld, Plant Industry Branch, Truro or Jack van Roestel, Plant Industry Branch, Kentville. Field crop Best Management Practices booklets are available from the Plant Industry Branch. Two line-transect cords for measuring residue levels are also available from the Plant Industry Branch, NSDAM, Truro.

References

Carter, M.R., 1994. Conservation Tillage Workshop, Truro, N.S.

Dehaan, R., 1994. NSCP erosion monitoring project final report. P.E.I. Department of Agriculture and Fisheries. pp. 191.

Water management

Many soil degradation problems in Nova Scotia are associated with wet soils. The province has substantially more precipitation than evapotranspiration in the spring and fall and many of the agricultural soils have shallow, dense subsoils which slows internal drainage. Proper management of water movement through the soil and over the soil surface is a major step in controlling soil degradation. This can be accomplished by improving the internal drainage of the soil with subsurface drainage, and by removing surface water from the field with ditches, grassed waterways, terraces or surface inlets.

Subsurface drainage

Subsurface drainage removes the excess soil water which permits increased water infiltration and decreased water runoff and erosion. Subsurface drainage systems allow the soil to dry faster and the reduced soil moisture permits more field workdays for seedbed preparation and harvesting. Soil structure is improved in tile-drained fields by permitting field operations to be performed on dry soils which lessens the chance for soil compaction. The improved soil structure allows plant roots to penetrate more deeply into the soil which makes them more resistant to drought. There are four subsurface drainage contractors in the province and, at present, installation of drainage tile is subsidized by the Land Improvement Program which is offered through the Extension Engineering Department, N.S.D.A.M., Truro.

Surface drainage

Occasionally farmers complain that their tile drainage system is not working because there is water ponding on their field. In most cases the problem is not the drainage system at all but the sealing of the soil surface with fine soil particles. These fine soil particles are present because the surface soil aggregates are pulverized by excessive tillage and move to low areas in the field during rainstorms. To determine the reason for water ponding on your field, first check the drainage system outlet to see if it is damaged or plugged. If it is working properly then check the soil surface in the ponded area for a smooth, tightly packed crust that prevents the water from entering the soil. If the soil surface is not sealed then contact the drainage engineer at Extension Engineering, N.S.D.A.M.

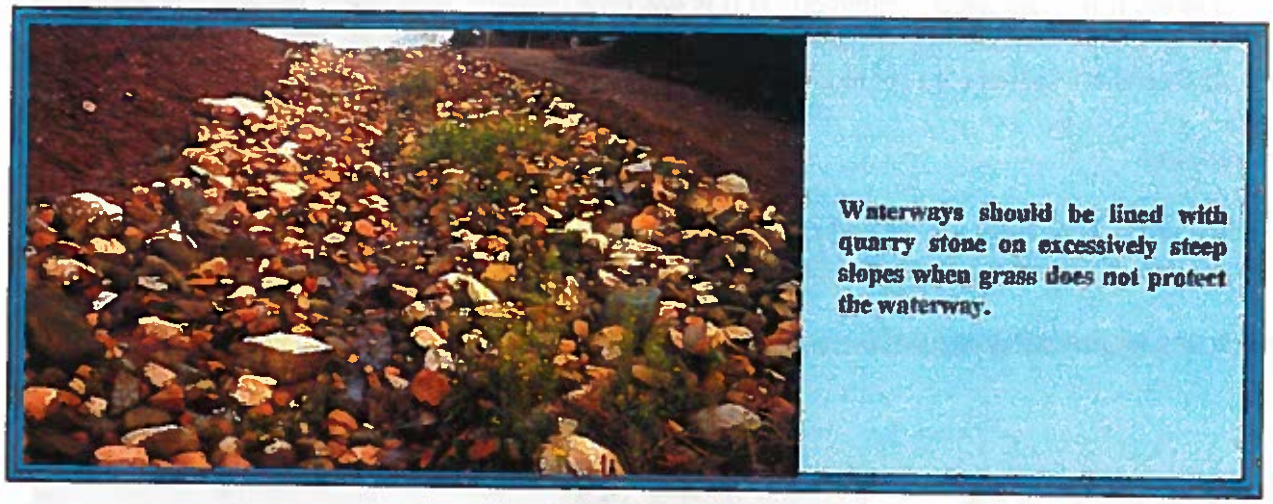
Waterways

Gully erosion is the most visible and extensively damaging type of soil degradation in Nova Scotia. Many fields that are not in permanent grass and have long slopes or steep slopes can experience

Grassed waterway to safely remove surface runoff water from the terraces to the base of the field.

gully erosion in depressional areas of the field on a regular basis. On many farms gully erosion is fixed each year by filling in the gully with the surrounding topsoil. After several years the crop grown beside the gully area is noticeably stunted compared to the crop in the rest of the field due to the depleted topsoil. Also the topsoil used to fill the gully has been disturbed and has little soil structure left and would easily erode in the future. These depressional areas should be shaped into wide, shallow channels and permanently grassed with a mixture of creeping red fescue, meadow fescue, Kentucky blue grass and perennial ryegrass at a rate of 110 kg/ha and underseeded to spring or fall cereal (depending on seeding date) at a rate of 70 kg/ha. It is also recommended to use erosion matting on the channel bottom of the waterway to prevent erosion while the grass is being established. The waterways can be shaped with graders, bulldozers or tractor hauled blades. Whether the farmer plans to construct the waterway or hire a contractor, it is a good idea to consult the provincial drainage engineer for information on waterway design and to see if funding is available.

On excessively steep or long fields, grassed waterways may not be sufficient to prevent erosion. In these cases the waterway should be stabilized with quarry stone which is larger than field stone and will not be washed away under high flow rates. The waterway should be lined with a geotextile before placing the rocks. Waterway outlets into watercourses should also be stabilized with rocks to dissipate the runoff energy and prevent disturbance of the stream bank and bottom.



Waterways should be lined with quarry stone on excessively steep slopes when grass does not protect the waterway.

Changes may be required in field management once a waterway is constructed. Tillage should be performed perpendicular to the waterway and the tillage implement lifted gradually when approaching the waterway. This will allow runoff water to enter the waterway and avoid water movement along the edge of the tilled field parallel to the waterway. Waterways should not be used as turning areas and traffic should be limited to avoid rutting. If a waterway becomes rutted it should be fixed as soon as possible.

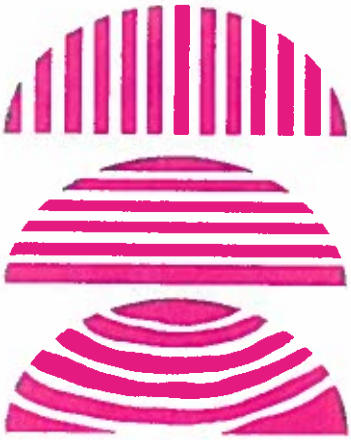
Another method of surface water drainage that can be used when waterways are not practical is

surface inlets. They are plastic or metal screened inlets which are positioned in low areas of fields where water collects. The water enters the screened inlet and is removed from the field through below ground piping. Surface inlets should be installed by drainage contractors and are more expensive than grassed waterways but take up less area in the field.

A surface inlet located in a catch basin will prevent runoff water from a road culvert from flowing across the field and causing erosion.

Cross-slope and contour farming

Cross-slope and contour farming is the practice of conducting field operations perpendicular to the field slope. Whether farming straight across a field perpendicular to the main slope or following along a contour, erosion rates can be reduced by up to 50 % compared to farming up and down the slope because runoff water is intercepted by ridges formed from tillage and crop rows. To implement farming across the slope, fields must be of sufficient width to permit efficient field operations. Fields should also have grassed waterways and headlands for turning machinery. If a field has a long slope, other soil conservation practices such as strip cropping or terracing may be required in addition to control soil erosion.



Tilling and planting across the slope or on the contour can reduce erosion by 50 % and decrease fuel costs.

Growing corn across the slope can reduce erosion by 50 % compared to farming up and down the slope.

Cover cropping and green manuring

Cover crops are planted to protect the soil from erosion and to enhance soil structure. A good example of that is the rye cover crop traditionally used to protect the soil after a crop of tobacco.

Green manures are grown and returned to the soil to add fresh organic matter, improve soil structure, or stimulate biological activity. For example, ryegrass may be included in a rotation with vegetables, and is incorporated into the soil before the next crop.

