Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Program

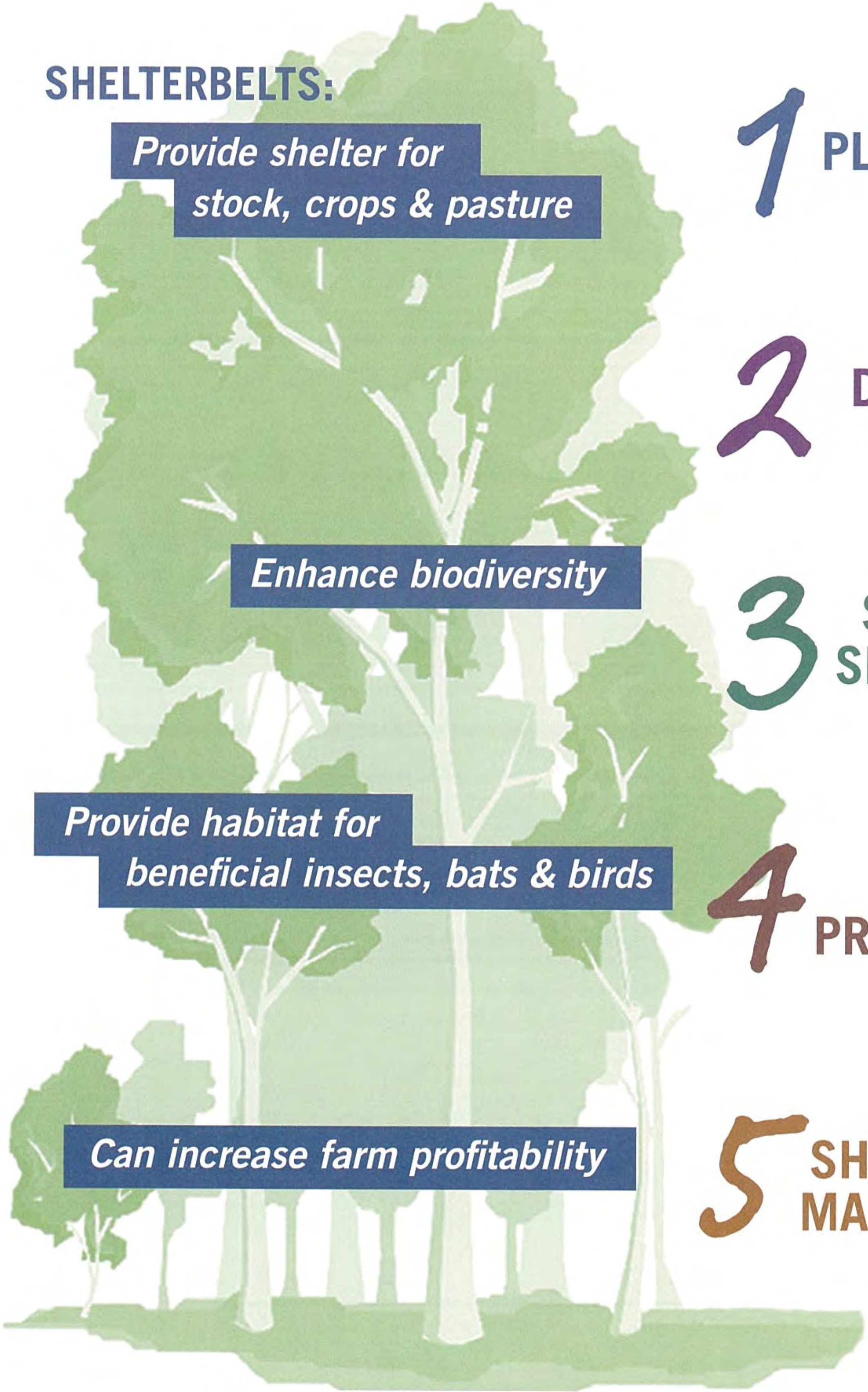
North-West Environment Centre

Native Shelterbelts
for North-West Tasmania

Increasing Productivity and Biodiversity on farms

Contents

Native Shelterbelts booklet overview



Introduction

This booklet aims to provide the main information needed to design and construct native shelterbelts in the highly productive landscapes of North-West Tasmania. It also provides easy to access information on the importance of native species shelterbelts to increase both agricultural production and enhance biodiversity. The booklet forms part of a project funded by the National Landcare Program, which is also establishing six demonstration sites to illustrate best practice shelterbelt design on sites with not only different conditions, but also different farm enterprises. While this booklet is aimed towards the North-West of Tasmania, it will also be useful for other areas of Australia.

This booklet demonstrates that there are significant benefits to be gained from planting shelterbelts and provides details on:

- The benefits of planting a native shelterbelt
- How to plan and design your shelterbelt
- How to select species
- Site preparation and planting, and
- Shelterbelt management

The North-West is the most agriculturally productive region in Tasmania. The fertile red soils of the North-West coast support a range of agricultural industries. Dairying, vegetable growing and beef cattle are the three major agricultural industries, with prime lamb production, orchards and other horticultural and livestock enterprises also playing a role in the highly diverse agricultural industry. Many areas of the North-West are rich in biodiversity, including a very diverse range of vegetation types. This diversity of vegetation in turn supports a large range of wildlife, including threatened species such as the Wedge-tailed Eagle, the Orange-bellied Parrot and the Tasmanian Devil.

Shelterbelts have been used for many centuries to combat wind and favorably change local climatic conditions, and therefore benefit crop and animal production. Strong winds, together with drought, flood and extremes of temperature, are among the major natural causes of crop and animal production losses. Most shelterbelts in southern Australia were established to reduce the exposure created after the original landscape was cleared in the late nineteenth century. A large number of these used exotic species, particularly Monterey pine (Radiata) and Monterey cypress (Macrocarpa). Since some of these species planted in the past are now dying, it is timely that the benefits of using native species are being increasingly recognized, and are replacing exotic species.

Shelterbelts are especially important to the North-West of Tasmania, due to the strength of its prevailing westerly winds, the Roaring Forties. They are likely to become even more important in the face of climate change, particularly due to their ability to reduce evaporation. Shelterbelts can also provide habitat for native animals such as birds and bats, which in turn can provide natural pest management services. Other benefits shelterbelts provide are to decrease local waterlogging, decrease evaporation, increase survival rates for livestock and improve the aesthetic value of farmscapes. These benefits are claimed to be maximised if 10% of the land is planted to shelterbelts[1] and other native vegetation, while others claim over 30% maximises the benefits to production.[2] Shelterbelts therefore need to be as wide as possible, with five or more rows providing good all round benefits.

Terms used in the booklet

In this booklet, the term shelterbelt refers to the use of trees and other vegetation to provide shelter for crops and animals, and alter the microclimate. Other similar terms used in the literature are windbreaks, shelter wood, and shelter trees. Leeward refers to the sheltered side of the shelterbelt. Since many of the effects of shelterbelts are a function of the height, throughout the booklet, H refers to shelterbelt height.

In a nutshell...

