Best Management Practices

WIND EROSION

Wind erosion is a primary cause of soil degradation. It occurs when a strong ground-level wind detaches soil particles from the field surface, transporting them through the air until gravity deposits them back to the soil surface. Left unchecked, wind erosion can lead to other forms of serious soil health problems, such as reduced water- and nutrient-holding capacity, and lower yields.

Sandy or muck soils that are low in organic matter, recently worked, and located in open, unprotected fields are at the greatest risk for erosion by wind. Sandblasting by wind-eroded sand particles will lower fruit and vegetable quality.

This infosheet describes a set of diagnostic tools used to describe the type, nature and extent of wind erosion on Ontario cropland soils. Proper diagnosis is essential to identify the most suitable best management practices (BMPs) for a given field.

THE ROLE OF HEALTHY SOIL IN A CHANGING CLIMATE

Agriculture and climate are directly linked – anything that has a significant effect on our climate will influence farm production. Greenhouse gas (GHG) emissions and climate change are global concerns, and agriculture can be part of the solution.

BMPs that improve soil health can also help lower GHG emissions, reduce phosphorus loss from fields to surface water, and improve resilience to drought or excessively wet conditions. Healthy soil – an essential component of a healthy environment – is the foundation upon which a sustainable agriculture production system is built.

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How wind erodes cropland

Understanding how ground-level wind can erode field surfaces is the first step to controlling it.

Soil erosion by wind is the detachment, transport and deposition of soil particles by flowing air. The size of the soil particle determines the extent of erosion. Fine sands erode more readily than coarse sands.

Wind is air in motion. It has mass and energy. With sufficient mass and energy, wind can move (erode) soil particles. Wind erosion can occur only when wind speed at the soil surface is sufficient to lift and transport soil particles. Erosive wind energy increases exponentially with wind velocity. High-velocity winds mean more energy to detach and move the soil farther distances. A small increase in wind velocity results in a large increase in erosive wind energy.

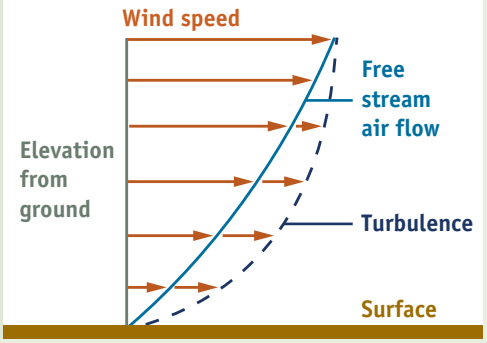
The nature of the surface over which the wind is traveling can greatly influence the wind profile, as well as the wind energy near the surface. The soil surface characteristics (roughness, vegetative cover) affect the amount of soil that moves from wind erosion. Roughness and vegetative cover help to slow and trap the wind, reducing the energy of the wind to detach and carry particles.

Soil physical properties affect the susceptibility of soil to wind erosion. Poor soil structure leads to wind erosion, especially if the soil is dry. A poorly structured, bare, recently tilled soil is highly susceptible to wind erosion even though the soil surface is rough. A crusted soil surface may resist erosion because the surface is sealed. High clay, organic matter or other cementing agents can hold the soil in place to resist wind erosion.

Dry, sandy soils that have been recently disturbed by tillage are at risk of wind erosion.

The greatest amount of soil is moved in the direction of the prevailing wind. This direction is primarily influenced by the duration and velocity of wind from different directions. The wind high above the soil surface, unrestricted by barriers or objects, is known as "free stream" air flow and moves more or less parallel to the surface. The wind near the surface affects the soil and vegetation, which remove energy from the wind and slows it. The average forward velocity near the soil surface is lower than in the free stream. The velocity increases as the distance above the surface increases. This velocity gradient is known as a "wind velocity profile."

