Technical Information Sheet No. 9 Level 2

Farm Forestry

Why farm shelter?

Farm shelter is promoted as a means of reducing wind speed and ameliorating the local microclimate. High wind speeds lead to chilling of livestock and physical damage to crops through abrasion, drying and wind throw. Well-placed and well-managed shelterbelts can therefore be used to increase agricultural productivity (Table 1).

A range of native and exotic species can be used. Choice and mix of species will depend on the height and depth of shelterbelt required to make it effective at your site. If your shelterbelt includes commercial species some management (e.g. pruning and thinning), the shelterbelt can be sold for timber when it has reached the end of its working life. The income will often more than pay for the replanting of the shelterbelt.

How shelter works

The benefits of shelter are gained through changing the microclimate. Most of these benefits usually occur on the leeward side of the shelter. Figure 1 shows how microclimate changes with a shelterbelt present.

Note that a large reduction in windspeed (up to 60%) is produced by a shelterbelt and this is accompanied by a large reduction (up to 40%) in water loss (evaporation) from crops or dams. These changes are accompanied by increases in soil moisture, air and soil temperature, and relative humidity.

The maximum beneficial effects of a shelterbelt are experienced at a distance of about four shelterbelt heights (4H) downwind from the shelterbelt. At a

Table 1: Benefits of shelter for agriculture

animals	crops	other
• reduced stock losses during breeding	• less soil erosion and nutrient loss	• protection for buildings and work areas
• reduced energy for maintenance	• conservation of soil water	• reduced evaporation from dams
• less winter feed required	• reduced need for irrigation	• assist in grass fire control
• faster growth to target weight	• extended growing season	• habitat for wildlife and predatory birds/insects
	• reduced physical damage	

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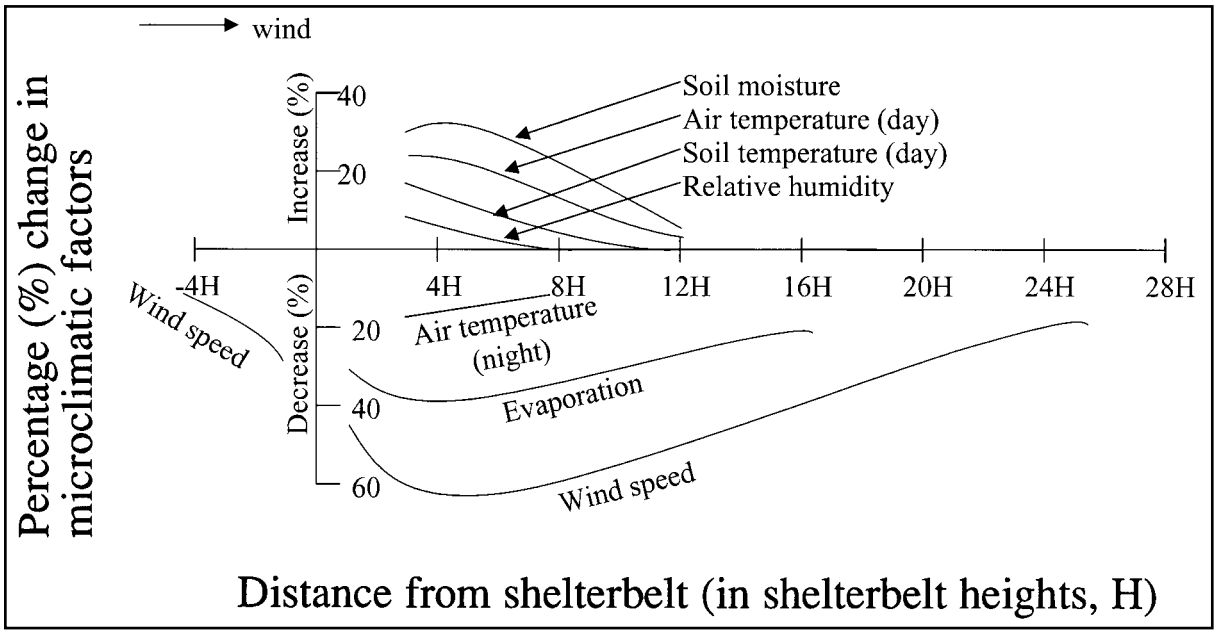
Figure 1: The effect of a shelterbelt on microclimate (modified from Marshall 1967))