Both of these types of crops can be grown concurrently with a commercial crop such as a small grain, or grown after the commercial crop has been harvested, if the harvest is not too late. These techniques may prevent soluble nutrients from being leached out of the root zone by being taken up in the fall and stored into plant tissues. The nutrients will be subsequently released back into the soil after decomposition of these plant tissues, hopefully at a time when a crop is ready for nutrient uptake.

Nova Scotia farmers have been using these two techniques as they intensify crop production on marginal land. Many farmers have perfected a practice whereby a cover crop is grown by chisel plowing a field of grain 3 to 5 days after harvest. Grain that escaped the combine germinates and grows into a thick protective cover crop which is winter-killed but still provides adequate cover to prevent erosion.

Vegetable farmers may include ryegrass as a soil conditioner in the rotation, or grow a cover crop of fall rye if there is enough time after harvest.

Barley growth germinated by chisel plowing a field after grain harvest in mid-August.

Windbreaks

Wind erosion is most easily identified in the winter, when snow becomes covered with a reddish brown powder. Farmers in the Annapolis Valley have attempted to cope with this type of soil erosion by planting windbreaks and avoiding bare soil. Poplar windbreaks have their limitations because the lower trunk areas tend to be denuded, depending on the variety, and allow the wind to funnel through. They are also short-lived. Coniferous windbreaks have been planted more recently, but these run the risk of being too dense and causing unwanted wind turbulence in the field they are supposed to protect. Their needles also acidify the soil where they fall. There is one good example of a windbreak made of jack pine in the Annapolis Valley on Webster Farm Ltd. It consists of three rows and seems to have adequate porosity. The presence of this particular windbreak convinced the farmer to plant more windbreaks on his farm.

A good windbreak should have 40 % porosity in the summer to slow the wind rather than block it like a wall. This porosity should be uniform from the soil up to the top of the trees. This is most easily achieved by having a shrub component as well as a tree component with fast and slow growing species. The use of deciduous trees allows for more porosity in the winter time for a more uniform snow cover over the protected field.

Mulching in Blueberry Fields

Mulches are being used in some blueberry fields to control soil erosion from bare patches. Blueberry waste, wood shavings and sawdust are the main materials used. They are very effective, but must be replenished as the materials break down, and are labour intensive to apply. But they provide necessary humus as they break down, which the blueberry plants need in order to grow rhizomes and multiply.

Demonstration Projects

Demonstration projects were conducted on several farms throughout the province in 1993 and 1994. Their purpose was to make the farming community aware of soil conservation practices not presently used or under-utilized in Nova Scotia. The acceptance of these practices is accelerated when farmers see their neighbors using them productively.

Mulching

Mulching is the practice of spreading hay or straw on soils left bare after late vegetable harvest. It controls erosion by covering the soil surface to reduce soil particle detachment from the impact of raindrops and runoff velocity. Research has shown that mulching can reduce soil loss by a factor of 100.

Three sites were selected for demonstrations: Highland Village Farm, Highland Village, Colchester County, Eaton's Farm, Canard, and Dykeview Farms, Port Williams, Kings County.

Carrot field protection

On Highland Village Farm, mulching was done on a 1.5 hectare strip of the homestead field in 1993 and provided effective erosion protection. The application rate in 1993 was 5 t/ha which was difficult to plow under. On December 12, 1994, 4.9 ha were mulched on the eastern section of the field which had been in carrots with harvesting being completed on November 19. This area of the field was split in half with the eastern section receiving 4.5 t/ha and the western section 2.2 t/ha of hay which was supplied by the farmer. The normal and below normal hay application rates were used because the field was not overly steep (4 to 6 % slope) and would allow for easier incorporation of the hay into the soil.

Rill erosion across bare soil is stopped by hay mulched on the soil surface.

Carl Williams of Great Village was hired to hay mulch with his Haybuster Big Bale Buster. It took one day to spread 60 round bales over the field but the time could have been cut in half had hard core bales been available for use instead of soft centered bales. The weather was cold and windy with about 2 cm of snow on top of frozen ground. Mulching on top of a thin snow cover is not a problem.

Gully protection

At Eaton Farms, Canard, there was interest in controlling erosion in a 250 meter long gully which runs through the middle of the field located on the southern side of highway 341 about 2 km east of Highway 358. The field was in potato production in 1994 and was harvested in October then chisel plowed.

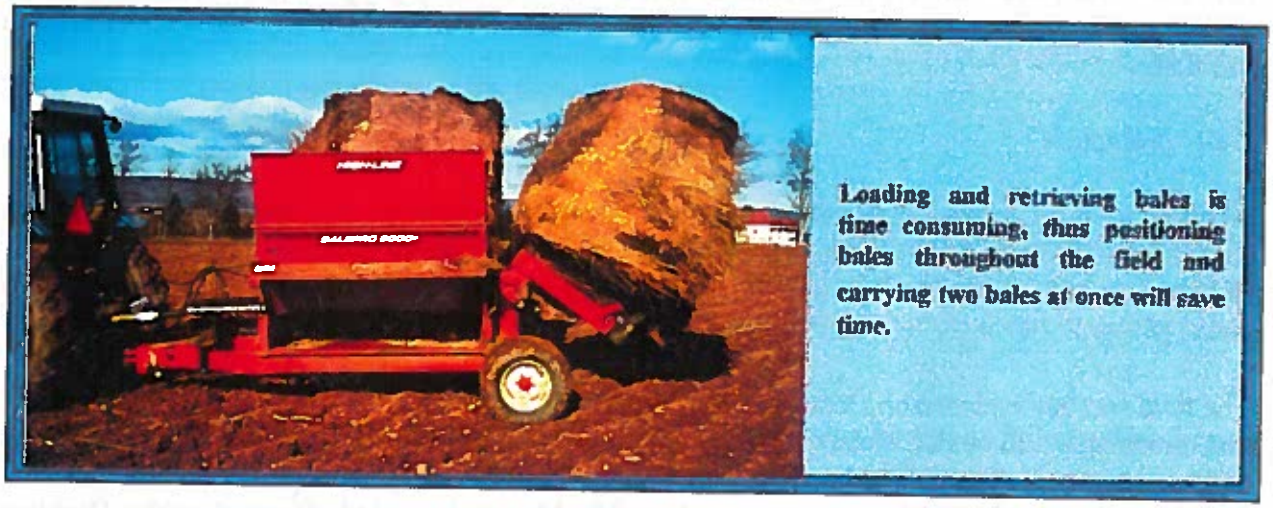
The field was hay mulched on December 1 on a clear, cold and windy day. The high winds dictated that mulching could be performed in one direction only. The frozen soil allowed for travelling up and down the gully without leaving wheel ruts which are very susceptible to erosion from concentrated water flow. Mulching was conducted by Morse's Farm Ltd., Berwick with a Highline

Hay mulching on a snow covered carrot field at rates of 4.5 (left) and 2.2 tonnes per hectare (right).

Balepro 6000+ round bale "bale buster". The machine is self loading and can carry an extra round bale while it mulches another. This is important because retrieving and loading the bales can take as much time as spreading the hay. Proper positioning of the hay bales in the field is also important for maximum efficiency.

The tractor, bale buster and custom operator charged $60 per hour for services. The round bales were supplied by the farmer and were soft centered bales which do not spread as fast or as evenly as hard core bales.

The hay was spread at a rate of 9 t/ha (4 t/ac) in the gully which is about double the normal rate used when mulching an entire field. It should be noted that hay mulching is not intended to prevent



Loading and retrieving bales is time consuming, thus positioning bales throughout the field and carrying two bales at once will save time.

erosion in gullies with large flows but may work well if the entire field is mulched which would reduce the flows. A grassed waterway is probably the best solution for this gully.

Steep sloped potato field protection

Dykeview Farms, Port Williams grew potatoes in the field located behind the packing warehouse on Church street about 1 km east of highway 358. Harvesting occurred in October and some soil eroded before hay mulching occurred on December 1. The weather conditions and the "bale buster" were the same as reported for Eaton's farm.

Ten or more hectares can be mulched in a day if tightly wound bales are used.

The eastern side of the field was mulched at a rate of 4.5 t/ha and the western side at 7 t/ha. The normal and above normal hay application rates were used because of the steep field slope (>8 %).

Cover Cropping

Selecting the correct cover crop depends on the farmers needs: how much ground cover will the crop supply, can the cover crop be harvested the next season, date of seeding and the importance of weed control, soil improvement and nutrient conservation. The following trials conducted in 1993 and 1994 were initiated to address some of these needs.

