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Title: Control of Soil Erosion

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Introduction

While protecting and improving land investment, controlling soil erosion will:

- sustain or improve crop yields
- reduce drainage costs
- retain nutrients and chemicals where applied
- reduce hazards when working on eroding soil, and
- help improve water quality.

Management of soil for water and wind erosion control is based on sensible soil conservation practices. The majority of these practices are recognized components of good soil, crop, and water management. For effective erosion control:

(a) maintain good soil structure
(b) protect the soil surface by adequate crop and residue cover, and
(c) use special structural erosion control practices where necessary.

These factors often control both water and wind erosion. Not all erosion control practices will fit into every farm management scheme. However, each erosion problem can be remedied by choosing one or more of the remedial practices appropriate to the problem.

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Soil Structure

Good soil structure is a result of management systems that include the regular use of soil- improving crops such as forages; the frequent return of organic matter in residues and manure; and tillage practices that avoid unnecessary breakdown of soil structure.

A forage crop, such as grass-legume hay, in a rotation improves soil structure as reflected by an increased degree of aggregate stability.

Table 1. Effect of forage crops in rotation on aggregate stability - Haldimand clay

Cropping System	Water-stable Aggregates >0.25 mm (%)	Corn Yield (%)
Corn, oats, hay, hay rotation	74*	100
Continuous corn	22	90

* Measured in the second hay crop of the rotation.

Corn stover residue, when not removed, also improves soil structure and reduces soil erosion. However, soil losses from plowed soil - even where the stover is not removed - can easily exceed the limit (7 tonnes per hectare) considered tolerable for most field situations. By leaving corn stover residue at the soil surface as with no till or mulch tillage, soil losses may be reduced below tolerable limits.

Table 2. Effect of corn stover residue on aggregate stability and erosion control with a continuous corn cropping system - Guelph loam with 8% slope

Residue Management	Water-stable Aggregates > 0.25 mm (%)	Soil loss in runoff t/ha*
Stover removed -- plowed in fall	18	54
Stover not removed -- plowed in fall	32	35
Stover not removed not plowed	-	4

* Metric tonnes per hectare (15 t/ha = 1 mm depth of soil)

Figure 1. Crop residue cover reduces erosion.

Tillage practices also affect soil structure. Proper tillage reduces soil aggregates to the most effective size for a favourable seedbed. Excessive tillage, however, can break down soil aggregates, destroying the soil structure formed by good crop and residue management. Excessive tillage will also contribute to undesirable compaction, accelerate erosion, and waste time and energy. Timeliness of tillage operations is also important. For example, working finely-textured soils when wet should be avoided in order to prevent compaction, puddling, and the resulting formation of hard clods when dry. Timely tillage will help maintain soil structure and reduce its erosion potential. See OMAF Factsheet, Tillage for Crop Production on Ontario Soils - Principles, Agdex 110/632, Order No. 83-035.

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Crop & Residue Cover

The benefits of growing the appropriate crops on specific soils is important. Crops help reduce the erosive forces of water and wind by means of their canopy intercepting rain, and acting as a windbreak. Root systems stabilize the soil and reduce losses. Crop residues perform similar functions and, in addition, form small dams that help retain runoff water, thereby reducing erosion.

Crop Rotations

Fallow land has the highest erosion potential in any cropping system. Row crops such as corn or beans reduce this potential by half, which is still considered to be excessive. Sod crops such as hay and permanent pasture keep soil erosion to a minimum and should, therefore, be used in rotation with other crops where erosion is a problem. Compared to continuous corn, hay or pasture crops reduce soil loss by about 90%. A rotation involving row crops and grain crops, while not as effective as a sod-based rotation, may reduce soil losses by 30% compared to continuous row crops.

Table 3. Reduction in soil loss compared to continuous corn or beans*

Crops	% Reduction
Mixed grain or winter wheat	40
Rotation of 1 year corn, 1 year grain, 2 years hay pasture or 3 years corn, 3 years hay pasture	60
Rotation of 2 years corn, 4 years hay pasture	70
Hay pasture	87
Permanent pasture	93

* Values from parameters used in Universal Soil Loss Equation.

A crop rotation that includes forages can reduce soil loss by water erosion and, at the same time, slow the buildup of insect and disease problems encountered with a continuous cropping program. On farms where crop rotations are not adequate to control soil erosion, other conservation practices should be considered.

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Tillage Practices

Proper tillage practices, employed separately or in combination with crop rotations, can be very effective in reducing soil erosion losses. Compared to conventional fall plowing, a mulch tiller used in the fall can reduce soil loss by up to 40%. On sandy soils, planting can be done without any previous tillage or following discing only. Compared to fall plowing, water-related soil losses can be reduced by up to 80% by practising the methods listed in Table 4. The objective with any tillage practice is to leave the soil surface in a rough condition, and, where practical, protected with crop residues. These conditions facilitate easier infiltration of water by slowing surface water runoff, and minimize soil erosion. Choice of a tillage program depends on many factors, which are described in OMAF tillage factsheets.