Shelterbelts can:

- increase soil and air temperatures and reduce evaporation
- reduce plant damage from high winds
- increase soil stability
- improve irrigation efficiency
- increase livestock production

Shelterbelt benefits

Benefits to crops and pasture

Enhancing microclimates

Shelterbelts alter the average wind speed, wind direction and turbulence of the airflow. Decreasing the effects of wind events that cause plant damage and soil erosion are ways shelterbelts can increase production. Plant damage can be caused by sandblasting which buries or removes seedlings from the soil, damages leaves and stems, and tears and strips leaves.

Shelterbelts can also make soils warmer by day and lose less moisture through evaporation and evapo-transpiration. This can encourage earlier germination, plant growth and improved water use efficiency. Trees decrease inward radiation during the day, and reduce outward radiation at night; therefore they give plants at ground level protection from extreme weather events such as frost.

The following figure illustrates the extent and nature of shelterbelt effects on microclimates. Figure 1 shows that crops grown adjacent to shelterbelts may have lower yields as a result of competition for light, water and nutrients, however in the area from five times the height of the shelterbelt to 25 times the height, growing conditions are improved, in particular by warmer temperatures and increased humidity.

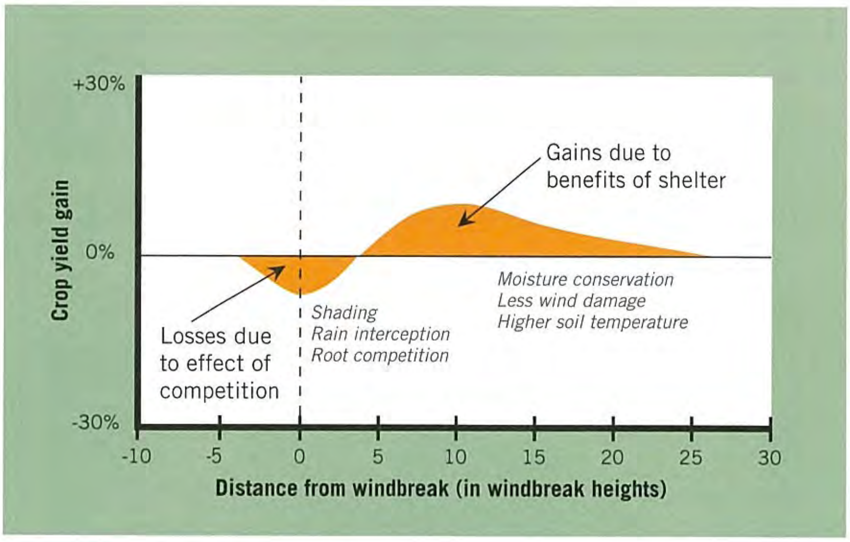


Figure 1: The impact of shelterbelts on crop yield.
(Adapted from Abel et. el. 1997)

Soil stability

Topsoils are normally the most fertile part of the soil profile, and are therefore vital for crop and pasture growth. Loss of topsoil or soil erosion generally occurs because of over-clearing, over-grazing, strong winds and/or rain. Shelterbelts and other plantings of trees can help reduce erosion by decreasing wind speeds and water flows, holding soil together, and increasing infiltration.

Shelterbelts are more effective than plantings of single trees to reduce erosion, especially on sloping ground. The rate of soil loss increases with the length of the slope; slope length can be decreased by planting trees in a shelterbelt across the slope.[3]

Irrigation

Windy conditions can greatly reduce the uniformity of sprinkler irrigation, which affects both cropping and grazing industries. Investigations by Agriculture Western Australia have shown that yield variation due to poor irrigation uniformity is common on many properties. Reducing wind speeds by the use of shelterbelts allows irrigation systems to function more efficiently and reduces water use, in addition to the general reduction of evaporation as a result of shelterbelts.[4] In some cases, shelterbelts can also reduce evaporation from dams by 20 to 30%.[5]

Nutrient Cycling

Trees can extract nutrients from deep in the soil and concentrate them in the surface layer. This positive effect on nutrient cycling may in turn may have a positive influence on pasture growth in the vicinity of the trees. For example, many eucalypts return substantial amounts of Ca, N, K, Na and Mg to the topsoil via leaf-drip and litter fall.[6]

Benefits to livestock

The benefits of shelterbelts for animal production include increased liveweight gain, with experiments showing that strong wind and rain events can double the need for energy for maintenance for sheep and cattle. Other benefits are reduced loss of new borns, lower mortality, higher fertility, and reduced incidence of some diseases e.g.10% decrease of cases of mastitis.[7]

Livestock can be affected by both hot conditions and cold stress, the latter as a result of low temperatures combined with wind and rain. Cold stress in particular causes a diversion of energy towards the maintenance of constant body temperature, thus reducing energy available for growth and lactation. Livestock will attempt to increase their metabolic rate by strategies such as shivering, accompanied by an increased intake of feed. Even the immune system of new-borns is adversely affected by cold stress.[8] The provision of shelter reduces this stress, and therefore reduces maintenance costs such as food supplementation.[9]

"It makes farming easier when your stock is sheltered, happy and healthy."

Anthony & Kathy Lalor, The Weekly Times, 19/12/07

Did you know?

Eucalypt species repel insects such as blow flies.

Biodiversity and ecosystem services

Native shelterbelts designed on the following five ecological principles will be most effective for achieving long-term sustainable agriculture: plant species diversity, structural diversity (layers of vegetation), nutrient cycling, landscape connectivity and ecosystem resilience and stability. Designing shelterbelts using these principles in particular maximises ecosystem services.

There is increasing recognition of the value of enhancing biodiversity to capture the benefits of ecosystem services. Ecosystem services are the benefits nature provides, such as clean air and water, natural fertilisation and nutrient cycling in soils, mitigation of climate, pollination of plants including crops, control of pests, provision of genetic resources, and the production of goods like food, fuel and fibre.[10]

Managing agricultural pests using biological control is a particularly useful ecosystem service that has the potential to reduce pesticide use. The modified nature of many agricultural systems are unfavorable environments for the natural enemies of pests. When annual crops are continually rotated or replanted, the predator-prey relationship can be disrupted. In such systems, lack of habitat, hosts or prey may prevent natural enemies from persisting. Encouraging habitat and food sources in shelterbelts for beneficial fauna can thus help prevent pests from reaching levels where damage occurs. Permanent strips of vegetation within a field such as a shelterbelt may attract beneficial fauna year-round, especially insects, birds and bats.[11]

Insects

Beneficial insects can be classed as:

- Natural enemies – predators (insects that feed on other insects) and parasitoids (insects that develop on a host insect, killing the host)
- Pollinators – bees and other insects that pollinate flowers while collecting nectar and pollen

Beneficial insects require:

- Shelter: moderated microclimates, overwintering sites and reproduction sites
- Food: nectar and pollen

Shelterbelts planted with perennial native vegetation provide an undisturbed habitat and food source to maintain beneficial insects such as lacewings, ladybirds (Figure 2), parasitic wasps and flies, native bees, predatory mites, and a range of spiders. Many beneficial insects that prey on horticultural pests are native and thus are adapted to native vegetation.

In a nutshell...

