Agriculture WESTERN AUSTRALIA

Farm Forestry Advisory Service

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

TreeNote

No. 22
July 1999

Windbreak design and management

in the greater than 450 mm rainfall zone of Western Australia

This TreeNote describes general principles for windbreak design and management. A separate TreeNote, No. 23 'Timber production from windbreaks', contains information on growing windbreaks for commercial timber.

How windbreaks work

Tree windbreaks slow some of the wind as it passes through, while the rest accelerates over the top. Wind speed at ground level is reduced for a short distance upwind and a much longer distance downwind. A windbreak's effectiveness at providing shelter depends on factors such as height, orientation to the wind, position in the landscape, permeability to wind, and uniformity (or absence of gaps).

Trees make excellent windbreaks because they grow tall, and are cheaper and more durable than most other alternatives.

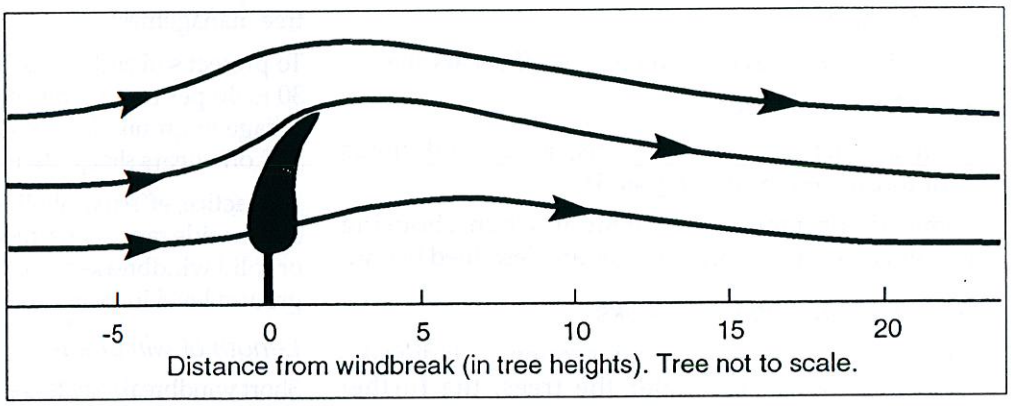
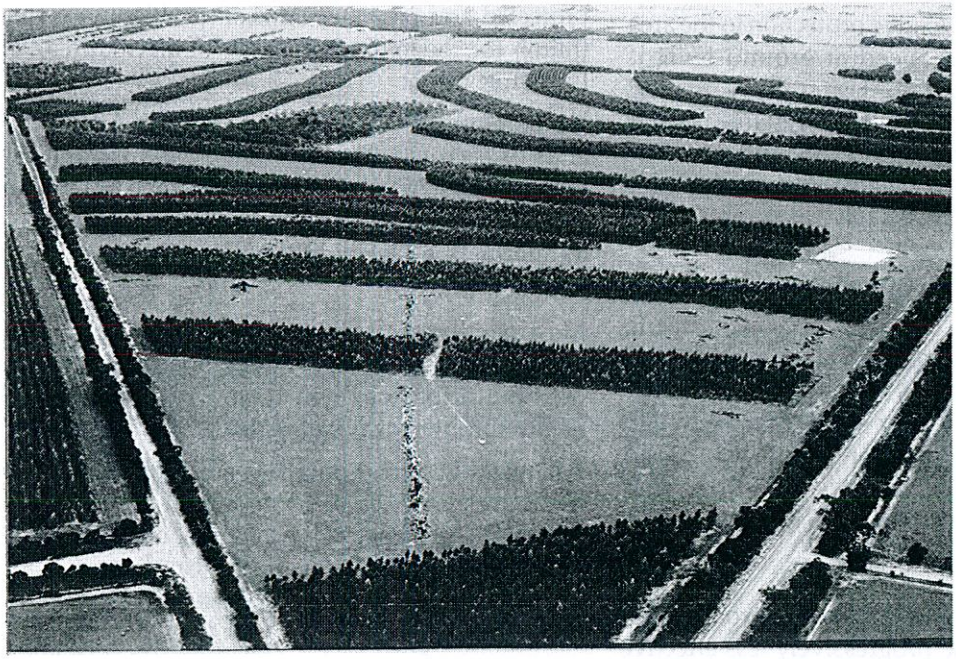


Figure 1. Effect of a permeable windbreak on airflow



Aerial view of M. & M. Swainston property at Kronkup west of Albany. Eight and 12-row belts of Tasmanian blue gum (Eucalyptus globulus) *provide excellent shelter from cold southerly winds for beef cattle. The trees create diversified income (pulpwood crop), help redress a waterlogging problem and have created a pleasing visual amenity in the farmscape.*

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Benefits of windbreaks

Windbreaks can increase farm productivity by:

- preventing soil erosion
- protecting crops and pastures
- providing shade and shelter for stock

Tree windbreaks when managed appropriately can also reduce groundwater recharge, increase biodiversity and yield valuable timber products.