distance of between 20 and 30 shelterbelt heights downwind (20H to 30H), these effects have been lost (Figure 1). These effects of shelterbelts determine the distance apart they should be planted to maximise the benefits for agriculture. Table 2 gives the average percentage reduction (-) or increase (+) in wind speed, plant growth, maintenance energy for stock and lamb survival for a whole farm where shelterbelts have been planted at 250 m or 500 m spacings across the farm.

Although shelterbelts have many benefits, there are some negative effects (Figure 2). They produce shade, reducing the amount of light available for the growth of crops and pasture nearby, and they compete with neighbouring crops for the water and nutrients. Trees also deposit leaves and branches as litter or as slash when harvested. There may also be more subtle negative effects on crops/pastures. Shelter creates a warmer, more humid environment which tends to increase incidence of fungal disease. The trees may also attract unwelcome birds/insect pests.

Table 3 gives verified cases of improved crop production following strategic placement of shelterbelts.

Table 2:
Some anticipated percentage benefits from well-managed shelter belts at maturity

Factor	Shelterbelts 500 m apart	Shelterbelts 250 m apart
Windspeed	-33 %	-50 %
Plant growth	+10 %	+20 %
Maintenance energy for stock	-10 %	-17 %
Lamb survival	+5 %	+5 %

Figure 2: The relative effects of a shelterbelt on crop/pasture yield. Most of the benefit usually occurs on the leeward side.

