LAND MANAGEMENT

SUSTAINABLE LAND MANAGEMENT
Wind Erosion and Control

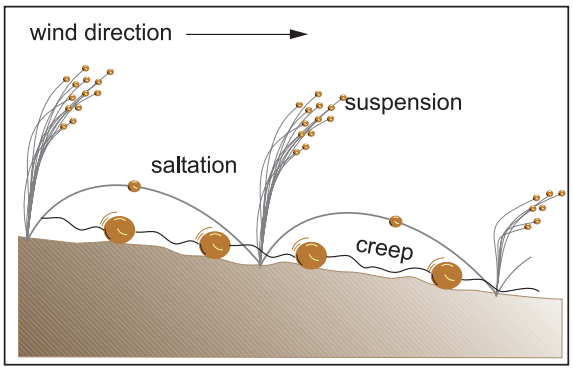
Introduction

This Environment Topic explains how wind erosion occurs, and outlines techniques to manage it. Understanding the wind erosion process is essential if we are to conserve valuable soil resources.

Hawke's Bay is subject to strong winds in spring, the same time as many crops are being planted. Combined with cultivation of light, highly erodible soils, this gives the region one of the highest rates of wind erosion in New Zealand.

The nutrients lost in eroding soil are very valuable. If 1cm of top soil is removed, the fertiliser needed to replace lost nutrients can cost from $300 to $1,000 per hectare.

Many Hawke's Bay soils are formed from river or wind-blown deposits on either pumice or old river gravel. Once lost, these soils can not be replaced. In many areas, they are already very shallow, and further losses will make them unsuitable for cropping or even pasture.



The wind erosion process (based on Wind Erosion Research Unit, USDA www.weru.ksu.edu/weps.html)

How does soil move?

There are three ways soil particles move, depending on their size and weight. These are suspension, creep and saltation.

Suspension - the smallest particles are picked up and suspended in the wind, causing very visible dust clouds that are too often seen around the region. While the amount of soil moving is quite small, it is a very valuable part, containing much of the available fertility.

Creep - the largest, heaviest, particles remain stable or creep along the soil surface. Generally they do not travel very far.

Saltation - the medium sized particles account for 50-80% of soil movement, through a process known as saltation. Wind causes medium sized particles to vibrate, then bounce from the soil surface. Too big to remain suspended, they fall to earth and dislodge other particles that repeat the process in a snowballing effect. This creates soil avalanches - thick soil clouds up to two metres deep moving down wind.

Saltation in a cultivated field with 20 km/hr winds

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Saltating particles are the main cause of seedling and crop damage. Techniques that control saltation can significantly reduce both erosion and crop loss.

What conditions favour wind erosion?

Wind erosion is increased if:

- vegetative cover is sparse or absent
- wind speed increases
- soil is loose, dry, fine or very light
- soil surface is smooth
- the exposed area is large

Controlling wind speed

Erosion begins once wind reaches a critical speed, known as the threshold velocity. For many Hawke's Bay soils, the critical wind speed is only about 20-25km/hr, a speed that is often exceeded. Above this threshold, a doubling of wind speed causes eight times more soil movement.

The only real way to reduce the effects of wind speed is to use shelter. Because halving wind speed causes an eight times drop in soil movement, shelter is a very important tool for reducing erosion.

As a general rule, well maintained shelter gives protection for about ten times its height. So a nine metre high shelterbelt protects about 90m of ground.

Shelterbelts should be continuous and not too dense. About 50% permeability is best, as a solid barrier will cause wind to eddy and may actually increase wind speeds and erosion down wind (see other Environment Topics on *Shelter Design for Horticulture and Cropping on the Plains and Shelter Species for Horticulture and Cropping on the Plains).*

Well maintained 50% permeable shelterbelt

Controlling soil conditions

Cultivation and Particle Size

Appropriate cultivation is the key to managing soil condition. No-till systems are preferred on very light soils as even minimum cultivation exposes fine, highly erodible particles.

Whatever the soil type, avoid over-working soils as this creates more small particles. On some light soils, such as Takapau, one cultivation can be too many. Soil that is 'fluffed up' by cultivation must be compressed by rolling to avoid loose particles.

Avoid cultivating during strong winds as the disturbance associated with cultivation can trigger saltation, causing much greater erosion than if the soil was left alone.

Soil Moisture Levels

Irrigating during a wind erosion event is **ineffective**. It is generally impossible to apply sufficient water to settle soils, and the impact of water droplets on dry soil can trigger saltation.

While moist soils blow less easily than dry, water must be applied before problems begin. Even so, because wind will rapidly dry the soil, moisture management alone is insufficient to control erosion.