- Shelterbelts can provide food and habitat to attract beneficial fauna
- Beneficial fauna such as insects, birds and bats reduce pests of pastures and crops
- Native vegetation will maximise the habitat value of the shelterbelt
- Diversity of species and structure of vegetation is important

Figure 2: Transverse ladybird – ladybirds eat pests such as aphids and scale insects. Source: Dept. Primary Industries and Water.[12]

Birds

Birds play a vital role in agricultural ecosystems by controlling insect populations, including pests of pastures, crops and trees. Birds also perform important ecosystem services such as pollinating plants and dispersing seeds. A healthy bird community can remove 50% percent of the insects produced (about 30 kilograms per hectare per year).[13]

Native vegetation on farms provides food, shelter and nest-sites for many beneficial birds that take insects from the ground such as the Australian magpie, robins and fairy-wrens, and for birds that forage for insects on foliage, branches and trunks. Native shelterbelts and remnant and riparian vegetation provide habitat for bush birds that feed on leaf-defoliating insects of eucalypts. For example, hairy leaf-eating caterpillars are devoured predominately by cuckoos but also by the cuckoo-shrike and the grey shrike-thrush.[14]

The key to attract beneficial birds to live on farms is to protect existing remnant and riparian vegetation and link them with native shelterbelts. Diverse native shelterbelts with canopy eucalypts and a variety of understorey trees and shrubs provide birds with food, shelter and nest-sites.

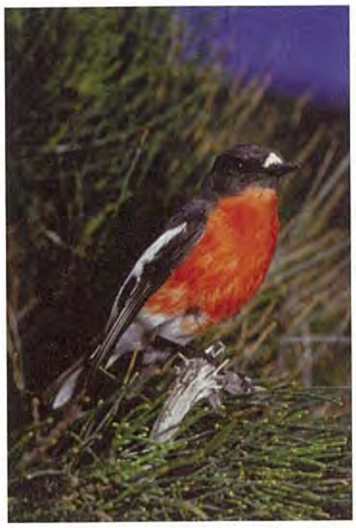


Figure 3: Flame Robin – a declining ground foraging insectivore
Photo: Trevor Waite

Bats

All Tasmanian bats live on insects, and do not eat fruit. They are nocturnal and opportunistic feeders, and most commonly eat moths, beetles, caterpillars, mosquito's and other flying insects, and thus help control the numbers of, for example, mosquito's and other crop pests. Surveys in Victoria have found that pest species make up 80% of a bat's diet at certain times of the year.[15]

Bats utilise a number of different roost sites; some prefer cracks in dead trees, some small hollows, some nest in bark, and some in dead branches on live trees, indicating the importance of vegetation diversity. Bat boxes can be effective in attracting bats to shelterbelts, but a lot of boxes are needed. As an indication, 30-40 boxes would be needed for a 500m square area.

Figure 4: Chocolate Wattled Bat – they catch insects from the canopy to the understory.
Source: Tasmanian Parks and Wildlife Service, Dave Watts

Other species

Many other species such as bandicoots, quolls, and Tasmanian devils also play an important role in the health and productivity of Tasmanian farms. The diet of Eastern Quolls, for example, consists mainly of insects, as well as rabbits, mice and rats.

The key issue in using plants to attract beneficial fauna is to grow as many different plant species of varying shapes and sizes as possible. For example, tall eucalypts and other trees can provide perches and nest sites for birds including birds of prey and magpies that attack agricultural pests, while dense or prickly shrubs offer refuge to many smaller bird species. Another important strategy is to include a range of plant species in your shelterbelt that together provide flowers throughout the year to help attract beneficial fauna.

Overall shelterbelts benefits:

Plants

- **Increased growth of pasture**
- **Increased growth of crops**

Animals

- **Increased liveweight gain**
- **Increased fertility**
- **Decreased mortality**
- **Increased wool production**

Environment

- **Decreased soil erosion**
- **Increased water quality**
- **Decreased pesticide use & pollution**
- **Improved farm landscapes**

Economic benefits

Shelterbelts have been found to increase farm profitability when they reduce the severity of wind events.[16] The ways that shelterbelts can increase farm income is summarised (left), with some direct evidence shown in Table 2. It is important to note that many of the results showing increased returns from shelterbelts have occurred during extreme weather events, as this is when the main production benefits are evident. While factors such as increased pasture production have been measured in a variety of studies, other direct economic benefits are more difficult to quantify, particularly in attributing them specifically to shelterbelts. These include reduced soil erosion, increased water quality, decreased pesticide use and improved farm landscapes.

Carbon trading may also provide an additional monetary incentive for planting shelterbelts. Understanding and acknowledging the role of trees in cycling oxygen (by taking in carbon dioxide, a greenhouse gas, and releasing oxygen) is becoming increasingly important as a solution for mitigating climate change. Through the CarbonSMART program, farmers can receive regular payments for tree planting for up to 30 years; there also may be the possibility of financial assistance with the initial planting. For further information including eligibility information, see www.carbonsmart.com.au.

Significant research was conducted in northern NSW between 2004 and 2005 on various practices that enhanced both biodiversity and production benefits on commercial wool growing properties. The project generated a range of financial models at the whole farm level that utilised farm financial data from over 20 farm families. The management practices that were modeled included the use of shelterbelts, with Figure 5 demonstrating that over a 20 year period the net present value of a shelterbelt was $113/ha compared to not having shelterbelts on a property.[17]

A particular benefit of shelterbelts is that their greatest effect on pasture in many studies has been found to occur in winter, when pasture is in short supply. For example, a study conducted by the Joint Venture Agroforestry Program in Canberra found that pasture productivity in areas protected by trees at the sites studied was significantly higher than adjacent open sites. Across five seasons it was on average 26% higher per unit land area, with the largest effect occurring in winter.[18]

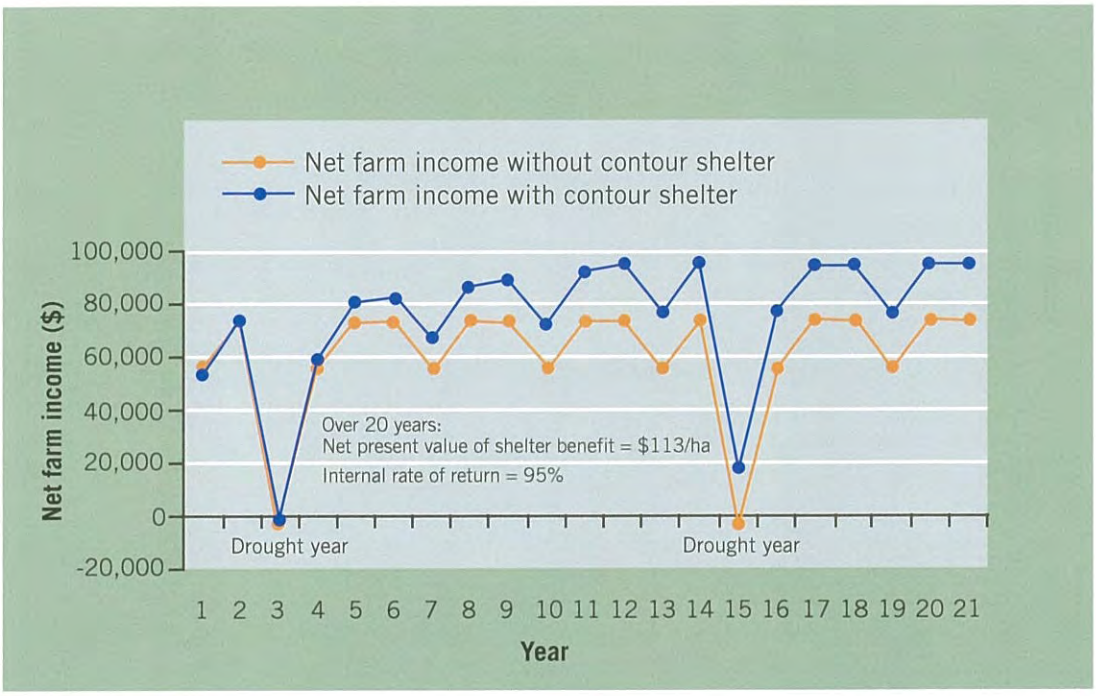


Figure 5: Whole farm returns from shelterbelts, Land, Water & Wool Northern Tablelands Project