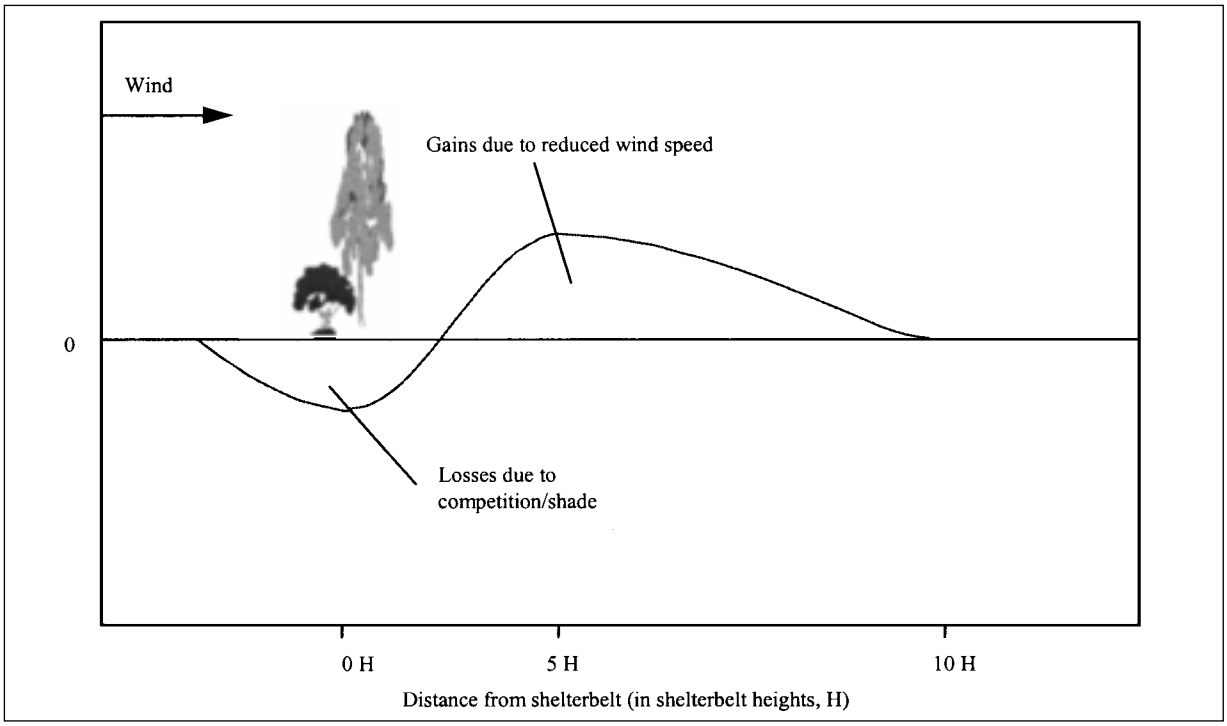


Table 3: Improved crop production adjacent to shelter

Crop	Increased yeild due to shelter (%)	Width of sheltered paddock (in shelterbelt heights, H)	Location
potatoes	6.7%	0-30 H	Atherton Tablelands Qld
oats	35%	1-6 H	New Zealand
oats	51%	4 H	New Zealand
wheat	30-40%	1-10 H	Northeast Victoria
lupin	30%	0-10 H	Esperence WA
Horticultural crops	5-50%	0-10 H	Australia

Design of shelterbelts

Shelterbelts usually consist of a few rows of trees. In shelterbelts consisting of up to five rows of trees, each tree should benefit from the space outside the belt. Wider plantings will behave more like woodlots and the effects of inter-tree competition will be more important in determining growth within the inner rows because of competition and shading between the trees.

Planting shelterbelts in the farming landscape will not only increase yields but also make your farm activities more sustainable. For example, shelterbelts can be planted to control groundwater recharge, erosion and salinity, to protect streams, to provide shelter and shade for buildings, dams and livestock, and to enhance colour, shape, form and texture in the landscape. Maximum benefits from shelterbelts are achieved if about 10% of the

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farm is planted to strategically located shelterbelts.

Shelterbelts should take account of the whole farm plan and be designed to direct the air in a way that maximises benefit to the farm. Where possible they should follow existing fence lines. In addition they should:

- not trap cold air descending downslope or create frost pockets
- not create funnels that increase air speed
- not be so dense as to prevent some filtering of the air through the belt. They should have 30 - 50% permeability.

A cushion of slow air moving through the belt deflects the main volume of wind upwards and prevents it from descending for some distance from the belt. The design and layout of shelterbelts in the farming landscape is considered in detail in Technical Information Sheet No 10: Design considerations.