Table 4. Reduction in soil losses compared to fall plowing*

Table 3. Reduction in soil loss compared to continuous corn or beans*

Tillage Practice	% Reduction
Spring plowing	15
Spring chisel	30
Fall mulch tiller	40
Disk-plant	70
No-till plant	80

* Values from parameters used in Universal Soil Loss Equation.

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Contour and Strip Cropping

Tillage and planting of the crop across, rather than with the slope, can reduce soil loss by 25%. (Value from parameters used in Universal Soil Loss Equation). Strip cropping þ alternate hay and grain strips þ is an erosion control measure that can be used on long, smooth slopes where forages are part of the rotation. Strip cropping across the slope can reduce soil losses by 50% when compared to up-down slope cropping. Contour strip cropping will reduce soil losses even further. Strip cropping, ideally, involves alternating strips of forage and a row crop on the contour. In situations where forage is not being grown, cereal crops are a reasonable substitute to be alternated with corn or soybeans.

Figure 2. Strip cropping can reduce soil losses by 50%.

Wind Erosion Control

Management practices to control wind erosion are critical on sandy, muck, or peat soils, and should also be considered on clay or silty soils. Maintaining good soil structure and residue cover provides good resistance to wind erosion. Where little or no residue is left on the soil surface, (e.g., corn silage), a cover crop of winter rye may be sown to protect the surface of wind-susceptible soils until spring. Fencerows and snowfencing also provide good protection. Strip cropping, or even planting crops at right angles to prevailing winds is a method of controlling wind erosion on land susceptible to strong winds.

Tree windbreaks should be planted along the north and west boundaries of fields, and may be planted all around fields where wind erosion is a particular problem. On very steep slopes or areas where blowouts or rills/gullies frequently occur, permanent sod or tree cover should be maintained, and may in fact provide better financial returns.

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Structural Erosion Control Practices

When surface water concentrates, rills develop. If these rills are not addressed with appropriate control practices, a gully may result. Water runoff may continue to be a problem on some areas even after conservation tillage and cropping practices are followed. A properly constructed and maintained waterway with good vegetative cover can be a practical way to prevent this type of water erosion. Waterways must have a shallow, saucer-shaped cross- section and an erosion-resistant vegetative cover to carry water safely. A wide, shallow waterway shape will facilitate machinery crossing. See OMAF Factsheet, Grassed Waterways, Agdex 751, Order No. 94-039.

Figure 3. A properly constructed and maintained grassed waterway.

Water and sediment control basins, or channel terraces, can achieve the same objective as grassed waterways. They are used to pond surface water from small upland areas (less than 20 hectares) for short periods of time (less than 24 hours), and direct these flows into subsurface tile systems. These structures effectively reduce the peak flows of surface runoff and control rill and gully erosion. For more information, see OMAF Factsheet, Water and Sediment Control Basins, Agdex 751, Order No. 89-167.

Buffer strips along the banks of drainage ditches and streams stabilize the banks by preventing slumping and washouts as well as subsequent siltation. The buffer strips should be maintained with grass cover. Ditch or stream banks should have proper side slopes based on the soil type and be permanently vegetated. Properly installed and maintained buffer strips and vegetated banks will reduce maintenance costs for ditch cleaning. See OMAF Factsheet, Considerations for Stable Open Ditch Construction, Agdex 751, Order No. 85-067.

Concentrated flows of surface water must be directed to protected points along the ditch bank where they may enter the watercourse. Drop structures such as rock chute spillways or drop pipe inlets will safely convey this water to the ditch or stream bottom. For more information, see OMAF Factsheet, Drop Inlet Spillways, Agdex 751, Order No. 85-057.

Tile drainage systems can also be an effective means of reducing surface runoff. By maintaining the water table at a constant, desired level, the soil surface will remain in a drier condition to more effectively accept water without eroding. Tile drainage systems complement surface water control measures such as grassed waterways, water and sediment control basins, terracing and water inlet systems.

Tile drainage outlets should be protected from erosion at the point where tile systems enter ditches and streams. Proper installation of rock riprap or other erosion-resistant materials will ensure that tile water is safely discharged into watercourses. Refer to OMAF Factsheet, Tile Drainage Outlets, Agdex 573, Order No. 90-233.

Controlling livestock access to streams and ditches can be an effective means of maintaining bank stability, decreasing sedimentation, and improving water quality. Several OMAF Factsheets address this subject.

In summary, wind and water erosion control practices are based on maintaining a good soil structure, protecting the soil surface and making use of erosion control structures. Adherence to these practices will do much to enable farmers to continue to maximize crop yields, minimize soil erosion, and enhance the quality of surface water.

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