Wind Velocity Profiles

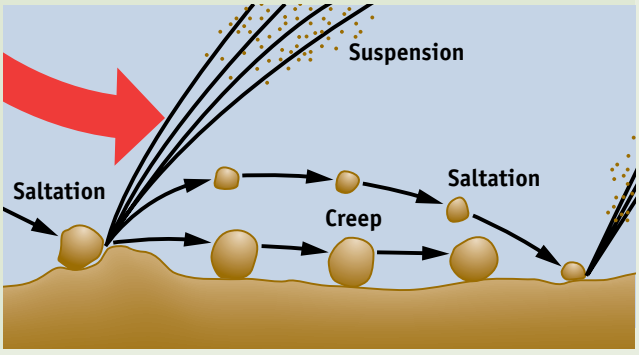


TRANSPORT MODES OF WIND EROSION

Saltation – movement of soil from a series of short bounces along the surface. Sand particles and very fine aggregates remain close to the ground as they bounce. This process accounts for a majority of total soil movement. During saltation, particles (i.e., fine sands) bounce against larger particles (i.e., medium sands) on the surface, which can cause the movement of larger particles along the surface to creep. With smaller particle sizes, the collision can cause the suspension of soil particles.

Soil Creep – rolling or sliding along the surface of soil particles. Creep accounts for the movement of particles up to 1.0 mm in diameter (i.e., medium and some coarse sands).

Suspension – the movement of dust-sized soil particles (less than 0.10 mm in diameter) parallel to the soil surface (i.e., very fine sands and silt-sized particles).



Conditions where wind erosion is likely

SOIL CHARACTERISTICS

Erodibility

- Soil texture – sandy soils and finely worked organic soils are more erodible.
- Organic matter content – mineral soils with low levels pose a higher risk for wind erosion.

Surface roughness

- Surface roughness of cultivated soil – rough soil surfaces obstruct and slow wind erosion, whereas smooth surfaces pose no obstruction.
- Roughness is increased by standing dead crops, wind strips, stubble or crop residue.

Vegetative cover

- Duration of cover – cover needs to be present during all of the non-growing season, especially during dry, windy conditions (early fall or spring).
- Extent of cover – more cover means more protection; solid stands of forages or pasture provide more protection than cover crops, which in turn provide more cover than 30% residue (mulch tillage).

Residue counts are important to ensure that there is at least 30% residue cover on the soil to protect against wind erosion. A simple rope can be used to help estimate coverage.

CLIMATE FACTORS

- Season – high winds during periods of low cover (before cropping season) cause the most damage.
- Direction of prevailing wind – fields exposed to prevailing winds are more vulnerable to wind erosion.
- Wind velocity – higher ground-wind speeds are more erosive.
- Wind turbulence – turbulent winds are more erosive and the placement and configuration of wind barriers may cause erosive levels of wind turbulence downwind.
- Dry and warm climatic and soil conditions – dry soils are more susceptible to wind erosion; risk is higher during low water conditions.

TRAVEL DISTANCE

- Distance across field and between wind obstacles – e.g., windbreaks, shelterbelts, forests/woodlots, buildings, sheltered farmsteads, etc.

PAST AND PRESENT MANAGEMENT

- Fall primary tillage followed by spring secondary tillage performed every year (i.e., a finely worked seedbed) pulverizes the soil and increases vulnerability to wind erosion.
- Tillage passes are parallel to prevailing winds, allowing winds to pick up speed without obstruction of rows.
- Annual row crops are grown in short rotations.
- Fields are overgrazed.
- No or little crop residue is left on the soil surface.
- Fall or overwintering cover crops are not planted.
- Fencerows, woodlots or other barriers on field edges and adjacent parcels are removed.

The removal of fencerows, woodlots or other barriers on field edges/adjacent parcels also removes obstacles to the erosive power of wind.