"Originally, we planted mainly trees, and very few shrubs, but we soon found that they can get pretty sparse, especially when they don't all survive," says Caroline. "So we moved on to planting shrubs with the trees to provide extra cover. We are now planting 60% trees and 40% shrubs."

"We have also moved from three-row to six-row windbreaks over the years in order to make room for the shrubs and to get better density, wind protection and biodiversity. Our standard tree line is now four rows of trees and two rows of shrubs on the lee side."

James & Caroline Street, Wool farmers

Table 2: Effects of shelterbelts on plant and animal production.

Research findings	Region
Benefits of trees on crops	
An increase in wheat and crop yields in sheltered zones estimated to be between 22% and 47%	Rutherglen, Victoria
An increase in lupin yield by 19-27%	Gibson, Western Australia
Crop yields from windbreaks increased by 25%	Overseas (not specified)
Increased yields of 25%-45% in sheltered crops of wheat, oats and lupins and yield increases of 20%-100% in horticultural crops	Not specified
Benefits of trees on pasture growth	
20-30% higher yield with annual benefits of $38 to $66 per ha	Mainland Australia
20% increase in average annual pasture growth was estimated for protected areas of a farm	Australia and overseas
Benefits of trees for beef, dairy and lamb production	
Increase total dairy production by 30% (20% improved pasture growth, 10% improved milk production)	Victoria
On a day of 27°C, unsheltered cows will have 26% less dairy milk production than shaded stock	Australia
31% wool production increase and 6 kg (21%) more liveweight and 18% increase in pasture (in a 5 year trial)	Armidale, NSW (rainfall 860 mm)
Lambing losses halved from 36% loss to 18% loss	South-west Victoria
27% increase in survival of single lambs[19]	Southern Australia
Beef cattle sheltered by windbreaks gained an average of 15 kilograms more than cattle in an open feedlot. Requirements for feed were 7 percent greater for those in open lots than for similar animals with shelter[20]	Montana, USA
Benefits of trees for orchards	
Grade 1 fruit was 67% in protected blocks with 40% in unprotected blocks	Australia
Increased yields of between 13% and 16% due to increased fruit set and size, increased tree canopy growth of between 8% and 12%.[21]	Australia

Initial planning

How do I start?

1. Walk around your property and observe which direction your strongest winds come from. This is indicated by your existing trees – if they have a slight lean, or less branches/ foliage on one side, then your prevailing strong winds come from the opposite direction.

2. Identify where shelter is particularly needed. Plan your shelterbelt to be located at right angles to your prevailing winds wherever possible, and note all other areas where trees could be planted for example to connect your shelterbelts, or to connect to remnant vegetation. Decide on the width of your shelterbelts, remembering that four or more rows (five rows is considered best practice for a range of benefits) provide more benefits than three rows.

In a nutshell...

- Pre-planning, starting with observation of your property is important
- Start planning your shelterbelt one year before you intend to establish it
- Native species have a number of advantages over exotics
- Diversity of plant species within the shelterbelt is important

Have you done a Whole Farm Plan?

This will help you identify where to locate your shelterbelts.

Figure 6 - Use your farm map to plan locations of any new work

Shelterbelt design

The effectiveness of shelterbelts is influenced by:
- density
- height
- number and type of rows
- layout
- connectivity

Generally, planting 5 to 10% of land to trees in shelterbelts can achieve a 50% reduction in windspeed.[22] Small reductions in wind speed result in large reductions in wind erosion. **The height of the shelterbelt and the density are the most important factors affecting the performance of shelterbelts.**

Density

Density* (see left) depends on the proportion of solid material, mainly branches and foliage within the shelterbelt. The optimum density of a shelterbelt depends on its purpose. A high density shelterbelt provides a high level of shelter over a shorter distance, therefore for example, will provide maximum shelter for stock. However a high-density shelterbelt creates turbulence on the leeward (sheltered) side of the shelterbelt, and provides less shelter effects further away from the shelterbelt.

On average, a medium density shelterbelt (40-60% density) will provide good general benefits. It is important that it is evenly dense from top to bottom to avoid wind tunnelling through any gaps. Ways to increase the density of shelterbelts are to use plants with dense foliage and increase the number of rows in the shelterbelt. Plants can also be spaced closer together; the following gives the recommended plant spacings within each row for a medium density shelterbelt.

Height of mature vegetation	Plant spacing (metres)
Shrubs (up to 6 metres)	1.5-2.5
Medium trees (up to 15 metres)	2.5-4
Tall trees (above 15 metres)	3-4

In a nutshell...

- The denser the shelterbelt, the greater the reduction in wind speed, the shorter the sheltered zone and the greater the turbulence in the lee
- The taller the shelterbelt, the larger the area of shelter provided
- Since wind speeds are higher at the ends of shelterbelts, the area of shelter provided is a triangular shape
- Dense (60-100%) shelterbelts are best for sheltering animals
- Semi-dense (40-60%) shelterbelts are best for crops

****Density** *is determined by the amount of space in a shelterbelt through which air can travel and is easily judged by the amount of light that can be seen through the leaves, twigs and branches along a shelterbelt's face.***

Figure 7 shows the difference between a low density, porous shelterbelt and a high-density non-porous shelterbelt. This shows that denser shelterbelts decrease windspeed more than low density porous shelterbelts.