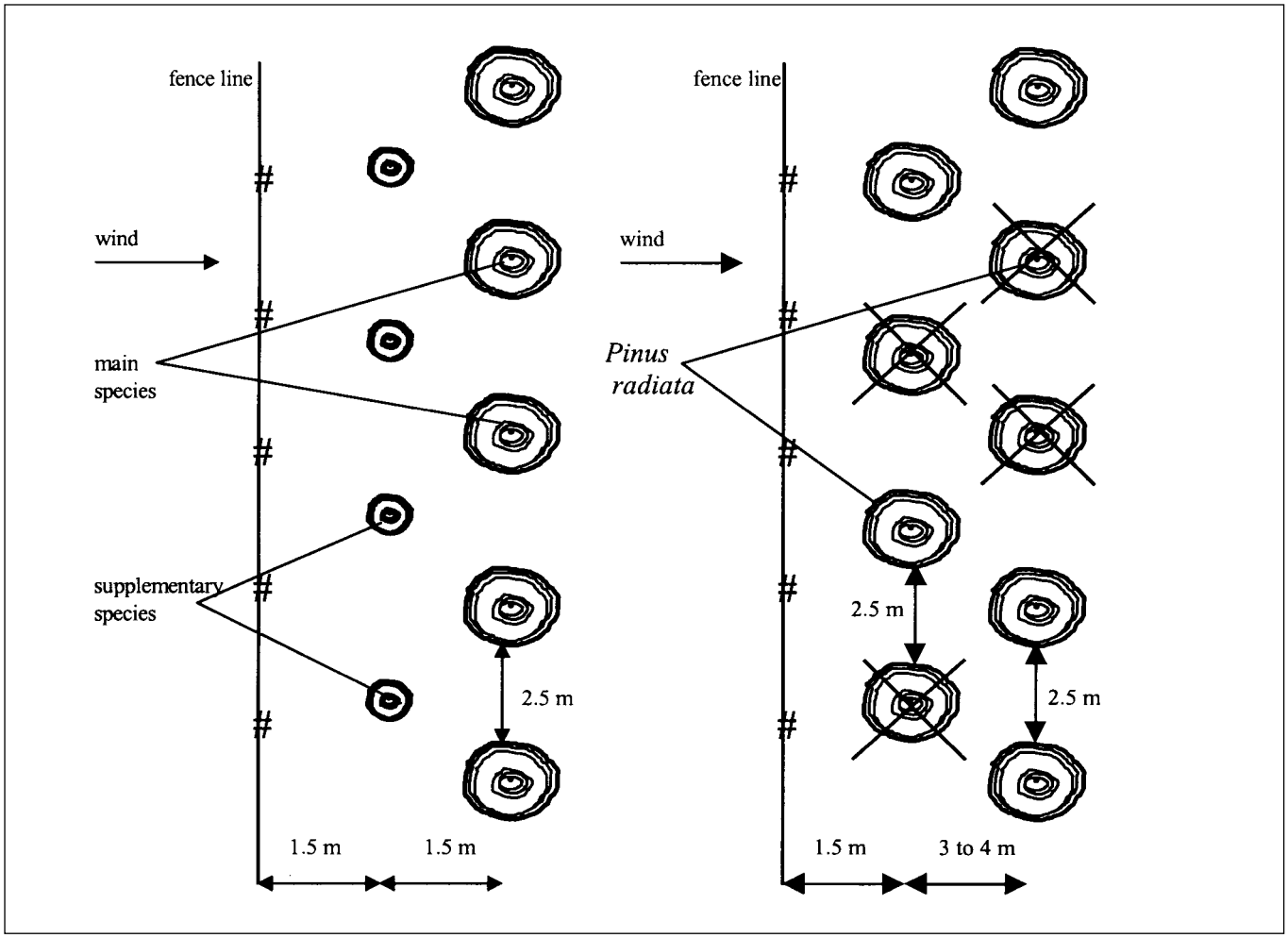
Choice of species and numbers of rows

Pinus radiata and *Eucalyptus globulus* and *Eucalyptus nitens* are excellent commercial species to use where shelterbelts are to be planted in environments suitable for their growth (see Technical Information Sheet No 5: Matching species to site). *E. globulus* and *E. nitens* do not retain their lower branches in the same way as radiata pine and therefore supplementary species are recommended where shelterbelt trees are pruned for timber production. Slower-growing supplementary species, usually either native or exotic shrubs, are often used in the understorey to fill in the gaps to make the shelterbelt more effective.

The trees can be planted or directly sown. Shelterbelts managed for high value timber over a short rotation should be based on high quality planted stock (see Technical Information Sheet

Figure 3: Two types of shelterbelt designs (a) a single row of trees with a supplementary species; (b) two rows of *Pinus radiata*. The crosses indicate trees of poor form removed at thinning.

(a) (b)



No 13: Plant genetics and quality) using suitable site preparation (see Technical Information Sheet No 14: Site preparation), planting (see Technical Information Sheet No 16: Planting), weed control (see Technical Information Sheet No 15: Weed control) and fertiliser (see Technical Information Sheet No 17: Fertilisers) practices. Even if shelter is grown with no commercial product in mind, following the good silvicultural practice described in the Technical Information Sheets above will ensure that the positive effects of a good shelterbelt are seen in the shortest time.

Single or multiple rows/species

Single rows of one species are the most easy to manage and minimise the area of the paddock affected by shading and competition. If you are managing the shelterbelt for timber, then pruning and thinning will be required (see below). Pruning your trees opens up the lower part of your shelterbelt and reduces its effectiveness. Single row plantings should therefore include the planting of a supplementary species a minimum of 2 m to the windward side of the main planting. The supplementary species is planted between the main species (Figure 3a) and should be mechanically trimmed as required to prevent encroachment of branches over the paddock.

Multiple-row/multiple species plantings are inevitably more difficult to manage but provide an opportunity to mix and match species so that your shelterbelt retains live branches to ground level and remains effective over long periods. For example, eucalypts grow rapidly, but as they age, their canopies become more open, particularly at ground level, and they provide high shelter only. Bushy shrubs or smaller trees can be combined with the eucalypts to provide shelter in the lower storey.