Fall rye and winter wheat before and after carrot harvest

Great Village (Colchester County) carrot farmers requested that some field trials be performed on their farms to attempt to find some practical solutions to the soil erosion problem. Two farmers volunteered to plant cover crops.

Fall rye and winter wheat on Mill Farm

Common fall rye and winter wheat (variety Fundulea) were broadcast with a Vykon fertilizer spreader onto the carrot tops at rates of 147 kg/ha and 155 kg/ha respectively, four days before carrot harvest, on Sept. 21, 1993. The same cover crops were also broadcast after carrot harvest in two more sections of the field, on Oct. 5, 1993. The earlier plantings had time to establish a more extensive root system than the later ones before winter. The cover was rather sparse in both cases and the seeding rates should probably be increased for a more effective cover against erosion. Fall rye had a better winter survival than winter wheat. The following spring, the fall rye cover was disced twice and planted into barley because of fall rye seed contamination.

Winter wheat on Folly River Farms Ltd.

Winter wheat (variety Fundulea) was drilled in a previously harvested carrot field after disking at the rate of 135 kg/ha on September 25 1993. Winter survival was poor, and the cover certainly did not provide sufficient protection against rill erosion. For better results, the cooperator felt that the wheat should have been planted at least one week earlier, and on a more level seedbed than that afforded by two passes of the disk harrow.

Oilseed radish on newly cleared land

Linden Hill Farm has been clearing land on their Beaverbrook, Colchester County dairy farm for each of the last twenty years or so. They have noticed that it generally takes several years before these new soils become productive. They were looking for a cover crop that would reduce soil compaction and improve soil structure on land that was recently cleared and decided to try oilseed

radish because it is a known soil conditioner. Its central taproot with many fibrous lateral roots are effective at loosening the soil.

The newly cleared field is very susceptible to erosion because of its great length and slope (6 %). A 2 ha section of the field was cleared, rock picked and deep chisel plowed by the end of July. This was seeded with a drill on August 5 at a rate of 18.5 kg/ha. The oilseed radish seeds are shaped like little ball bearings but still did not get to the outer drills very well and left a few bare patches in the field. Triple 17 fertilizer at a rate of 202 kg/ha and 4.5 t/ha of lime were applied to the field. The rest of the field was ready for planting in late August. Two hectares were seeded to oilseed radish and five acres to oats at a rate of 90 kg/ha on August 25.

Although soil conditions were very dry in August and September, the oilseed radish grew rapidly. The crop seeded on August 5 had to be mowed because it was going to seed. The mowed tops decomposed quickly to mush and offered little erosion protection. The oilseed radish planted on August 25 provided considerably more ground cover than oats seeded at the same time. The oilseed radish seed costs $3.21/kg and is not always easy to obtain. Seed must be ordered well in advance.

Ground cover provided by oilseed radish five weeks after seeding.

Inter-row Mulches in Strawberry Production

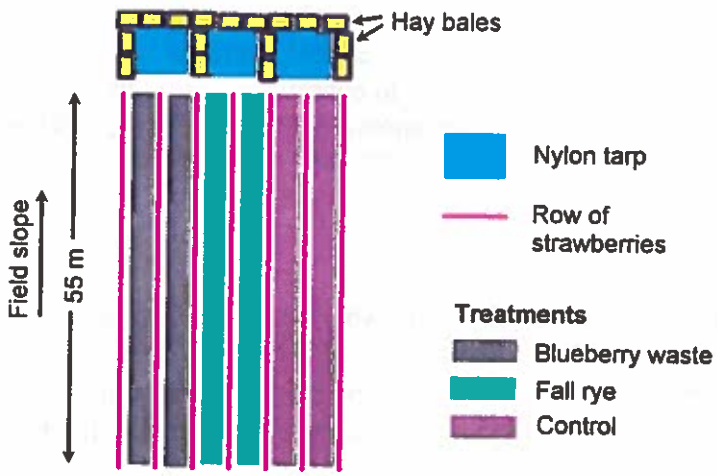
Rainbow Farms in Upper Rawdon, Hants County has been experiencing severe soil erosion on its best producing strawberry field. The field has a sandy soil and a slope ranging from 6 to 10 %. This spring a combination of rill erosion and gully erosion deposited soil to a depth of 15 cm over an area of 100 m by 30 m in the woods at the bottom of the field. The field was planted in strawberries up and down the slope this spring after the last strawberry plants had produced very well for 7 years. Rainbow Farms were interested in mulching between the rows of strawberries to save the soil. Cover crops are very effective at reducing erosion but some also have been shown to suppress weed growth, even as a dead mulch. Interplanted cover crops may also increase soil organic matter, water infiltration, reduce soil compaction, repel insects and act as a poor host to diseases.

Three treatments were:

- blueberry waste
- fall rye
- no cover (control)

These treatments covered the soil between the rows of strawberries only and the plants were covered with wood shavings in November for winter protection. Each treatment consisted of two rows 55 m long starting from the base of the hill. Erosion control evaluation will include visual inspection of the rows and sediment traps to get a quantitative measure of erosion. The sediment traps were constructed out of hay bales covered with nylon tarps. They were designed to collect the runoff water from each treatment and as the traps filled up with runoff water the sediment would settle out and the water would flow over the top of the hay bales.

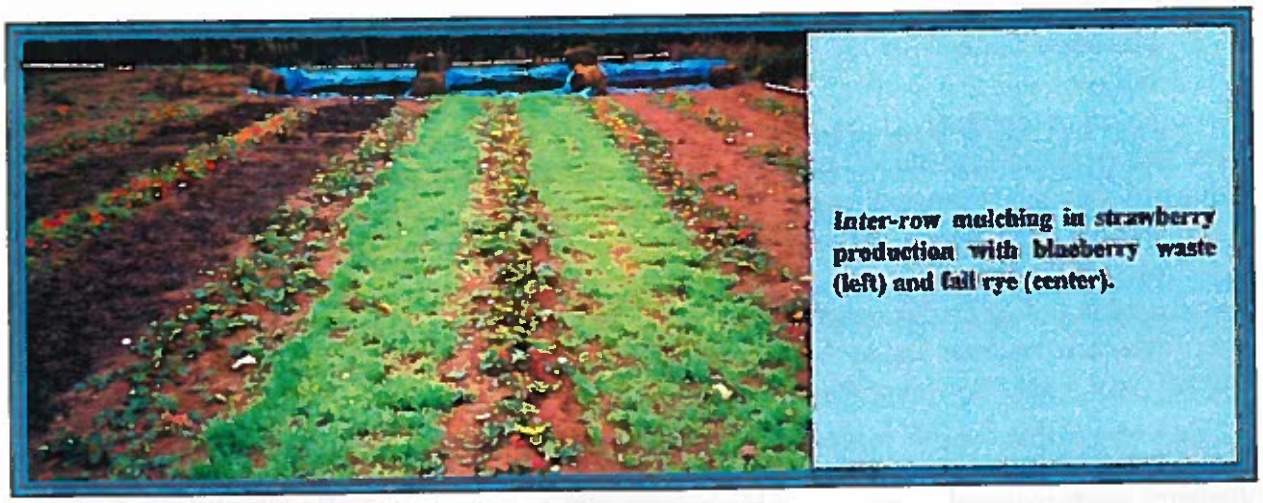
Rainbow Farms operation includes a blueberry receiving and cleaning station Several tonnes of blueberry waste material consisting of leaves, stems and small blueberries are generated from the cleaning operation. Approximately two cubic meters of blueberry waste were spread over the two



Layout of the treatments and sediment traps.

rows of the treatment. Half of the blueberry waste was fresh from this year and the other half was a year old and decomposed. It was decided to use the blueberry waste for mulching because of its availability in large quantities year after year. The mulch has the potential to increase disease (Botrytis) in strawberries and will be monitored. The fall rye was seeded heavily on October 4 and filled in quite well by snowfall.

On January 23, 1995 the site was inspected for erosion after two weeks of warm weather, rain and snow melt. There was some rill erosion visible on the control plot but no erosion was visible on the mulched treatments. Soil collected from the sediment traps showed that the control plot had 19 kg of eroded soil while there was no soil in the sediment traps at the bottom of the other two plots.



Inter-row mulching in strawberry production with blueberry waste (left) and fall rye (center).