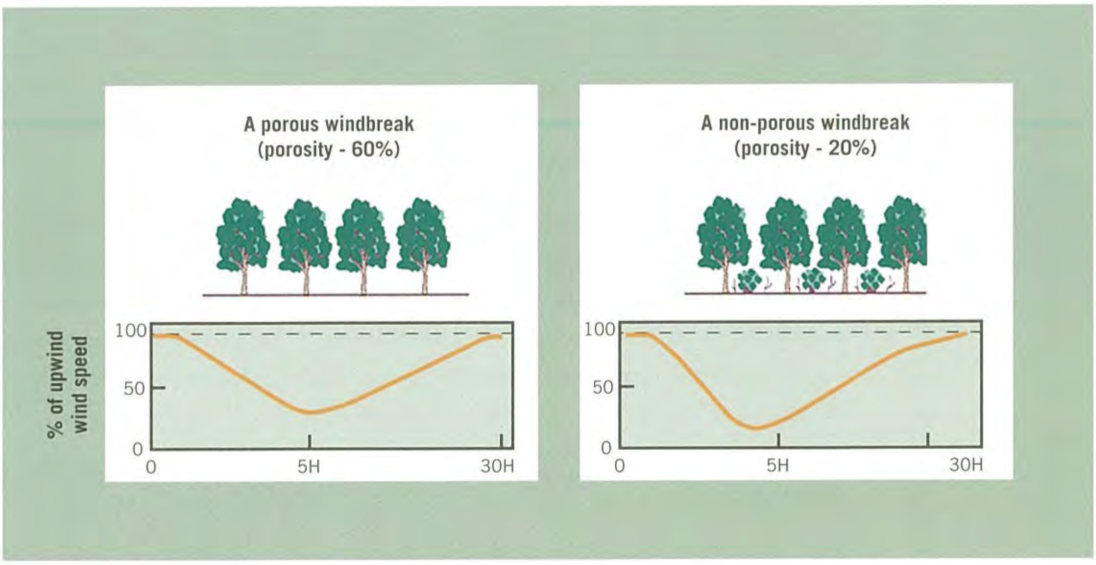


Figure 7: Difference in reduction of windspeed of porous shelterbelt compared to a non-porous shelterbelt (H = shelterbelt height). (Abel et. el. 1997)

In windy situations, such as exposed hilltops, wider shelterbelts are preferable (greater than 10 metres). Wide belts provide greater protection and allow species, protected deeper within the shelterbelt, to reach greater heights.

A general guideline for creating sufficient density is for the proportion of shrubs and trees to be 60% shrubs and 40% trees. Others advocate that shelterbelts should be comprised of 1/3rd tall, 1/3rd medium and 1/3rd small species. The proportion used will depend mainly on what plants are available, and the function required for the shelterbelt. For example, if a small area is required to be sheltered with a high degree of protection, a denser, wider (eg 20 to 30 metres wide) shelterbelt with an even mix of species will be effective. Figure 9 shows the most common shelterbelt patterns, with option c) showing how to create access through the shelterbelt, while decreasing wind tunnelling.

Height

The higher the shelterbelt, the larger the area of shelter provided. To maximise height, include at least one row of the tallest native species that grow in the region, and consider fast growing species. For example, shelterbelt height of 20 m or more can be achieved by growing local eucalypts. Another way to maximise shelterbelt height is to establish the shelterbelt on a mound or ridge. The shelterbelt should contain plants of different heights, with as many rows as possible, to reduce the possibility of gaps which result in an acceleration of windspeed. Where a denser but shorter shelterbelt is required, for example to provide maximum shelter over a smaller area, either Blackwoods or tall shrubs can be used as the canopy.

Number and type of rows

To maximise benefits, best practice shelterbelts are five rows wide, but three rows will still provide some benefits. Increasing the number of rows in the shelterbelt has the added advantage of decreasing the impact of some of the plants not surviving the initial establishment period. Rows should be spaced between 2 to 4 metres apart to allow the plants to grow relatively unrestricted. A five-row shelterbelt can consist of either a central row of tall trees with medium trees then tall shrubs on each side or three central rows of tall trees interplanted with medium trees then tall shrubs on the outer rows.

Placing shrub species on either side of rows of trees has a number of benefits. It provides better habitat for wildlife, and larger tree branches are less likely to damage fencing if they fall. Shrubs on the outside rows also avoid being shaded out by the taller species. Growing a canopy of tall eucalypts and layers of understorey trees and shrubs enhances diversity and structure within a shelterbelt and provides habitat for many kinds of beneficial fauna.

Frost

Cold air flowing downhill can be trapped or dammed up behind dense shelterbelts causing frost damage in susceptible crops. On sloping areas a shelterbelt above the crop can reduce this problem. The lower end of the shelterbelt must not be blocked, so that cold air can move away freely.

Layout

The direction of prevailing and other winds and the location of stock and crops that require protection are major deciding factors on the orientation of shelterbelts. Shelterbelts should be placed perpendicular to problem winds. No single orientation of a shelterbelt will provide protection from all winds. Therefore several belt orientations will provide greater shelter.

Although shelterbelts are commonly linear, for example following existing fencelines, non-linear shelterbelts are also effective. Planting shelterbelts along waterways and gullies is becoming more common (see Figure 8); the corners of paddocks are also increasingly being incorporated into shelterbelts. The incorporation of remnant vegetation will provide a cost-effective shelterbelt and one that enhances biodiversity values.

Figure 8: Shelterbelt following gully. Photo: Jim McLeod

Ideally belts should form a grid using north-south and east-west orientations If excessive shade is a concern, north-south orientations are the best format. This will provide shade for stock at different times of the day and protection from winds coming from all directions. Another option (more suitable for grazing) is to space shelterbelts closely together, for instance at 6 H or 12 H spacings. A different form of shelter is provided by cluster plantings, which are an economical way of providing shelter for live stock, although not nearly as effective as a continual shelterbelt. Figure 9 shows the most common shelterbelt patterns.

To reduce shading, leaf litter and competition from tree roots, shelterbelts should be planted at least 10 m from the cropping area. A greater buffer area is needed for tall windbreak species. Sufficient room should be left to allow ripping of the tree roots and vehicle access and turning space. A greater distance between crop and shelterbelt is required when trees are planted to the north of the cropping area so as to minimise shading in winter.

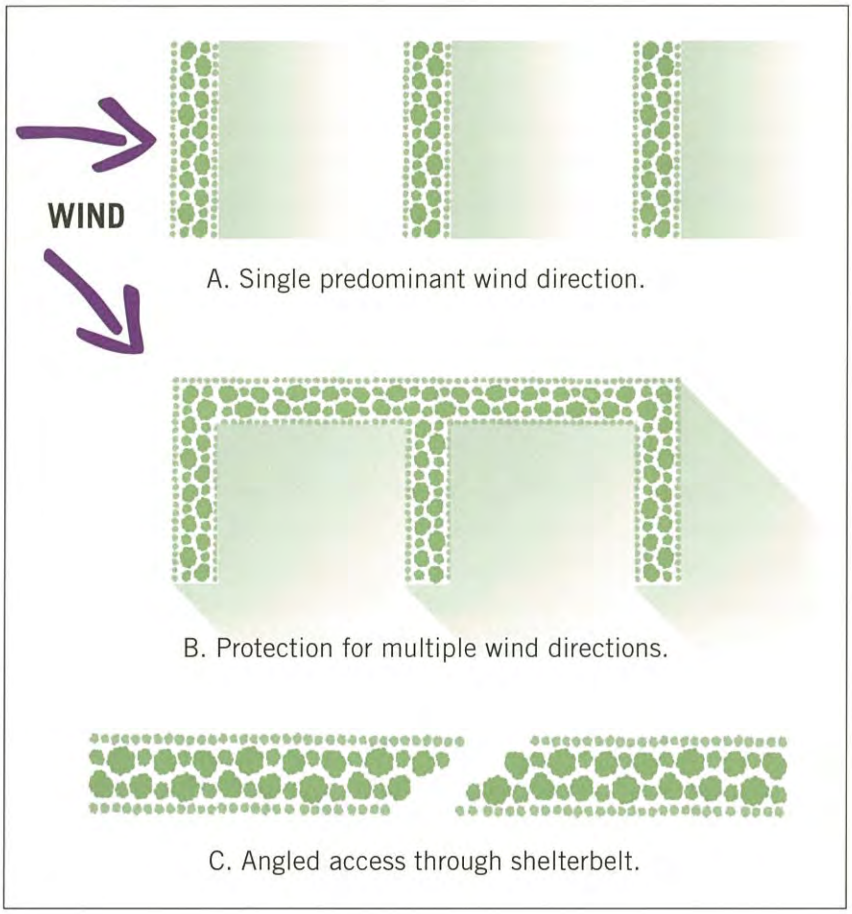


Figure 9: Common shelterbelt configurations
(Adapted from Abel et. el. 1997)

