Wind erosion

Second edition

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Wind erosion is a natural part of the Australian landscape and has been responsible for shaping much of it. However, when land is managed inappropriately, the rate of wind erosion is accelerated. During drought, when the cover of vegetation is sparse and soil is pulverised, wind erosion increases and good land management practices become more critical. Wind erosion can be minimised using appropriate farming and grazing management.

Wind erosion can be reduced if managers understand:
- how erosion occurs
- what control methods are available
- which is the best control method to use in a particular situation.

Wind erosion causes the following detrimental effects:
- loss of soil
- loss of nutrients for plants
- scalds (areas of bare, hardened ground that do not easily soak up water)
- reduced infiltration of water
- burying of on- and off-farm infrastructure.

Wind erosion can also have a considerable impact away from the site of soil loss by affecting human health, reducing visibility and disrupting electricity supplies.

This publication briefly describes how wind erosion occurs and how to control it.

How wind erodes soil

When the force of the wind exceeds the resistance of the soil surface, soil will be eroded. On agricultural land, the most damaging action of wind erosion is called saltation. This occurs when soil particles with a diameter of 0.1–0.5 mm are bounced across the soil surface by the wind, abrading and eroding the surface.

As the saltating particles crash into the surface they splash up more particles that also bounce across the surface. This bombardment of the surface causes an avalanching effect that spreads out in a fan shape, with more and more soil particles being mobilised downwind.

With the continual bombardment of the surface, dust particles of less than 0.1 mm diameter become suspended in the air and are carried far away by the wind. Not all dust ejected from the surface is carried in the air indefinitely. The larger dust particles of diameter greater than about 0.05 mm are dropped within a couple of kilometres of the erosion site. Particles of less than about 0.005 mm diameter can travel thousands of kilometres.

With constant wind speed, the rate of erosion changes with the distance downwind from the point where the erosion starts, and with time over a period of erosion lasting several hours, because the surface is continually modified as it is eroded.

The amount of soil eroded increases with distance downwind until it reaches a maximum. For sandy soils, erosion can start within about 0.2 m and reach the maximum erosion rate within about 5 m from where the erosion started, e.g. at the edge of a paddock. This has implications for erosion control. Any method of erosion control should be intended to stop saltation before it reaches its maximum rate; therefore, the non-erodible roughness (clods or vegetation) should be no more than a few meters apart.

During a period of wind erosion, the rate of erosion in a paddock increases over time to a maximum as the surface is bombarded by eroding particles, then the rate of erosion slows until it reaches an equilibrium.

This occurs because as the erosion continues, the surface starts to 'armour up'. The armouring layer mainly consists of soil particles that are too large for the wind to blow away and pieces of vegetation that are anchored. The armouring layer is a sign that a significant amount of soil has already been lost. It forms when the finer particles of soil are winnowed out of the top few millimetres, and it is these finer particles that leave the paddock.

Larger particles in the armouring layer protect the soil surface because they are more difficult to erode. This armouring also has implications for erosion control. If the armouring layer is disturbed, then the loss of newly exposed, fine soil particles may increase.

Prevention is better than cure

In most sandy soils, wind erosion is difficult to control after it has started. Prevention is the best control method.

Mechanical and binding methods either tend to be ineffective on sandy soils, or are too expensive (more than $500 per hectare) to be used on large areas (more than 10 ha), because sandy soils have little soil structure. Even in good years, very sandy mallee soils contain few aggregates (clumps of soil) with a diameter of more than 0.85 mm. Sandy soils rely on vegetative cover for protection.

Soil erosion can be minimised by adopting conservation farming practices that maximise retention of crop residue and reduce pulverisation of soil (Plate 1). On grazing or fallow paddocks, wind erosion can be minimised by destocking early and keeping vegetation cover at more than 50%.

Plate 1. Surface roughening and retention of stubble can help to prevent soil erosion on cropping paddocks.

Not all problems are caused by domestic stock. Rabbits are particularly destructive of vegetation and loosen the surface when digging for food. If erosion is already a problem in the area, warren ripping should not be used because it loosens soil. Other methods of control, including baiting and fumigation, are preferable in these circumstances. Goats and kangaroos can also reduce vegetative cover, and they should be managed to ensure the cover does not drop below a critical level.