The site will be examined in the spring to evaluate the erosion control effectiveness of the mulches. The site will also be monitored for weed populations and crop production. The fall rye can be killed with the herbicide Fusilade which is entirely safe to the crop or a permanent cover may be established. Another possible solution to control soil loss at the site would be to construct a terrace part way down the slope that would remove runoff water to the field edge and help alleviate the high runoff flow down the field.

References

Doohan, D. 1993. Weed control in strawberries with living mulches. Agriview. Vol. 3 (2).

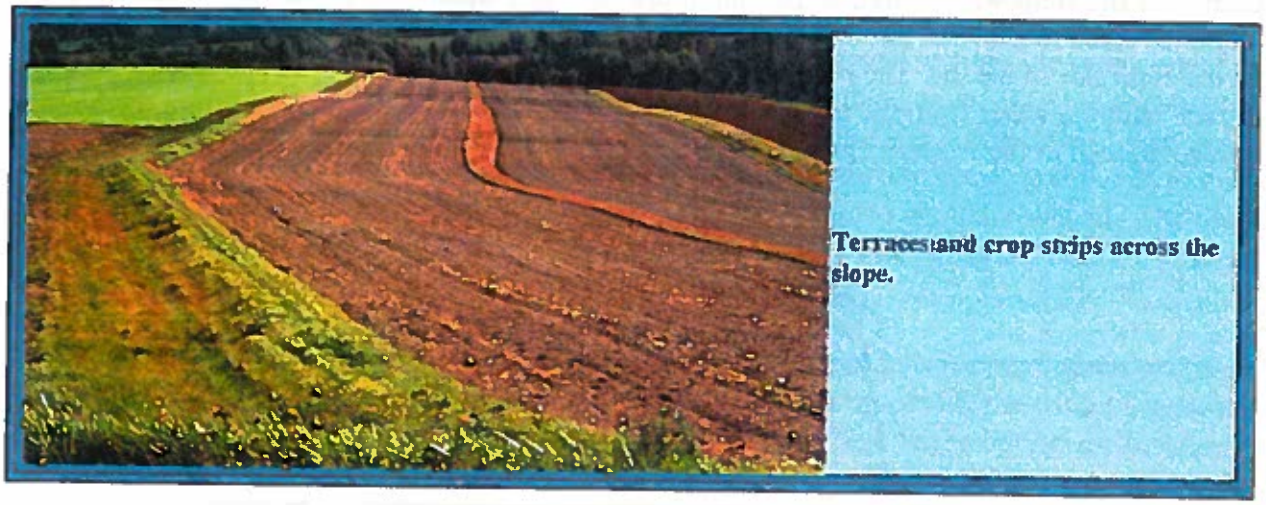
Pritts, M.P. 1992. Weed control in strawberries: some new approaches. Proceedings 1992 annual meeting North American strawberry growers association. Williamsburg, Virginia.

Strip cropping and terracing

Strip cropping and terracing are erosion control techniques that prevent soil loss by providing a crop cover, reducing the length of slope and safely removing runoff water from the field. These practices have been used in New Brunswick and Prince Edward Island for the past several years. Strip cropping consists of growing strips of grain and/or forage across a slope between strips of row crops. The plants or crop residues in the grain and/or forage strips increase water infiltration and reduce surface runoff flow over the strips of row crops. This is especially important when the soil is bare before row crop establishment or after harvest. The row crop strips will be seeded to grain and/or forage the following year which will add organic matter and improve the soil structure.

Terraces are shallow grass waterways with a berm on the downhill side which are constructed across

a slope to intercept surface runoff water moving down the field. The terraces decrease the slope length and remove the water safely from the field.



Terraces and crop strips across the slope.

Cole crop and grain rotation

A strip cropping and terracing project was conducted on Medford Farms Ltd., Medford, Kings County in the summer of 1994. Medford Farms purchased a 15 ha field and decided to make improvements to the land while it was fallow. The field has been an orchard at one time but the last section of apples trees was cleared in 1993 and recently most of the field had been used for potato production. Crop production had been limited by excessive wetness and a shallow (less than 30 cm), dense subsoil throughout the field. It was felt that a combination of tile drainage, strip cropping and diversion terracing would help remove excess water and prevent the remaining topsoil from eroding.

Design

A topographical survey was conducted at the site by the surveying staff of Extension Engineering, N.S.D.A.M., Truro. A plan was produced with field boundaries and contour lines which were used in the design of the strip cropping and terraces. Factors that influenced the design are: crop strip widths, number of strips before a terrace, field slope, field shape, outlets for runoff water and field access roads. The width of crop strips depends on the farmer's sprayer equipment. Medford Farms' sprayer covers a width of 12 m, thus crop strips must be 24 or 36 m depending on field slope. . On the top part of the field where field slope is 4 % the crop strips are 36 m wide and on the lower part of the field where slopes range from 6 to 12 % the crop strips are 24 m wide. There is a 1.5 % error factor added to the crop strip widths which makes the widths 25 and 37 m. The number of crop strips before a terrace depends on crop strip width and field slope. The maximum allowable slope lengths for field slopes of 4 and 12 % are 183 and 62 m respectively. The shape of the field and limited access by roads dictated that the crop strips would be parallel to the south west field

boundary. This would leave only the south east corner of the field with an irregular shape but easy access to this area would not hinder cropping practices. A group of small trees in the south west corner of the field was cleared to provide more land and square off the field. Medford Farms requested that a road be left through the middle of the field that led to a bridge to access the fields on the north side of the site. The road was constructed on the crest of the field and bisected the top terrace with the water from the terrace draining to each side of the field. Water from the bottom terrace drained to the western end of the field.

Field plan showing field contours, crop strips, terraces and grassed waterways.

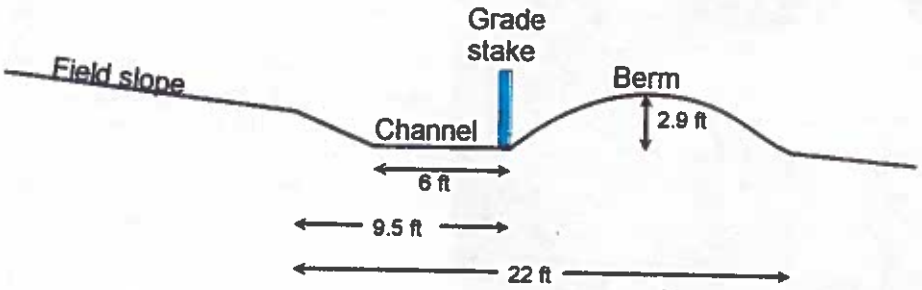
Plans of tile drainage that were installed at the site in the early 1980's were put on to the field plan and were used to determine areas that would receive the proposed amount of tile drainage. In early August, Corkums Land Drainage installed approximately 3050 m of tile at 12 m spacings connected to the existing drainage systems in the top section of the field. Medford Farms Ltd. received a Land Improvement Grant that reimbursed 50 % of the money invested in tile drainage, grassed waterways and terracing up to $10,000. The grants are subject to change from year to year.

Construction

Terraces

Terrace locations and grades were set by the surveyors. G.K. Morse Trucking Ltd. was contracted to do the construction of the terraces, waterways and ditches with a grader. Terrace construction began by peeling away 10 cm of topsoil for 5 m on either side of the grade stakes. The grader started digging the channel just above the stakes with the spoil pushed to the downhill side to make the berm. This proceeded rather quickly until the grader encountered compact subsoil. The dense subsoil had to be removed in thin slices which slowed the process. A channel depth of 37 to 45 cm was required to provide enough spoil to make a berm 83 cm high.

The berm on the downslope side of the channel enables the channel to carry more water and avoid overflow problems encountered when the channel fills with ice and snow in the winter and spring. The berm was shaped with the grader. The topsoil was scraped back in the bottom of the channel



Schematic diagram of terrace cross section and dimensions.

and over the berm to provide a suitable medium for grass growth. The terraces were hydroseeded with the hydroseeder built and operated by the crew from Extension Engineering, N.S.D.A.M. in

Shaping the terrace berm with a grader. Notice the shiny channel bottom indicating where the grader was scraping the compacted subsoil.

Kentville. The hydroseed mix consisted of 61 kg/ha of N. S. Department of Transport seed mix, 56 kg/ha of fall rye, 45 kg/ha of soluble 20/20/20 fertilizer and 225 kg/ha of Cellumulch.