A preferred multiple-row option is a shelterbelt consisting of two rows of *Pinus radiata*. The trees are planted at 2 m to 3 m spacings within the row with 3 m to 4 m spacing between the rows. When tree height is about 10 m and/or tree crowns are touching, trees of poor form can be removed to give trees spaced, on average, at 4 m to 5 m in the row (400 – 500 trees/km of belt, Figure 3b). The retained trees may have been pruned (see below). Retention of some trees with branches to ground level on the windward row is often necessary to maintain the effectiveness of the shelterbelt. These trees can be thinned occasionally to control branch growth (see below).

Managing shelterbelts for timber

Trees can be used to combine the benefits of shelter and commercial timber production. Where shelterbelts are managed for timber, they may be called timber belts.

The most valuable part of a commercial tree is the butt log and its value is increased if the branches are removed by pruning. The knot-free wood (clearwood), attracts a premium for appearance-grade timber and veneer. Pruning should be undertaken to at least 6.4 m and thinning may be necessary in multiple-row shelter belts to prevent reduced growth of pruned trees. Pruning will also prevent large branches in the lower crown of the trees on the edge of your shelterbelt from throwing excessive shade on the adjacent field. The branches are removed when they are green (that is still alive) but in several lifts. The removal of large branches that develop and potentially compete with the growth of the main stem also may be necessary before the lift-pruning is undertaken.

Removal of green branches has the potential to reduce the growth of the tree but this can be minimised or prevented if only a few branches are removed in each lift. For eucalypts, branches must be removed before they reach a large size (30 mm) as with increasing diameter, there is an increased the risk of decay entering the cut. Decay entry, if not contained by the tree itself, will reduce the value of your solid timber products.

The upper part of the tree which is not pruned may not be suitable for high-value log grades and may only be saleable as pulpwood, a very low value product. Careful tending of your pruned trees is essential to reap the maximum commercial benefit from your shelterbelt.

Large branches will develop above pruning height on either side of the trees along the edge of the shelterbelt and reduce the value of the wood in this section of the bole. If the trees are spaced closely (at 2.5 m intervals) within the row an effective shelterbelt will develop rapidly. This reduces development of large branches within the row but inter-tree competition for resources will reduce their growth. To remedy this, thinning of alternate trees may be necessary if you want to harvest large trees, i.e. trees with diameters greater than 30-35 cm at breast height (at a height of 1.3 m). The thinned trees of this size are also

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large enough for solid timber products.

If selective pruning of some trees is undertaken, thinning may be necessary before they have reached a commercial size. The information sheets on pruning and thinning (see Technical Information Sheets No 20: Pruning and No 21: Thinning) provide advice on the correct management of multiple-row plantings.

Commercial shelterbelts - two success stories

- Five to six row wide unmanaged radiata pine shelterbelts planted 60 years ago at 2 by 2 m spacings in the Bothwell area were harvested by a Timber Cooperative in 1997. Part of the wood was exported to India for sawing and part sold locally for pulpwood. The estimated value of the wood was $17 000. These belts have provided excellent shelter and an income at harvest even though this low rainfall area is considered unsuitable for commercial forestry. The returns would have more than doubled if the trees had been managed for timber. Those realised were used to re-establish the shelterbelt.
- In a high rainfall area in the North Island of New Zealand, similar to Tasmania's north-west coast, a single row of radiata pine in a 28-year-old two-row shelterbelt managed for commercial timber production, yielded a profit of $30 000 per kilometre when harvested in the mid 1980's.

Protecting your farm shelter

Your young trees must be protected from grazing stock animals, as well as wild animals and vermin. To reduce the cost of fencing, locating shelter belts along existing boundaries means that fencing is required on one side only. The fence lines should be at least 1.5 m from the outer row of trees. Tree guards are an alternative to the construction of elaborate fences with netting and electrification to exclude wild animals. They should be maintained until the main stems have developed beyond likely damage from your suite of herbivores. See Technical Information Sheet No 18: Browsing damage to seedlings, for details.

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