When it's too late for preventative measures

If erosion does start on a paddock, there are three basic control methods:

- maintain any remaining vegetative cover
- roughen the soil surface
- use chemical bonding.

Maintain any remaining vegetation

The preferred method of erosion control is to maintain a cover of vegetation over more than 50% of the soil surface, when viewed straight down, after the vegetation has been flattened. If erosion does start on a paddock, then try to maintain any remaining cover.

Vegetation cover helps to control erosion by:

- acting as a blanket that prevents the wind from picking up any soil particles
- absorbing the force of the wind and reducing the wind speed at ground level
- trapping eroded soil particles and reducing the amount of bombardment on the soil surface.

If you have stubble, plants, grass butts or small shrubs (higher than 10 cm) that sit up into the air, these offer even more protection, and you will require slightly less cover. Shrubs and tussock grasses protect the soil when the spacing between the plants is less than three times their height, and when they are evenly distributed across the paddock.

Surface roughening

Surface roughening helps to control erosion by:

- covering the surface with soil clods that are too large to be lifted by the wind
- making the surface sufficiently rough with tillage ridges and furrows that can trap any loose soil that may be moving.

Surface roughening should only be considered when there is insufficient (less than 50%) vegetation cover to protect the soil surface or when the soil type will produce sufficient clods to protect the surface. Roughening can be used in both crop and pasture country.

Surface roughening alone is inadequate for sandy soils because they produce few clods. Tillage ridges, about 100 mm high, should be used to cover the entire area that is prone to erosion. Ridges that are lower than 100 mm quickly fill with sand, whilst the crest tends to erode very quickly on ridges that are higher than 100 mm.

Surface roughening gives better results on loam and clay soils. The area to be treated should include the entire eroding area plus some additional buffer areas. Start roughening on the upwind edge and work downwind if the landscape is flat. On sloping land, roughening should be done on the contour. Strip ripping and cultivation are surface roughening methods that can be used to prevent or control erosion.

Strip ripping can be used to catch the bouncing particles before the rate of soil erosion reaches its maximum. This has the advantage that the entire paddock does not need to be cultivated. A ripper is used to penetrate the surface at 10–20 cm depth, and create a furrow lined with cloddy material. The aim is to create clods that cover the loose material, and to catch any moving particles in the roughness.

Plate 2, left. Two inch (50 mm) ripper points used for strip ripping.
Plate 3, right. Strip ripping at 750 mm spacing. The foreground area was ripped at 6 km/h; the background area was ripped at 13 km/h, which gave more clod.

Plate 4, left. A two inch (50 mm) ripper point with a delver for throwing up a ridge in loose soil , e.g. on sandy country.
Plate 5, right. A two inch point with a Turlec wing welded on above it, to create ridges.

Spacing of the rip lines is critical. Because erosion can reach its maximum rate in less than 5 m, rip lines should be spaced less than 2 m apart, or closer (e.g. 750 mm) if erosion has commenced or if the area receives erosive winds from different directions (see Plate 3).

Extra rip lines can be placed between the first lines, or ripped at right-angles if the first lines have filled with sand, and a second treatment is necessary. In areas with sodic soils, rainfall disperses clods and roughness is reduced, so follow-up ripping is needed.

In areas with sandy or sodic soils, it is an advantage to throw up a ridge as well as clod because this will last longer than just a rip line. To throw up a ridge, some sort of wide point or delver is required (see Plates 4 and 5).

It costs a lot of time and money to put in rip lines, and they can make the situation worse; so it pays to do it in the right way, the first time.