Spacing between shelterbelts

Not only is the width of your shelterbelt important, you will also maximise benefits if you repeat shelterbelts a certain width apart. As shown in figure 1, the gains due to the benefits of shelter reduce to zero generally at a distance of 25 times the height of your shelterbelt. Therefore it is recommended for sites with low to medium exposure to wind, to space shelterbelts at a distance of between 30 to 35 times the height of your shelterbelt.

For example if your shelterbelt will grow to 20 metres high, you should space your shelterbelts between 600 and 700 metres apart. If your site has high exposure to winds, or a high degree of protection is required, a spacing of 20 to 25 times the height of your shelterbelt will be most effective, which equates to a distance of 400 to 500 metres apart if your shelterbelt will grow to 20 metres.

Connectivity

Many native animals require a connected network of habitat for their survival, dispersal and reproduction. The linkage of large and small patches of habitat with habitat corridors such as riparian vegetation and shelterbelts is vital for animal movement. Designs that incorporate broad shelterbelts of many native trees and shrubs provide more habitats for beneficial birds, bats and insects than narrow, less diverse shelter. Shelterbelts provide more benefits if they incorporate and link with existing remnant and riparian vegetation.

Species Selection

In a nutshell...

Remember:
- The right plant in the right place at the right time
- Natives have many advantages over exotics
- Diversity of plants is important

The first priority in planting any vegetation should be the **"Right plant in the Right place at the Right time"**. Most failures of tree plantings occur because the wrong species have been selected for particular site conditions, and/or they are planted at the wrong time of year. The key to selecting the most suitable native trees and shrubs for shelterbelts is to match the site (geology, soils, climate, aspect and elevation) with the best local plant species and communities adapted to that site. To identify species local to your area, look for the main plant species in remnant vegetation on your own and nearby properties, along roadsides and waterways, in reserves and parks, or see your local native plant specialist.

In addition to providing biodiversity benefits, it is best practice to select several species of trees and shrubs for use in shelterbelts to prevent losses of all the trees if there is an outbreak of insect pests or tree diseases. It is recommended to use natives for your shelterbelt, as they have the following advantages:
- good survival rates: able to survive most hazards such as fire, frost and drought
- need minimum water and fertilizer
- require minimum follow up management during establishment
- able to attract beneficial fauna
- naturally regenerate which can decrease the costs of maintaining shelterbelts.

Other considerations are the ability of shelterbelts to physically intercept dusts, gases and microbial particles eg spray drift, that are carried in the wind. Species with leaves with large circumference to area ratios shapes are more effective in this regard.[23] Native species that are particularly effective at trapping these particles are ones with needle leaves, particularly Allocasuarina or sheoaks. Finally, shelterbelts can reduce the spread of weeds by trapping wind-borne seeds and suppressing the growth of weeds within the shelterbelt. Some weeds may germinate within shelterbelts but will be suppressed to the point that seed is not set.[24]

The following gives more specific information on selecting native species for your shelterbelt, in terms of planting the right plant in the right place. The plant species that are mentioned are commonly found in North West Tasmania.

Figure 10: Hakea lissosperma-Hakeas produce nectar which attracts birds
Photo: Jim McLeod

Canopy eucalypts

To enhance diversity and effectiveness of beneficial animals select at least two species of local eucalypts. For example, Stringybark and White Gum grow on well-drained soils in valleys and slopes, Smithton Peppermint grows on less-fertile grey podsols and Swamp Gum and Brooker's Gum grow on wetter, low elevation sites. Two species of eucalypts that coexist in nature are Stringybark and White Gum, and White Gum and Swamp Gum. Thus within a shelterbelt row of tall trees, White Gum can be alternated with Stringyybark or with Swamp Gum (see Figure 11). It is important to grow different eucalypts since different insects and their predators and parasitoids are specific to particular eucalypts. An ash with fibrous bark like Stringybark tends to support a different suite of insects than a smooth-bark gum like White Gum. Thus Stringybark are favoured by bark foraging honeyeaters whereas White Gum is the preferred foraging tree of pardalotes that prey on sap-sucking insects.

Medium Understorey Trees

Nitrogen fixers such as wattles *(Acacia spp)* and she-oaks *(Allocasuarina spp)* are good for achieving diversity, structure and nutrient cycling. Tall Blackwood and shorter Sallow Wattle can be interplanted between eucalypts (see Figure 12). Within a windward row of eucalypts it is best to interplant with a tall wattle such as Blackwood since it lives longer than Silver Wattle. The leeward row of eucalypts can be interplanted with shorter wattles such as Sallow Wattle. Other dense understorey trees that can be interplanted between eucalypts are Cheesewood, Lancewood and Dogwood. On wetter sites Musk, Cheesewood and Dogwood can be interplanted between eucalypts.

Figure 11: Planting of a shelterbelt
Photo: Jim McLeod

Tall Shrubs

Shrubs, especially on the windward side, are an important component of shelterbelts because they provide low-dense foliage to slow wind speed and reduce wind tunneling and deflect wind through the more porous tree layers. Shrub layers on both the wind- and leeward sides provide better shelter for livestock. Figure 12 demonstrates a four row shelterbelt that incorporates tall shrubs in the outer rows. It has been designed for a dry site on a beef cattle property, but the plant species could be used in other designs on dry sites in the region.

Different species of tall shrubs, mostly 4-6 m high but up to 8 m, can be planted in sequence based on their shape, growth rates and requirements. For example, Manuka, a tall skinny, relatively slow-growing plant that tolerates dry conditions can be interplanted between more bushy shrubs such as Silver Banksia, Bulloak or Hopbush. Nectar-bearing plants such as Banksia, Bottlebrush and Correa that attract nectar-feeding birds can be planted apart from one another so as to provide birds with food as they move along the shelterbelt.

Matching plants to your site

Appendix 1 gives details of the conditions that species recommended for shelterbelts in the North West can tolerate. For example while many shrubs are adapted to dry conditions, some like Mountain Correa, Mountain Pepper, Woolly Tea-tree, Swamp Paperbark, Scented Paperbark and Lemon Bottlebrush prefer wetter sites.