DIAGNOSTICS for wind erosion

FIELD OBSERVATIONS

- Dust clouds or drifting sands during wind events
- Bare cropland surfaces very smooth or with ripples
- During winter, snow cover has brown colour
- Build-up of soil in leeward ditches or field edges
- Movement of crop residues to the leeward side of surface obstacles
- Lighter-coloured soil on knolls
- Reduced water infiltration

CROP OBSERVATIONS

- Seed exposed in seed trench following a wind storm
- Uneven stand establishment in spots where planted seeds have been dislodged
- Seedlings partially buried in furrows following emergence
- Sandblasted vegetation
- Pedestaled plants or exposed roots
- Crops buried by wind-blown soil
- Varied crop development and yields across a field, with knolls having reduced yields

In winter, during low snow cover periods, wind events can deposit topsoil on snow-covered areas – sometimes referred to as "snirt." This condition is more pronounced on open sandy fields with minimal crop or residue cover.

Soils in ditches or field edges following dry windy weather indicate recent wind erosion events.

Sandblasting of delicate crop features by eroded sands is a reliable indicator of wind erosion patterns.

Severe wind erosion events can deposit enough soil to bury crops.

SOIL OBSERVATIONS

- Smooth or rippled soil surfaces
- Loss of topsoil
- Loss of organic matter
- Soil has physically moved (aggregates have been broken and detached)
- Coarse fragments on pedestals because finer particles blew away
- Subsoil mixing with topsoil
- Poor infiltration rates and reduced water-holding capacity
- Reduced fertility in eroded areas

Look for lighter-coloured rippled sandy soil over topsoil to determine how much windblown soil has been deposited.

Dry muck soils are highly vulnerable to wind erosion. Look for small dust clouds over fields during the growing season or large dark clouds in the spring.

Suitable best management practices (BMPs)

- ✓ Reduce tillage – adopt a no-till or mulch tillage system.
- ✓ Manage residue – aim to leave at least 30% crop residue on the soil surface after planting:
  - 30% cover reduces wind erosion by 70%
  - 60% cover reduces wind erosion by 90%.
- ✓ Rotate crops – alternate row crops with solid-seeded crops (forages).
- ✓ Plant cover crops – keep soil covered during non-cropping seasons (including winter).
- ✓ Add organic amendments – a well-planned regimen of adding manure, biosolids or composts can increase soil organic matter (SOM) levels to reduce the erodibility of the exposed soil:
  - this approach works best if complemented with BMPs that cover the soil (e.g., cover crops, crop residue) during vulnerable periods.
- ✓ Use strip cropping (also known as crosswind strip cropping).
- ✓ Plant wind strips or windbreaks perpendicular to prevailing winds.
- ✓ Remediate soil – in certain landscapes, eroded soil material re-deposits in recoverable in-field locations such as depressions, and can be moved back to hilltops where it likely originated.
- ✓ Convert annual system to perennial system such as hay, pasture or other perennial crop (e.g., orchard, cane fruit).
- ✓ Retire fragile land – if topsoil layer (A horizon) has been lost and productivity has dropped substantially, consider retiring to trees or other native vegetation.

On level fields prone to wind erosion, alternating strips of field crops can help to reduce surface wind speeds.

Properly located and designed, field windbreaks will reduce wind speeds and help to control wind erosion.

The mulch effect of crop residue on the surface protects otherwise bare soils from wind erosion.

Narrow, evenly spaced strips of cereals can provide sufficient wind erosion control and protection from sandblasting for high-value fruit and vegetable crops.

For more information

ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

Many sources of supplementary information are available.

Below are some suggestions to get you started. Most can be found online at **ontario.ca/omafra** or ordered through ServiceOntario.

- *Agricultural Erosion Control Structures: A Design and Construction Manual,* Publication 832
- *Agronomy Guide,* Publication 811
- *Soil Erosion – Causes and Effects,* Factsheet 12-053

Best Management Practices Series

- *Controlling Soil Erosion on the Farm*
- *Establishing Tree Cover*
- *No-Till: Making It Work*
- *Soil Management*

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

- #15, *Soil Management*

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

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ADDITIONAL RESOURCES

Soil Management Guide
gov.mb.ca/agriculture/environment/soil-management/soil-management-guide/soil-erosion.html

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