Grassed waterways

Grassed waterways were constructed at the eastern end of the top terrace and the western end of the bottom terrace to allow water to flow down to the bottom of the field without causing soil erosion or sediment loading in the brook. Waterway construction consisted of peeling back the topsoil for about 9 m and digging a level channel bottom. The channel was about 2.5 m wide and 0.3 to 0.5 m deep. The sides of the channel were sloped and the topsoil was placed on the channel bottom. The waterway was hydroseeded and a jute erosion mat made by PEI Bag Company was installed

Waterway with grass growing through the erosion mat layed out and stapled in the channel bottom.

along the channel bottom. Laying out the erosion mat was made easier by hauling the bundle around on a tractor. Three rows of matting were layed out with each row overlapping the other by 10 to 15 cm. Each row of matting was held in place by 5 staples placed across the 1.2 m wide matting at 3 m intervals. The beginning of the erosion mat was buried at the top of the waterways where the waterways joined the terraces.

An interceptor ditch was dug at the south western side of the field and a ditch was dug along the western side of the field. An outlet for these ditches and the top terrace was constructed in a natural drainage area in the woods just west of the top terrace. This outlet was later stabilized with field stone picked from the farmers potato fields.

Costs

It was felt that grader time could have been reduced if the terrace and waterway areas had been tilled as if for a seedbed. A disc was used but there was lots of sod left which made it difficult when it came time to spread the topsoil back over the terraces and waterways. Terrace construction was

also slow because of hollow areas in the field where each terrace was constructed that required considerable time to fill in. A subsoil that was deeper than the channel depth of 45 cm or a less dense subsoil would have reduced grader time also as only thin slices of subsoil could be removed by the grader with each pass.

Design and construction costs of terraces and waterways.

Item	Amount	Cost ($)
Grader	43.5 hours	3044.68
Bulldozer	5 hours	275.00
Erosion mat	823 m long x 1.2 m wide	566.00
Hydroseed mix	400 kg	300.00
Field survey		50.00
Total		4185.68

In April 1995 the crop strips will be surveyed and marked by the Extension Engineering surveyors. Medford Farms plan to plant cole crops, grain and ryegrass in the crop strips in 1995. If conditions and technology allow, all crops will be no-till seeded. Medford Farms will look after the maintenance and occasional mowing of the terraces and waterways.

References

Atlantic Committee on Agricultural Engineering. 1992. Integrated erosion control on potato land in Atlantic Canada. ACAE publication no. 26. p. 15.

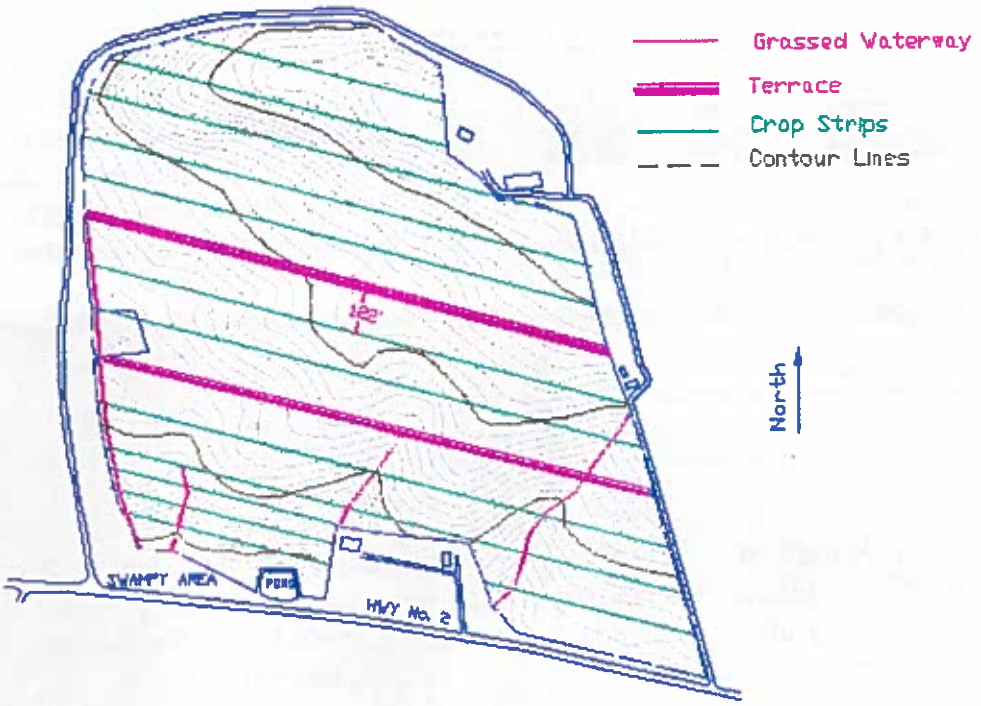
Canada-Prince Edward Island Agreement on soil and water conservation and development. Strip cropping and diversion terracing factsheet.

Carrot and grain rotation

Strip cropping and terraces were designed for a 22.7 ha field on Highland Village Farm in Highland Village, Colchester County. Carrots and grain are grown on the field which has slopes ranging from 4 to 10 %. Highland Village Farms plan to construct the terraces and switch to strip cropping in 1996 when there will be no carrots grown on the field. The field is long in the direction perpendicular to the main field slope so farming across the slope will be very efficient.

The direction of the crop strips and terraces is at right angles to the main field slope and parallel to

the field boundary next to the highway. This ensures that the maximum field slope in the direction of farming is less than 2 % and that the entire field is farmed efficiently.



Field plan showing terraces, grassed waterways, crop strips and contour lines.

The crop strip widths depend on the sprayer width (9 m) plus a 1.5 % error factor. The strips will be 37 m feet wide on all sections of the field except the southwest corner where slopes increase to 10 % and thus strip widths are reduced to 18 m.

The top terrace will be constructed less than 183 m (maximum slope length before a terrace with a field slope of 5 %) from the crest of the hill and the bottom terrace less than 122 m from the top terrace as the field slope increases below the top terrace. The top terrace and western half of the bottom terrace drain to the western side of the field where a grassed waterway along the western field boundary will safely remove water to the base of the field. The eastern half of the bottom terrace will drain into natural low areas in the field which will be grassed.

For more information on terracing contact Laurie Cochrane at Extension Engineering, NSDAM, Truro.

Windbreak Establishment

Benefits of Treed Windbreaks on Agricultural Land:

- Protection from wind damage for soil and crops: The area protected from wind damage is 10 to 15 times the height of the trees.
- Crop yield improvement: A properly planted windbreak improves the microclimate, pollination and yields.
- Enhanced snow cover in the fields: The use of broadleaved species in the windbreak allows a more uniform snow cover in the fields because of increased porosity after the fall of the leaves.
- A grid network of windbreaks, provides maximum protection for soils, crops, livestock and buildings

Grid network of windbreaks to provide erosion protection from the wind on bare soils.

A treed windbreak was established on Webster Farms, Cambridge Station to demonstrate a method of designing and planting windbreaks in order to prevent wind erosion on level farm land. The site chosen was 90 m long and used a simple but effective design consisting of one row of trees and one row of shrubs spaced 2 m apart. Native plant species suited to the sandy soil of the site were chosen because of their hardiness, low maintenance requirements and resistance to pests. These were:

- row 1: red pine (*P. resinosa*), red oak (*Q. rubra*), white birch (*B. papyrifera*)
- row 2: elderberry (*S. canadensis*), saskatoon berry (*A. alnifolia*), hazelnut hybrids (*Corylus avellina x cornuta*)

The shrubs were chosen for potential commercial fruit and nut production as well as for their suitability as windbreak species. At least two varieties of each shrub species were planted side by side to ensure pollination.

Small bare root and multipot stock was selected for two reasons:

- low costs, this type of plant material can be purchased for as little as $0.18/plant
- vigorous establishment, fast growth, and ease of planting.

Site Preparation

In the spring, as soon as the site was dry enough for tillage, it was tilled by the cooperator to prepare a planting bed. Compost was then spread over the two rows at a thickness of 2 cm and worked in lightly. The role of the compost was to provide slow-release nutrients for tree establishment and growth, as well as a source of organic matter for amending the soil. This could probably have been done more easily the previous fall when there was more time. The next step was to lay a black plastic mulch (1 mm thick) over the length of the two rows. A thick straw or hay mulch may also be used, but it would have to be raked away from the trunks in the winter time to avoid rodent damage, unless the trees are well protected with plastic or metal collars around their trunks.