Choosing plants to attract beneficial fauna

Shelterbelts using local native plant species are best able to provide habitat, corridors and landscape connectivity for biodiversity, especially beneficial birds, bats, bandicoots and invertebrates. Local native shrubs in the protea, myrtle and daisy families are especially important for providing food, shelter and nest-sites for pollinators (birds and insects), predatory birds and insects, and parasitic insects. Banksias, Hakeas, Tea-trees, Lemon Bottlebrush and local Correas, are an important source of nectar and insects for honeyeaters. Flowers of myrtaceous plants (eucalypts, tea-trees, paperbarks/Melaleuca), daisy plants (Musk, Blanket leaf) and proteaceous plants (Banksia, Hakea) are an important nectar and pollen source for parasitic flies and wasps, and native bees.

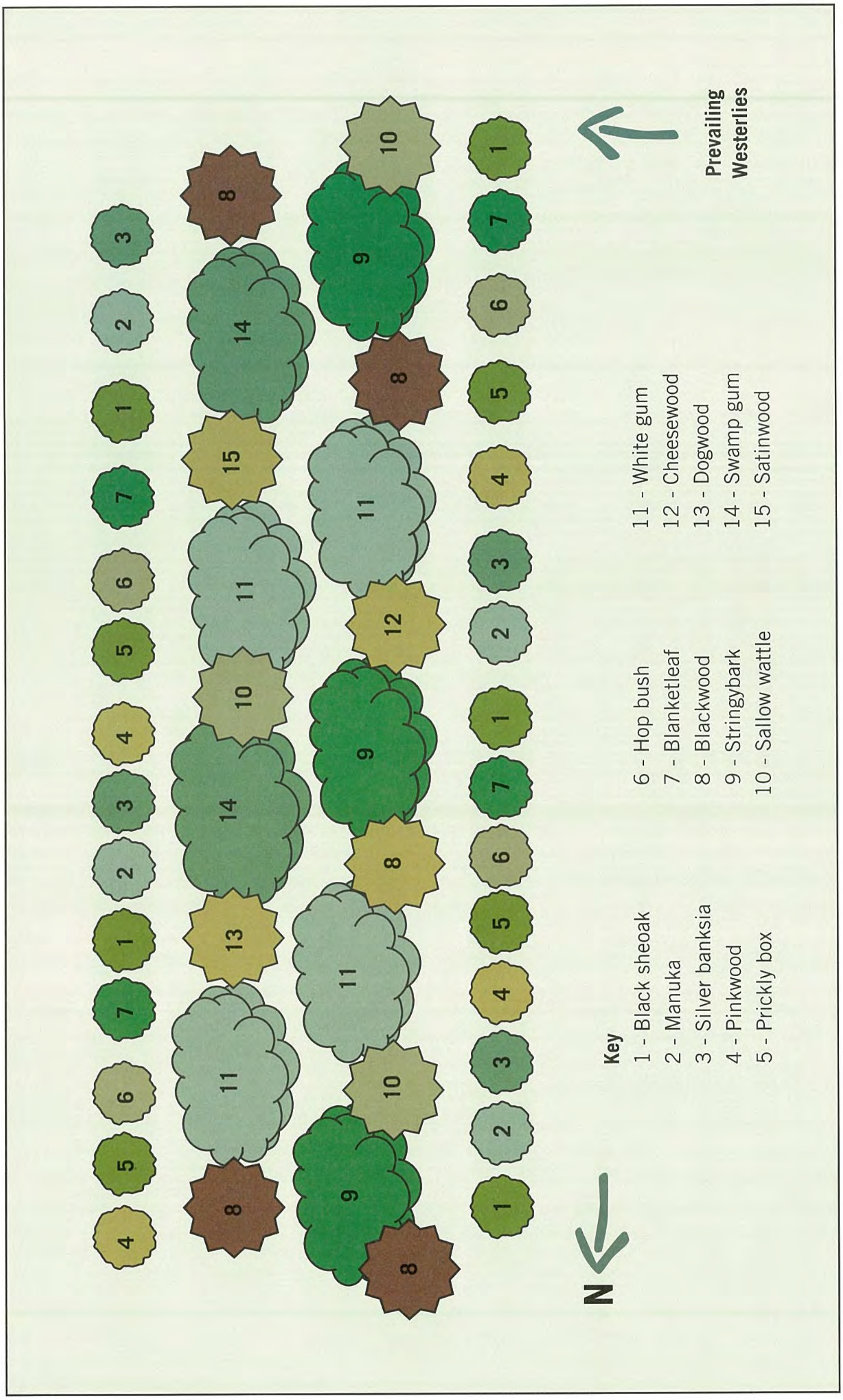


Figure 12: Species selection for a four row native shelterbelt on a dry site for a beef enterprise.

Site preparation using tubestock

Before you start:
- order plants one year before planting
- organise fencing

Autumn
Rip before the Autumn rains (especially if you have a site with highly compacted or rocky ground) while the ground is hard and dry, to get deep shattering of the soil.
- Rip 2 to 4 metres apart at a minimum depth of 45cm.
- Don't rip under the drip-line of existing trees
- Obtain weed matting and tree guards as required

Winter
Eradicate weeds between early May and late July, one month before planting. If you do not wish to use herbicides, either graze the area well, hand weed or use plant-derived sprays

One week prior to planting
Inspect any rip lines for regrowth and control any remaining weeds

Planting
Plant seedlings between early June to late August (depending on rainfall and soil type) - preferably one month after eradicating weeds. Use the "Hamilton" planter to make the job quicker, and note that it is easier to use this tool in unripped ground. Use weed mats and guards for best results.

In the first two years
Check plants – make sure there are no weeds within half a metre of plants through spring and early summer.

Note *- while using tubestock is recommended in North-West Tasmania, direct seeding may be suited to other areas. For further information on direct seeding, see Appendix 2.*

In a nutshell...

- Exclude stock
- Maintain tree guards and weed matting
- Control weeds
- Replace dead plants

Shelterbelt Management

The main ways shelterbelts can be maintained are:

- exclude stock by maintaining fencing. It is not recommended to let stock into the shelterbelt even once it has become well established. If stock are allowed to graze at any stage of the life of the shelterbelt, damage will still occur to both trees and shrubs and thus reduce the effectiveness of the shelterbelt. If using conventional fencing, it should be about two metres from the shelterbelt; electric fencing can be placed closer to the shelterbelt. See Appendix 2 for references on fencing

- maintain tree guards and weed matting. Tree guards may be necessary for up to 12 months – they give some protection from possums and wallabies, and good protection from rabbits. It must be remembered however to remove the guards once the plants become well established. Weed mats are particularly useful since they provide advantages both of suppressing weeds, and of conserving moisture

- continue to control weeds in the first two years of planting

- replace any plants that die during the life of the shelterbelt. Otherwise gaps will occur and reduce the effectiveness of the shelterbelt

- maintain plant and therefore shelterbelt structure and health by thinning and pruning. Thinning will be necessary if any over-crowding of plants occurs. Pruning eucalypts and blackwoods to a central leader improves branch structure and tree strength

- a further option is to sever lateral tree roots, that is prune tree roots, which can increase the growth of pasture and crops adjacent to the shelterbelt. The Australian Windbreaks Program found that severing roots at half of the height of the shelterbelt to a depth of 0.7 metres reduced yield loss in the area immediately adjacent to the shelterbelt by 25%.[25] Depending on the species, lateral root growth is considered to be around two to five times the height of the tree. Note that 'sapping' of the pasture by trees in the shelterbelt, being an important negative effect of shelterbelts, can be exacerbated by a lack of deep-ripping before planting the trees.