Windbreak design

When designing windbreaks, the first step is to decide what benefits you want from them – shelter, timber, aesthetic enhancement, or a combination of benefits. Next, consider your farm business and any limitations imposed by farm boundaries, roads, fences and soil types.

Because the cost of establishing windbreaks throughout a large farm can be high, give priority to:

- areas prone to wind erosion
- crops which are particularly susceptible to wind or spray drift
- paddocks for calving, lambing, or off-shears sheep
- stock holding yards
- infrastructure such as dams, roads and sheds (if threatened by shifting sand)

Some of the factors to consider when choosing windbreak locations and designs are described below.

Spacing between windbreaks

Tree height is the main factor governing a windbreak's effectiveness, so the taller the trees, the further windbreaks can be spaced apart.

Windbreaks are considered to give protection to the area around them where wind speed at ground level is reduced by at least 20 per cent. Using this yardstick, windbreaks can protect land for at least 20 tree heights in their lee, and up to four tree heights upwind. The area of greatest protection is between two and 10 tree heights downwind. Windbreaks have little or no effect beyond 30 tree heights.

In most areas, windbreaks spaced at 25 to 30 tree heights give adequate protection. However, on soils prone to wind erosion, or in hilly areas with complicated wind patterns, spacings of 20 times tree height or less are recommended. Use even closer spacings where high levels of shelter are needed, for example, around horticultural crops, feedlots, dairies, buildings, and paddocks for lambing or for off-shears sheep.

Orientation

Windbreaks are most effective for wind approaching at right angles. They become progressively less effective as the wind angle decreases. Farmers know from experience which winds are most damaging on their farms and can align their windbreaks accordingly. Where wind directions are highly variable, a grid pattern of windbreaks will give the best protection.

In winter in the south of Western Australia, strong winds blow from the north-west, west and south-west. North-westerlies can be destructive but south-westerlies are colder and more dangerous for stock. In summer, hot dry winds blow from the east.

A common orientation for windbreaks to protect crops is north to south, or north-east to south-west. A north-south orientation also minimises shading of crops or pastures.

To protect livestock from cold winter winds, windbreaks are often aligned north-west to south-east. If stock shelter is the main aim, wide shelter belts, or dense blocks of trees are more effective than narrow windbreaks.

Permeability

A windbreak's permeability determines the amount of air that flows through it, and therefore the degree of wind speed reduction in its lee. Permeability varies with tree species, number of rows, spacing between trees, and tree management.

To protect soil and crops, the ideal windbreak is about 30 to 40 per cent permeable to wind, and has uniform foliage to ground level on at least one side. For lambs and off-shears sheep, denser shelter is needed.

In practice, effective shelter is provided by windbreaks over a wide range of permeability. However, very dense or solid windbreaks can cause turbulence and eddies at ground level in their wake.

Length of windbreaks

Short windbreaks are less effective than long windbreaks because wind eddying around the ends reduces the area protected and can cause erosion problems. A rule of thumb for the minimum length of a windbreak is 20 times tree height.

If possible, establish a network of windbreaks, with the ends of each windbreak joining or butting into other windbreaks. Or increase the effective length of windbreaks by abutting them to other tall objects such as buildings, bush and hills.

Number of rows

Most windbreaks with shelter as their main purpose have at least three rows of trees. Plant adjoining rows of trees in an offset pattern to avoid making gaps at right angles through the windbreak.

A single row of trees can make a reasonable windbreak if the trees grow uniformly and retain their lower branches and foliage. However, if some of the trees die or lose their lower foliage, wind can 'jet' (or 'funnel') through the gaps at increased speed.

Tree Spacing

Tree spacing depends on the species used, the size they will grow on the selected site and the density of shelter required.