Some things to be aware of:

- When insufficient clod is produced during ripping, rip lines just provide more fresh soil to be eroded.
- On sloping ground, rip lines may concentrate water, and result in gullies.
- On soils with salty, sodic or acid subsoils, rip lines may bring up soil that will reduce crop and pasture growth in future years; therefore be careful of the depth of ripping.
- When rip lines fill with sand, they form a ridge that is difficult to level out after the season of erosion finishes. The aim is to have enough rip lines to limit the drift of sand and to catch all the loose sand on the ridges.
- In rangelands, rip lines may pull out valuable grass butts and fodder shrubs, and make an ideal environment for woody weed infestations. Careful planning is needed to minimise damage to existing vegetation.
- If the groundcover consists of more than 50% naturally occurring native vegetation, consent for clearing by ripping may be required under the *Native Vegetation Conservation Act 1997*. You should contact your nearest office of the Department of Infrastructure, Planning and Natural Resources before commencing ripping. Landholders should be aware that a cultivation and/or clearing consent may be required in the Western Division on rangeland areas for these activities. Please contact your local DIPNR office before conducting any surface roughening.

Cultivation can be used to roughen the whole surface and prevent any soil movement. The aim is to keep the soil rough and ridged to either prevent any movement initially or to quickly trap bouncing soil particles in the depressions of the rough surface.

For rough or ridged surfaces to be effective traps, they must be composed of clods that are too big to be eroded by the wind.

Soil clods with a diameter greater than 2 cm should comprise more than 50% of the soil surface. If the roughened surface of the soil is *not* covered in big clods, then the erosion will start again. So, it is imperative that the surface is left rough and covered with soil clods. If this is not achieved, surface roughening could make the situation worse.

It is advisable to cultivate a trial area to see if the right surface conditions are being created before attempting to cultivate the entire eroding area.

Tyned implements such as chisel ploughs and scarifiers with narrow (2 inch or 50 mm) points have good penetration and can provide good clod (Figure 6). If implements cannot penetrate dry soil, it is best to wait for moist conditions that will allow the implement to produce clods.

Implements may be modified so that every second or third tyne is removed to decrease draught requirements. Using narrow points (50 mm) at 900 mm spacing on the first row and 150 mm

points on the last two rows at 450 mm spacing can produce both good clod and ridges that are about 100 mm high.

Plate 6, above left. Cultivation with 10 inch (250 mm) points using 9 inch (230 mm) spacing created insufficient clod and low ridges.
Plate 7, above right: Cultivation with two inch (50 mm) points on a chisel plough using 12 inch (305 mm) spacing created a good cover of clods.

Plate 8, right. Narrow points (50 mm) at 900 mm spacing on the first row and 150 mm points on the last two rows at 450 mm spacing created a surface with a good cover of ridges and clods.

Chemical bonding agents

Bonding agents can be used to temporarily cement the surface. These agents are generally sprayed onto the surface to form a crust that inhibits soil movement. This method is expensive and should only be considered if capital improvements or high value crops are threatened by wind erosion.

Managing the land after rain

After rain, soil crusts form that reduce erosion. If the crust, roughness and ridging is still adequate, no action will be required. If the crust has loose sand grains on the surface, or the clods and roughness have been flattened, it may be necessary to ‘re-roughen’ the surface because the crust will break down through bombardment from the loose sand grains.

The most common mistake with all remedial measures is restocking the treated area too soon. It is highly advisable to prevent stock from entering a treated or eroding paddock until there is enough vegetative cover to control erosion, i.e. more than 50% cover. Keeping stock off the land also protects the soil crust and clods, maintaining control of erosion.

Summary

There are three basic methods used to control wind erosion:

- maintain vegetative cover
- roughen the soil surface
- use chemical bonding.

Vegetative cover needs to be greater than 50% (when it is viewed from straight down after being flattened down), or it should consist of shrubs and grass tussocks that are more than 10 cm tall and are evenly spaced at less than three times their height.

For surface roughening to be effective, it needs to cover 50% of the soil surface with clods greater than 2 cm in diameter and tillage ridges about 100 mm high. A combination of clods and ridges is ideal. Surface roughening with clods is best suited to loam and clay textured soils, rather than sands, which are best suited to ridging. Furrows and rip lines for catching fine soil particles need to be close enough (less than 2 m apart) to stop the avalanching effect of saltation.

There is no recipe for erosion control because there are many factors that will affect the outcome. However, with an understanding of how soil is eroded, strategies can be implemented to minimise erosion.

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