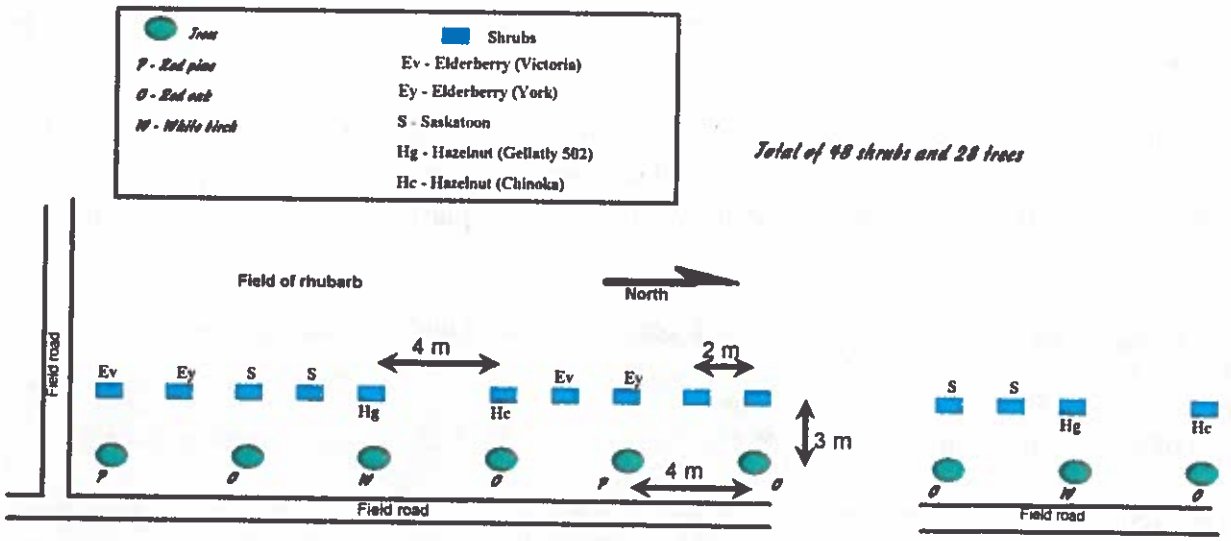
Plastic mulch was layed out over the compost before planting the row of trees (right) and row of shrubs (left).

Planting

Planting started on May 23, 1994. This was later than planned, due to some difficulties in getting all the plant material shipped on time. Ideally, planting should be finished before the plants break bud. The red oaks, the last plants to be received, were planted on June 3, 1994. The bare root stock was soaked in water for a couple of hours prior to planting. The plastic mulch was slit in a cross pattern every 4 m for the trees and hazelnuts, and every 2 m for the other shrubs. All plant material was planted in those holes, and then watered generously. A black geotextile collar was placed around the plants under the plastic to prevent weeds from growing in the planting holes. The special fabric allows water to percolate through. A cover crop was broadcast to a width of 0.5 m on each side of the plastic mulch and between the two rows. It consisted of the following mixture:

- 10% Sonja white clover
- 30% common red fescue
- 60% common Kentucky bluegrass

Replacement trees were planted in a nursery, at a quantity of about 15 % of trees in the windbreak.



Layout of the trees and shrubs at the site.

Maintenance Requirements

The windbreak plants should remain free of weed pressure for the first three years. Weeds will come up in the planting holes in the plastic, unless a collar is inserted around the base of the plant under the plastic mulch, and held in place by a shovelful of sand. Watering is important in the establishment year, and the plants should receive approximately 2.5 cm of water per week. The area between the rows and on each side of the rows (at least 0.5 m) should be cover-cropped for ease of maintenance, and this cover crop should be mowed regularly to avoid rodent damage in the winter time or the harboring of pests and diseases of fruit crops when the cover crops contain white clover. A tree collar can also be put around the base of the tree trunks in order to avoid girdling by rodents.

Costs

This is what it would cost a farmer to duplicate this method using bare root and multipot native plant material: 1) For 100 m of a two-row windbreak:

Item	Amount	Cost
Plant material	50 trees	32.50
Plastic mulch	100 m	18.00
Compost	6 m^3	60.00
Cover crop	0.88 kg	3.67
Total		114.17

Allowance for provincial tax and some replacement plant material brings the total cost to $127 per 100 m for materials only.

Material costs can be reduced by the use of well rotted manure instead of compost if a cheap local source is available. But more attention would be needed to control weeds in the planting holes. A plastic collar (30 cm^2) inserted around the plants under the plastic mulch would control potential weeds.

2) For 100 m of a two-row windbreak with commercial fruit and nut bearing shrubs:

- row 1: 25 trees x $0.65 = $ 16
- row 2: 50 shrubs x $8.92 = $446

rest of costs same as in option 1, therefore, total costs = $573 per 100 m for materials only.

The first planting of commercial shrubs can then be used as mother planting to propagate plant material to reduce costs for more plantings.

Conclusion

The trees and shrubs in this windbreak establishments site are treated like a crop, so that they will produce like a crop. This means careful soil preparation and amendment, weed control, cover cropping, and watering for the first one to three years. This ensures vigorous establishment and maximum growth, in order to obtain windbreak protection by the fifth year.

A list of suppliers of windbreak plant material can be obtained from Jeff Morton, Plant Industry Branch, N.S.D.A.M., Truro.

References

Tree Plan Canada. Natural Resources Canada 1993. Trees and the rural landscape.

The Tree Project. Windbreaks; trees and shrubs for crop protection.

Other Soil Conservation Techniques with Potential for Nova Scotia

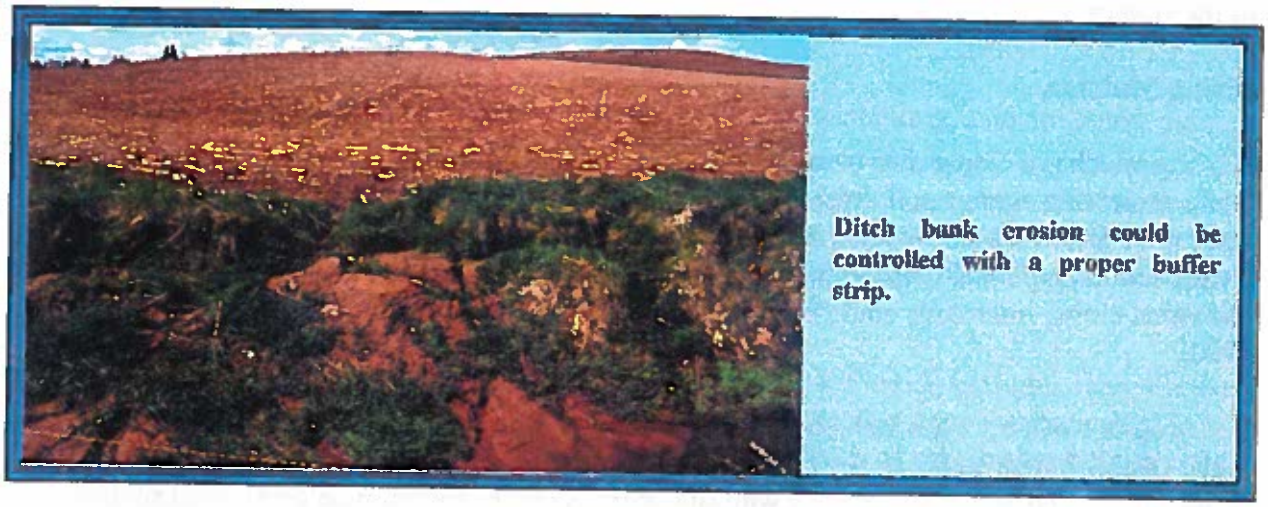
Buffer Strips

Buffer strips are an area set aside on each side of a waterway which serve two major purposes:

- To keep agricultural activities such as tillage and pesticide spraying away from the waterway; passes of machinery close to a waterway may destabilize the banks and cause bank erosion

- to filter runoff from agricultural land, reduce sediment, nutrients and agricultural chemicals from entering waterways.

Buffer strips can be planned on crop land and pasture land. In the case of pasture land, the buffer strips have to be fenced off, and an alternative source of water supplied to the animals. The water then supplied is usually of much better quality, often resulting in better animal health. There are pasture buffer strip projects in Nova Scotia and in P.E.I..