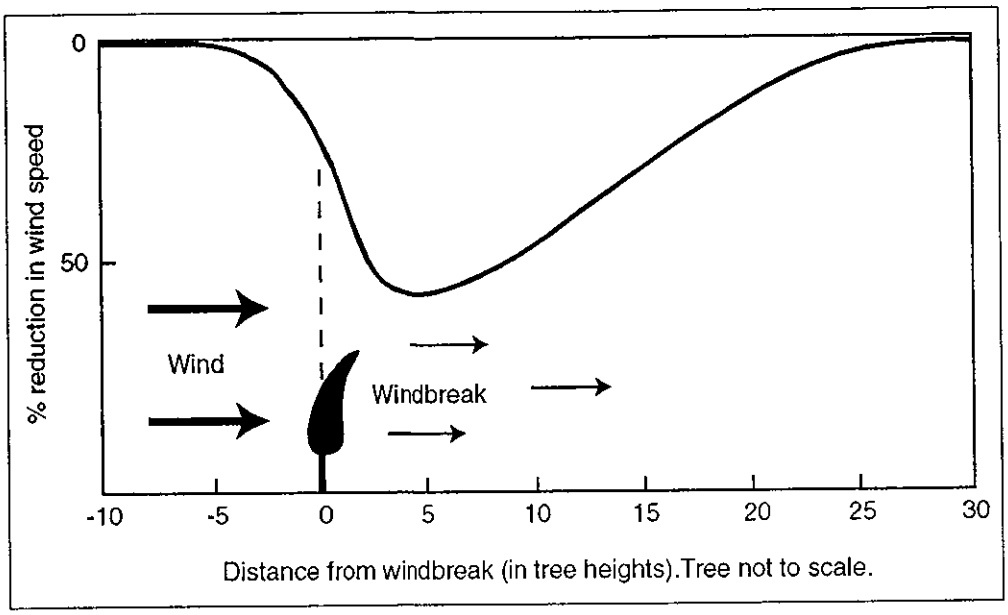

Figure 2. Reduction in wind speed at ground level near a windbreak. (From 'Design principles for farm forestry', RIRDC 1997.)

Large trees are often grown in rows three to four metres apart, with a similar distance between trees in the rows. Smaller trees and shrubs may need to be planted closer together. Choose a plant spacing that will give a continuous screen of foliage without gaps when the trees and shrubs mature.

Foliage gaps

Design windbreaks to minimise the number of gaps through which wind can 'jet'. For example, foliage gaps at the base of windbreaks are undesirable because they allow wind to jet through at ground level, increasing the potential for soil erosion under or near the trees. The risk is greatest on bare sandy soils, especially where stock camp, or where the trees have suppressed pasture growth. The wind jetting effect is less severe under wider windbreaks that have more than five rows of trees.

Access tracks

If access tracks are needed through wide windbreaks, place them diagonally through the trees, or in areas where wind speed is lowest, or erosion is least likely. For access tracks passing through a series of parallel windbreaks, stagger the gaps to avoid making continuous passages for wind.

Place gateways and gaps in areas of greatest shelter or where erosion risk is least.

Windbreaks in hilly country

Windbreaks on the windward side of hills need to be closer together because the area protected behind them reduces as the land rises. Place the top windbreak below the crest of the hill, so that when fully grown, the treetops will be at about the same height as the hilltop. Because hills act as solid windbreaks, there can be wind turbulence in their lee, just over the top. Closely spaced windbreaks may be needed there. Towards the bottom of lee slopes, windbreaks can be spaced further apart.

In hilly country, windbreaks are often aligned on contour, or on a safe grade to avoid water erosion problems during establishment, or erosion problems due to machinery operating up and down slopes between windbreaks.

Note that frost pockets can occur behind windbreaks on contour. If frost sensitive crops are being grown, position windbreaks to prevent them from damming up cold air, or use a wider tree spacing at selected 'drainage' points for the cold air.

Species

Many species are suitable for use in windbreaks. The choice depends on each windbreak's purpose, and the suitability of particular species to grow well and provide adequate shelter on the chosen site. Combinations of species are often used to maximise uniformity of foliage cover and to provide biodiversity benefits as well. For example, one or more rows of tall, fast growing trees can be combined with an outer row of dense shrubs to give a tall windbreak with good protection at ground level.

Some useful timber species are listed in the companion TreeNote No. 23 'Timber production from windbreaks'.

A comprehensive and useful guide to selecting species for windbreaks is in the REX 96 Revegetation software. A new version (on CD) is expected in 1999 and will be available from CALM, Agriculture Western Australia, Greening Australia (WA), and Robin Road Software (SA).

Fencing and maintenance

All windbreaks need to have stock excluded, at least while they are establishing. Unless shelter is needed for stock, it may be best to fence them out permanently.