Appendix 1

Native shelterbelt plants of N.W. Tasmania

Key	Type
a	Standalone windbreak
b	Understorey (shade tolerant)
c	Hedge or screening shrub
d	Tree with trunk

Conditions tolerated
1 - Dry
2 - Wet
3 - Coastal
4 - Frost hardy less than –7°C
5 - Poor soil

Note *- that the size each plant is likely to grow to is dependent on many factors including soil fertility, altitude and wind exposure. For example, Eucalyptus viminalis on poor sandy soil at Turners Beach exposed to coastal winds is only 5 metres tall when fully grown, but may be 20 metres tall on good basalt soil at Melrose.*

Botanical name	Common name	Type	Tolerates	Size (hght x width)
Acacia melanoxylon	Blackwood	a, b, d	2, 4, 5	10 m x 7 m
A. mucronata	Sallow wattle	b,c	2, 4	6 m x 4m
A. sophorae	Coastal wattle	a, b, c	1, 3, 5	4 m x 5 m
A. stricta	Hop wattle	b,c	1, 4, 5	3 m x 2 m
A. verniciflua	Varnished wattle	b,c	5	5 m x 3 m
Allocasuarina littoralis	Black sheoak	a, b, d	1, 4, 5	6 m x 4m
A. monilifera	Necklace sheoak	a	4	3 m x 2 m
A. verticillata	Drooping sheoak	a, b, d	1, 3, 4, 5	6 m x 4 m
Banksia marginata	Silver banksia	a, b, c, d	1, 3, 4, 5	5 m x 4 m
B. serrata	Saw-tooth banksia	a, d	1, 3, 5	6 m x 4 m
Bedfordia salicina	Blanketleaf	b	1, 5	4 m x 3 m
Beyeria viscosa	Pinkwood	b,c	1, 4, 5	3 m x 2 m
Bursaria spinosa	Prickly box	a, b, c	1, 3, 4	4 m x 3 m
Callistemon pallidus	Lemon bottlebrush	a, b, c	1, 2, 4, 5	5 m x 4 m
C. viridiflorus	Alpine bottlebrush	a, c	2, 5	3 m x 2 m
Correa lawrenciana	Mountain correa	b,c	4	3 m x 2 m
C. backhousiana	Velvet correa	a, b, c	1, 3, 5	2 m x 2 m
Dodonaea viscosa	Hop bush	a, b, c	1, 3, 5	4 m x 3 m
Eucalyptus amygdalina	Black peppermint	a, d	1, 4, 5	15 m x 6 m
E. brookeriana	Brooker's gum	a, d	4	20 m x 10 m
E. gunnii	Cider gum	a, d	4	10 m x 5 m
E. nitida	Smithton peppermint	a, d	2, 4, 5	20 m x 10 m
E. obliqua	Stringybark	a, d	4	20 m x 10 m
E. ovata	Swamp gum	a, d	2, 4	15 m x 10 m
E. subcrenulata	Alpine yellow gum	a, d	4	15 m x 5 m
E. viminalis	White gum	a, d	1, 3, 4, 5	20 m x 10 m
Hakea epiglottis	Beaked hakea	a, b, c	4, 5	3 m x 2 m
H. lissosperma	Mountain hakea	a, b, c	4, 5	5 m x 3 m
Leptospermum lanigerum	Woolly teatree	a, c	2, 4	5 m x 3 m
L. rupestre	Alpine teatree	a, c	2, 4	3 m x 2 m
L. scoparium	Manuka	a, b, c	1, 2, 3, 4, 5	5 m x 3 m
Melaleuca ericifolia	Swamp paperbark	a, b, c	2, 3	8 m x 3 m
M. squarrosa	Scented paperbark	a, b, c	2, 4	4 m x 3 m
Myoporum insulare	Boobiala	a, c	1, 3, 5	3 m x 2 m
Nothofagus cunninghamii	Myrtle beech	a, c, d	4	20 m x 10 m
Olearia argophylla	Musk	a, b, c	5	5 m x 3 m
Phebalium squameum	Satinwood/Lancewood	a, b, c	4, 5	5 m x 3 m
Pittosporum bicolor	Cheesewood	a, b, c, d	4, 5	8 m x 3 m
Pomaderris apetala	Dogwood	a, b, c	4	5 m x 3 m
P. elliptica	Yellow Dogwood	a, b, c	1, 5	2 m x 2 m
Prostanthera lasianthos	Christmas Mint Bush	b, c	4, 5	2.5 m x 2.5 m
Tasmannia lanceolata	Mountain Pepper	a, b, c	1, 3, 5	2 m x 2 m

Appendix 2

Further information

J .McLeod, S Gray, 2005, *Living with Plants: A Guide to Revegetation Plants for North West Tasmania*, Published by J. McLeod & S.Gray, Launceston.
This book gives a good range of information specific to the North-West of Tasmania: it not only describes 100 of the hardiest and most widespread native species of the North-West, it also gives information on growing plants at home, site preparation and planting out. It is available from most bookstores.

The Rural Industries Research Development Corporation has a number of useful publications on their website, particularly the following two:

- ***Design principles for farm forestry*** – the complete book is available at: http://www.rirdc.gov.au/reports/AFT/alldesign.pdf
- ***Trees and biodiversity: A guide for Australian farm forestry.*** Chapter 1 is available at: http://www.rirdc.gov.au/reports/AFT/03-047.pdf

The Victorian Department of Primary Industries have a number of 'Information Notes' on shelterbelts, as well as more generally on using natives, growing trees and direct seeding. Go to: http://www.dpi.vic.gov.au/notes/ and click on Native Vegetation or Growing Trees. Further specific information on direct sowing can be found at 'Direct Sowing trees and shrubs', http://www.regional.org.au/au/roc/1991/roc1991119.htm

D Fitzpatrick, 1994, *Money Trees on Your Property: Profit gained through trees and how to grow them'.* This book gives comprehensive information about topics such as direct seeding, planting seedlings, and fencing. It is available at your local library in Tasmania (ie State Library of Tasmania), or can be ordered through your local bookshop, such as Angus & Robertson.

R S Davidson, 1992, *Bushland on Farms,* Australian Government Publishing service, Canberra. This book highlights the importance trees and other vegetation for farm health, for example detailing how vegetation can attract beneficial fauna to control insect pests.

Dairying for Tomorrow, 2003, Shelter and productivity, health & welfare of livestock, available at http://www.dairyingfortomorrow.com/activities/reports/LitReview%20-%20Shelterbelts.pdf. While this publication is particularly useful for dairy farmers, it gives good general information about the shelter effects of trees.

Notes

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The North-West Environment Centre Inc is a non-government, not-for-profit community organization. It was formed in 2001 and aims to inspire a new perspective on our relationship with the environment and each other so that we may all act to create a socially harmonious and ecologically sustainable future. Raising awareness and empowering community members to come together and act for change is the focus of the Environment Centre projects.

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