Ditch bank erosion could be controlled with a proper buffer strip.

Buffer strips must be vegetated and ideally maintained free of weeds. They can be seeded to a forage mixture, or planted to trees and shrubs. A good forage mixture would include sod forming grasses such as tall fescue and creeping fescue. These have a dense mass of fibrous roots. Birdsfoot trefoil is a good candidate also, and can be seeded with creeping red fescue at 12 and 20 kg/ha respectively. This mixture tolerates fairly wet to droughty conditions, and birdsfoot trefoil supplies nitrogen. Unfortunately, this legume is susceptible to drift of some herbicides.

There are many tree and shrub species suited to riparian buffers. Here are some examples:

- trees: Manitoba maple (*Acer negundo*), red ash (*Fraxinus pennsylvanica*), willows (eg.: *Salix alba*), poplars (eg. *balsam poplar*), silver maple (*Acer saccharinum*), larch (*Larix laricina*) and black spruce (*Picea mariana*)

- shrubs: chokecherry (*Prunus virginiana*), willow shrubs, alders, *elderberry (*Sambucus canadensis*), wild raisin or witherod (*Viburnum cassinoides*), and indian pear (*Amelanchier sp.*)

Some of these, like willows, poplars and elderberry can be propagated by sticking cuttings from the wild in the ground before budbreak in the spring. Weeds should be kept in check around the new plantings for the first three years by mowing, weed whipping, or the use of a mulch (wood chips,

hay, straw, plastic).

* this shrub produces edible berries which can be turned into delicious wine, jelly or jam.

There is no consensus yet as to how wide a buffer strip should be. It will also depend on topography, soil type, the types of crops in adjacent fields and the type of waterway to be protected. There is a mandatory 3 m buffer strip in Quebec for crop land. In order to provide shade to keep a river cool for trout and salmon populations, a 15 m treed buffer strip is recommended, except on the north side of the stream.

Living Mulches

A living mulch is a crop grown between the plants of the main crop which serves to suppress weeds, while protecting against soil erosion and serving as a green manure or a mulch after harvest. A study in Pennsylvania showed that annual ryegrass could be grown between cabbage plants without a yield reduction, while controlling annual weeds. In Nova Scotia, a study showed that red clover and sweet clover intercrops could be planted in barley and corn without reducing yields (Warman 1990).

One crop in Nova Scotia which could benefit from the presence of a living mulch is strawberries in the establishment year. Research is needed in order to find an annual living mulch that would protect the ground without interfering with strawberry growth, and provide good weed suppression.

There is already enough information on intercrops in small grains for farmers to do their own field trials. They are planted at the same time as the grain, so do not involve and extra pass, and can provide nitrogen, organic matter, protection from erosion, and soil conditioning roots. One can choose an intercrop that will be winterkilled such as annual ryegrass or one that will require plowing the following spring like sweet clover.

One considerable advantage of a living mulch is that it is harvesting the sun's energy and adding organic matter to the soil.

Cropping systems

Intercrops, cover crops, mulches and residues provide soil cover for fall, winter and early spring time. These are the first line of attack against soil erosion.

Small grain

This is the easiest crop with which to integrate an intercrop. It works best if the grain seeding rate is reduced, but it can be done with the full seeding rate with good results. This technique used to be practiced to establish a forage field, but has been discouraged lately in Nova Scotia in favour of

direct seeding of forages. But the intercrop technique is becoming popular again in Ontario and Quebec.

Here are some of the possible combinations: oats, barley, wheat, underseeded to:

Crop	*Seeding rate*	*Approximate cost*
• *alsike clover	8 kg/ha	$10/ha
• *sweet clover	12-15 kg/ha	$20/ha
• yellow blossom		
• *red clover	6 kg/ha	$10/ha
• italian ryegrass	10-15 kg/ha	

*must be inoculated with the proper inoculant just prior to planting, and the seed must be non-treated.

These combinations must be matched with an appropriate weed suppression program. Dr. Doug Doohan, Plant Industry Branch, Truro, is the resource person to contact about choosing an appropriate weed suppression program.

The intercrops will actually "take off" after harvest, being exposed to full sunlight. They will have to be plowed in the following spring, if they are to be killed so another crop can be seeded in. The alternative is to use one of the more expensive annual clovers, such as subterranean clover, which will be killed over the winter time.

Some farmers refuse to grow an intercrop with small grains for fear of reducing grain yields (not generally the case with the recommended intercrops except perhaps for red clover). The most economical cover crop to use is the small grain seed that gets thrown behind the combine. Bay Bend Farms have developed a system which produces a remarkable cover. A barley field is chisel plowed three to five days after harvest, which produces a thick even cover crop that has time to become quite tall before the first killing frosts. The big advantage of this is that there is no plowing necessary to kill the cover crop. Less fall tillage often means less soil erosion. Leaving the straw on the ground is another option for cover.

If a cover crop is to be grown after grain, fall rye is the best alternative for erosion control, as anything else does not have time to produce enough biomass for good ground cover.

Corn

Some possible intercrops for corn exist, and it is recommended that they be planted when corn is knee high. The intercrops can be broadcast, or seeded with a Gandi seeder mounted on a cultivator-hiller. Here are some of the trials done successfully at CDAQ in Quebec:

- red clover, one cut: 15 kg/ha seeding rate
- hairy vetch 30 kg/ha

- crimson clover 15 kg/ha
- yellow sweetclover 15 kg/ha

None of these combinations are commonly used at the moment, except that vetch used to be commonly planted between corn rows in Ontario when grain corn was first grown. Care must be exercised in combining the intercrop with a compatible weed suppression program. Corn harvest is too late for anything to be grown after.

Vegetable Crops

Vegetable crops are the worst crops for soil erosion as they leave the soil bare for a long time, and very little residue at the end of the season. Intercrops are at the experimental stage presently, and forages like annual ryegrass and white clover are showing promise. Early harvested vegetable crops are the minority in this province, but they can be followed by:

- oilseed radish until approximately the third week of August
- fall rye until the end of Sept.
- oats until mid-August

With late harvested vegetables, there is only one option for providing soil cover, and that is to mulch with hay or straw at a recommended rate of 4 t/ha as soon as possible after harvest.

HUMAN RESOURCE DEVELOPMENT

The human resource development part of the project was an important one, with its primary objective to raise awareness of soil conservation issues and solutions for Nova Scotia farmers, NSAC staff and students, and NSDAM extension specialist.

- **1993**

The first activity prepared was a series of lectures at NSAC in Mr. Craig Miller's course entitled: "Soil Conservation in Agriculture". Practical methods of water erosion control were introduced to the students.

The second activity was a seminar presented at the college noon hour series called: The Need for Soil Conservation in Nova Scotia.

Dave Lobb, from the Eastern Soil and Water Conservation Center was invited to participate in a tillage demonstration at the 1993 plowing match in Shubenacadie. He was the soil conservation commentator as each piece of machinery was demonstrated.

Dave Lobb also prepared a poster booth on soil conservation in Nova Scotia with the project soil

conservation specialist, Marie- Therese Voutsinos, which was presented at various events, such as the Nutrient Management Conference in Kentville.

- **1994**

The soil conservation specialist organized a trip for seven Nova Scotia farmers to the Innovative Farmers' Conference in Toronto, in Feb. 1994. This was a No-Till Ridge-Till Workshop, and the project subsidized part of the total costs for the farmers.

A presentation was prepared for the carrot production short-course. This lecture was entitled: "Soil Resource Management in Carrot Production".

There was also a presentation given at the annual vegetable producers' meeting entitled: "Soil Management in N.S. Vegetable Production"

The end of the summer of 1994 brought two field tours of the field demonstrations, one for extensionists and one for farmers. An information package was handed out, enabling a novice to get started in soil conservation practices.

A short course which was given in 1988, entitled: "Management for Soil Conservation and Enhancement" was summarized from video tapes into a written document. Copies are available on demand from Plant Industry Branch, N.S.D.A.M., Truro.

The NSAC Soil and Water course benefited from a lecture prepared by Paul Brenton on soil conservation in Nova Scotia.

Marie-Therese Voutsinos participated in all of the public meetings to plan an environmental farm plan project for the maritimes. This project is spearheaded by the Atlantic Farmers Council.