Once established, windbreaks require little maintenance other than weed control and fence maintenance. However, trees grown for timber may need special management, depending on the tree species and the products being grown.

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Weeds may pose a fire hazard in young windbreaks before the trees shade the ground, but can be controlled by crash grazing with sheep once the trees are 1.5 to 2 m high, depending on the tree species. Remove stock before they start to damage lower branches.

Interaction with crops and pastures

Crop growth is often enhanced by the lower wind speeds in the shelter zone of windbreaks. Lower wind speed reduces evaporative demand, protects plants from damage due to rubbing and sandblasting, and prevents loss of topsoil and nutrients.

However, close to the trees some production is lost due to shading, and competition for nutrients and water. Production is also lost from the land on which the trees are grown, unless the trees have a commercial purpose.

Overall, well planned and managed windbreaks are likely to have a nett positive or neutral influence on crops and pastures throughout the high rainfall zone in southern Western Australia.

Competition from roots

Tree roots compete with agricultural plants for moisture and nutrients. Studies at Esperance have shown that increased crop yields in the protected area behind windbreaks can compensate for the reduced yield close to the trees if the trees are root-pruned.

Root pruning

To minimise competition from trees, rip at least 50 to 70 cm deep about 5 m away from the trees, starting when they are 5 m tall (about two to three years old). Root severance is most successful on duplex soils where most lateral roots are close to the surface. However, root pruning is only profitable if the increased returns from improved pasture or crop growth exceed the cost of the operation.

Further reading

'Design Principles for Farm Forestry: A guide to assist farmers to decide where to place trees and farm plantations on farms' (May 1997).

Published by the Joint Venture Agroforestry Program.

Available from the Rural Industries Research and Development Corporation, PO Box 4776, Kingston ACT 2604. Phone (02) 6272 4819, fax (02) 6272 5877. Cost: $16 plus $6 handling and postage. Pre-payment required.

'Windbreaks', by Steven Burke (1998). 130 pages. Available from NRE Information Centre, 8 Nicholson Street, East Melbourne 3002. Ph. (03) 9637 8080. Cost: $39.95.

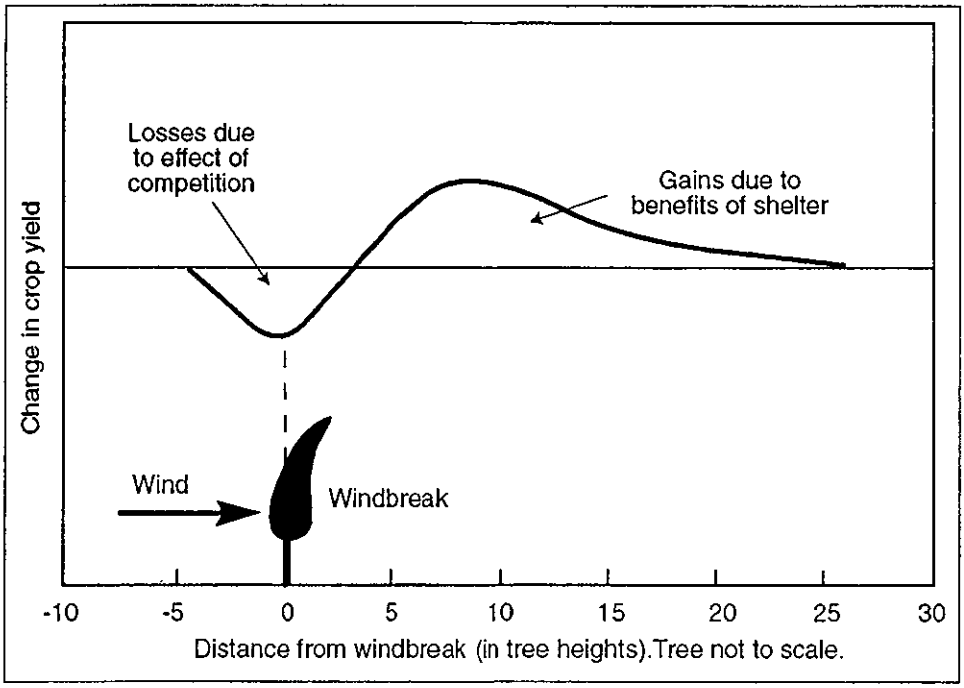

Figure 3. Effect of a tree windbreak on crop yield. (From 'Design principles for farm forestry,' RIRDC 1997.)

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