Soil surface roughness

Wind erosion is worse where the soil surface is smooth. Increasing surface roughness by ridging slows wind speed at the surface.

Research shows that creating ridges 50-100mm high, at right angles to the wind, reduces erosion. But erosion increases again if ridges exceed 100mm in height.

A cloddy surface will also slow wind and protect and trap smaller particles, reducing saltation and therefore erosion.

Fine particles picked up by strong wind lie trapped between stable ridges.

Controlling vegetative cover

Vegetative cover is one of the keys to effective erosion control. Vegetation holds soil together, slows wind and traps any moving particles. Cover can be alive or dead, but needs to be well attached to the soil.

No-till or minimum-till techniques maintain a protective cover on the soil surface, effectively preventing erosion.

Sweetcorn direct-drilled into sprayed off pasture

Leaving crop residue on the soil after harvest reduces erosion, and can help maintain soil organic matter, critical for soil quality.

The greater the amount of residue the greater the protection, but a minimum of 20% soil cover is needed for any effect.

While residue may create problems with pests such as slugs, these can be controlled with baits or stock treading.

Grass emerging through mulched corn stubble

Controlling the size of the area

The most important size factor is the length of wind run. This is because saltation increases at an increasing rate across a susceptible field.

How wide can cultivated strips be?

The maximum width of cultivated soil for wind erosion control varies with soil type

Widths to effectively prevent erosion from a smooth cultivated field when winds are 65km/hr are given in the table.

Soil Texture Class	Max Strip Width (m)
Sand	6
Loamy sand	8
Sandy loam	30
Silty clay	50
Loam	75
Clay loam	100

This shows why wind erosion is so severe on light Hawke's Bay soils. Fields are commonly 200-400m wide, and springtime wind speeds of 65km/h can be expected most years. Napier's weather record shows winds exceeding 96 km/h can be expected about twice per year. These can be at any time, though they commonly occur in spring.

Because soil movement multiplies across a field, losses get far worse as field width increases. Creating narrow 'isolated' fields will control saltation and minimise erosion.

What is needed to isolate a field?

A field is considered isolated when its upwind border is stable, and no eroding soil is entering the field from upwind.

Isolated fields can be created by shelterbelts and/or grass borders. Other techniques include strip cropping, strip cultivating or using 'trap strips' of stiff upright vegetation to catch and hold saltating particles. These isolating strips have several functions:

- acting as low shelterbelts
- catching moving particles
- protecting growing crops from damage by wind blown soil particles
- providing habitat for wildlife, including beneficial insects

Trap Strips

Trap strips are established to separate cultivated areas, stabilising the upwind border and trapping any moving soil particles. In this way the chain reaction of saltation is broken.The process must begin again from scratch on the next strip.

While a stiff upright strip 1m tall plant will give protection for 10m across a field, softer plants that bend with wind give less protection. A guide is seven times the height, or 7m protection from a 1m high strip.

Trials showed single or double rows of 1.2 m tall stiff 'grasses' (such as corn) planted about 9m apart reduced wind and cut erosion by over 90%. This requires careful matching of 'windbreaks' with cropping machinery to avoid inconvenience.

Strips of oats planted between asparagus beds provide good protection and increased returns to Hawke's Bay growers.

Normally trap strips are 1m high and about 3m wide. In Hawke's Bay, oats have been shown to be effective as illustrated below.

Oats planted to create trap strip (September)

Strip in same paddock after a gale in mid-November

The above photo was taken the day after strong winds in November. The soil is very light and was recently cultivated and planted. However, good shelter and the use of trap strips prevented soil movement and damage to young squash seedlings. Trap strips including mixed plant species, may have additional benefits by attracting and providing habitat for beneficial insects.

Soils with High Risk of Erosion when Cultivated

	Soil Surveys of Heretaunga Plains (1997) and Ruataniwha Plains (2001)		Other Soil Surveys of Hawke's Bay	
Extreme Risk	Pakipaki Takapau Turamoe		Gisborne Kopua Kopuawhara Mahia Mangatahi Matawai Mohaka	Puketitiri Ruakituri Taupo Tiniroto Titiokura Tuai
Severe Risk	Esk Farndon Flaxmere Gwavas Irongate Matapiro Moteo Okawa	Omahu Omarunui Pakowhai Poporangi Roroatara Tukituki Twyford Waipukurau Washpool	Matapiro Opoutama Waiwhare	

Summary

Prior to cultivating, look closely at your paddocks. Develop a management plan that minimises risk on erodible soils. This should include no-till or minimum tillage options. This will save your soil and crops, saving you money in both the immediate and the long terms. Ensuring adequate shelter and maintaining vegetative cover are your best tools.

For further information

For further information contact Hawke's Bay Regional Council Land Management staff for advice.

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