A blueberry production factsheet was produced entitled: "The Control of Soil Erosion in Blueberry Fields". A copy is included in the appendix.

A conservation tillage meeting was organized for selected NSDAM staff and farmers in Dec. 1994 as a kind of a follow-up on the Innovative Farmers' Workshop, and the interest shown by several Nova Scotia farmers. Some distinguished speakers were invited to give accounts of research or farm experience in conservation tillage systems, and a summary of that event is available on request.

Mrs. Voutsinos has been cooperating on a project lead by G. Patterson on creating a soil conservation crop planner linked with GIS capabilities. Some funding was also provided to that project.

A reference library was assembled on a diversity of topics related to soil quality, its conservation

and enhancement, and effects on the environment. The reference materials will be transferred to the NSAC library. An annotated bibliography of these can be obtained at the Plant Industry Branch, N.S.D.A.M., Truro.

CONCLUSIONS

The effects of soil degradation are not always apparent. Soil conservation practices may require a modest investment, a change from traditional farming practices or use of valuable field space. This makes many farmers hesitant to adopt them. Farming is a business and changes in operation methods should be made when it can increase profits or avoid problems. While it is obvious to farmers who recognize their soil degradation problems that soil conservation practices help avoid these problems, it is not always apparent that these practices can increase profits. For example, a 30 hectare field that looses 20 tonne/hectare of soil per year can loose over $60 per hectare in nutrients for a total loss of $1800. More costly fertilizer will have to be added to compensate for this loss.

The profitability of some soil conservation practices is much more apparent. One-pass conservation tillage in the spring before planting leaves high residue levels on the soil surface to effectively reduce soil erosion. It also significantly reduces labour and fuel costs. The high residue levels also help conserve soil moisture which may increase yields in years when drought in late summer limits crop production.

It is hoped that farmers will adopt appropriate soil conservation practices on their farms to make them more profitable, sustainable and environmentally friendly. These practices are in use in other areas of the Atlantic Provinces but some of these areas did not adopt the practices until several fields were eroded down to bedrock and were unfarmable. Hopefully that will not be the driving force behind adopting soil conservation practices in Nova Scotia.

The response by the farmers to the strip cropping and terracing, hay mulching, cover cropping and windbreak establishment demonstration projects was very positive. It appears more farmers may adopt these practices in the near future as they recognize the success of the current demonstration projects. In the past couple of years, the success of conservation tillage in growing corn and grain on Bidolosy Farms, Baybend Farms, and Phillarik Acres has been recognized by the surrounding community and more farmers in the area are implementing conservation tillage on their farms.

A continued effort should be made in the next few years to try and persuade at least one or two farmers in each agricultural community to adopt soil conservation practices. An established soil conservation structure or technology working productively on the farm is the best promotional tool.

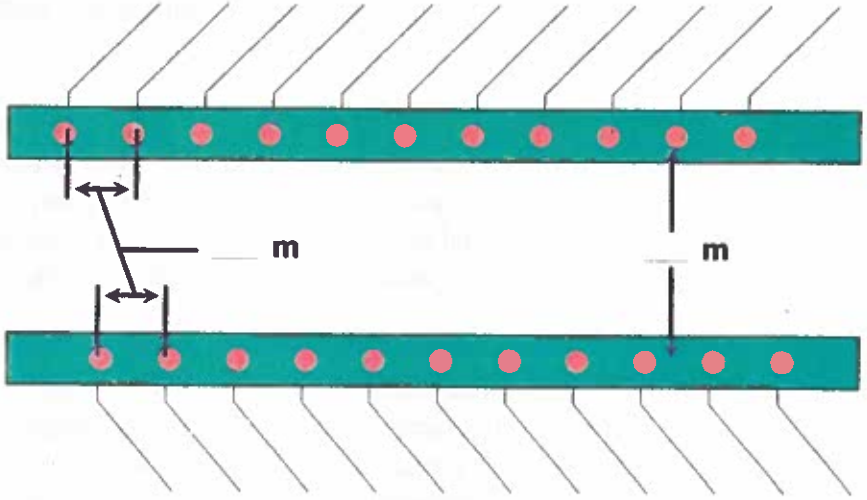
APPENDICES

Windbreak Design Worksheet

Field #:_____

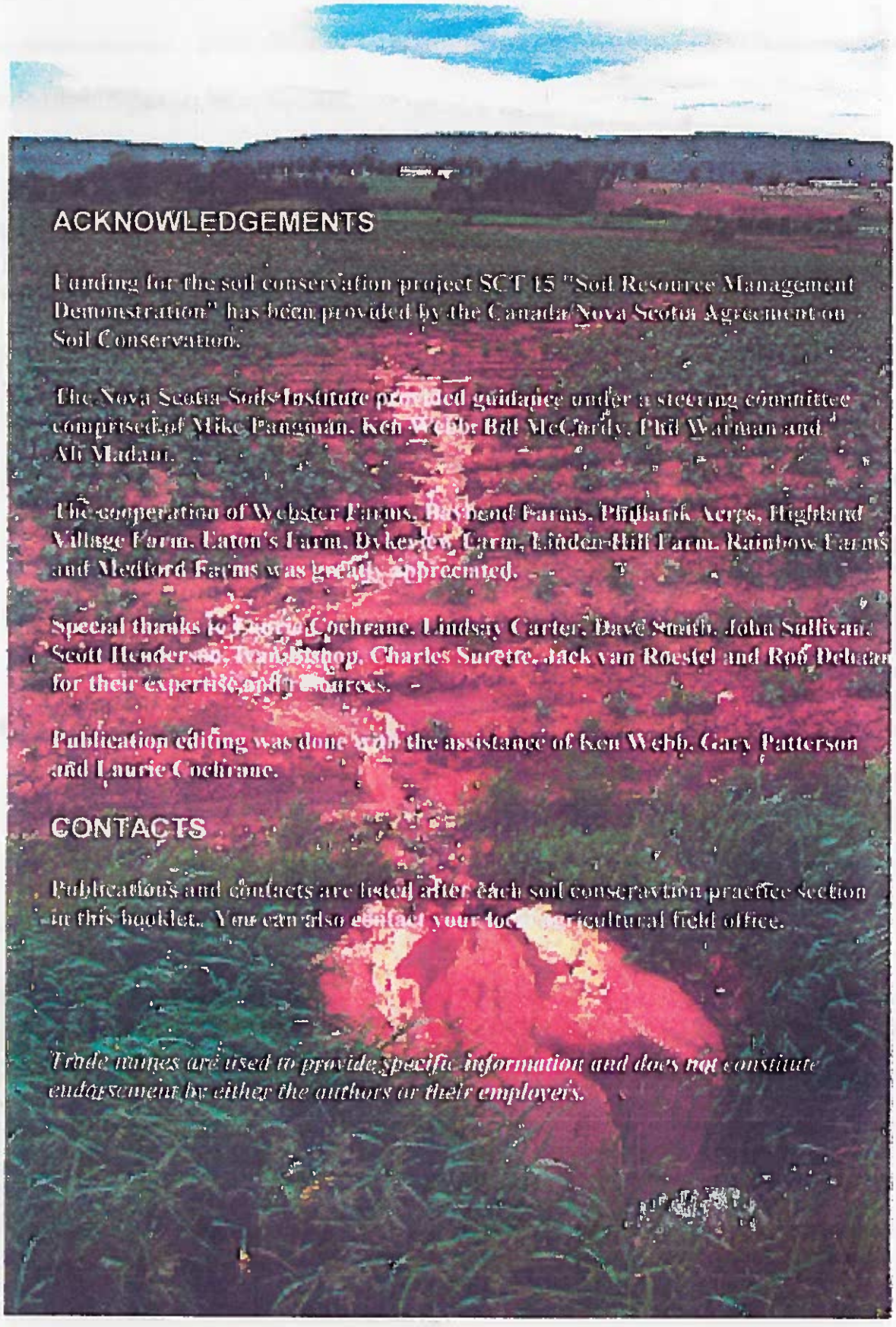
Drainage:_____ **(keep trees away from tile drains)**

Length of windbreak:_____**m**



Plant Material Needed:

Trees	For 10 m	For ___m	Shrubs	For 10 m	For ___m



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CONTACTS

Publications and contacts are listed after each soil conservation practice section in this booklet. You can also contact your local agricultural field office.

Trade names are used to provide specific information and does not constitute endorsement by either the authors or their employers.