Crops For Southland Inc

Protection from the Wind in Southland

A Resource for Farmers and Horticulturalists

Prepared by

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1.0 Introduction

This booklet provides basic information about how to design effective shelter from wind. It will cover a little of the basic science behind wind shelter, species selection, planting and management. Further advice should be sought from a shelter specialist before planting.

2.0 Advantages of farm shelter

Properly designed wind barriers offer many direct and indirect benefits to agriculture and horticulture:

- reduce stock losses during lambing, calving and shearing
- dramatically increase crop yields and pasture production
- reduce soil erosion
- improve capital and resale value of a property
- source of firewood
- source of timber
- source of pollen for bees
- create a more pleasant and attractive working environment.

For plants such as cut flowers a lack of effective shelter will result in crop losses every year. There are numerous recorded examples of the benefits of shelter to production of other crops. The following (from "Windbreaks" by Steven Burke, 1994) are based on fifty separate studies from around the world conducted between 1932 and 1985:

Crop	Mean yield increase (%)
Oats	6
Spring Wheat	8
Corn	12
Hay	20
Winter Wheat	23
Barley	25
Millet	44
Lucerne	99

Specific examples from New Zealand research include:

- Yields of soya beans in Canterbury increased by 15–20% behind good permeable shelter.
- Yields of oats and barley increased by 30–35%.
- Lodging in cereal crops was considerably reduced.

- Pasture dry matter production increased by 6% at a distance of 3–5 times the height of shelter at Hororata in Canterbury.

Shelter and shade benefit livestock, particularly in extremes of weather. Young animals are especially vulnerable to cold rain and wind because of their large surface area/volume ratio, poor thermal insulation and limited energy reserves.

3.0 Disadvantages of shelter

Even well established shelterbelts can have some disadvantages. They can:

- occupy potentially productive land
- reduce visibility
- take time to maintain
- reduce drying effects of the wind on very wet blocks
- increase pest and disease problems
- cause shading and icing on adjacent roads in winter.

Careful choice of species, correct establishment procedures and good maintenance will eliminate many potential problems. The increase in production resulting from shelter will more than compensate for the loss of potentially productive land occupied by the shelterbelts themselves.

Some species of trees for shelter require a heavy maintenance programme simply because they grow rapidly. Once the primary shelter is established subsequent belts can be of easy-care species.

4.0 Soils

Very few of the farmed soil types in Southland have fertility limitations to growing trees. Limitations arise mostly from physical properties of the soil. Problem soils can be:

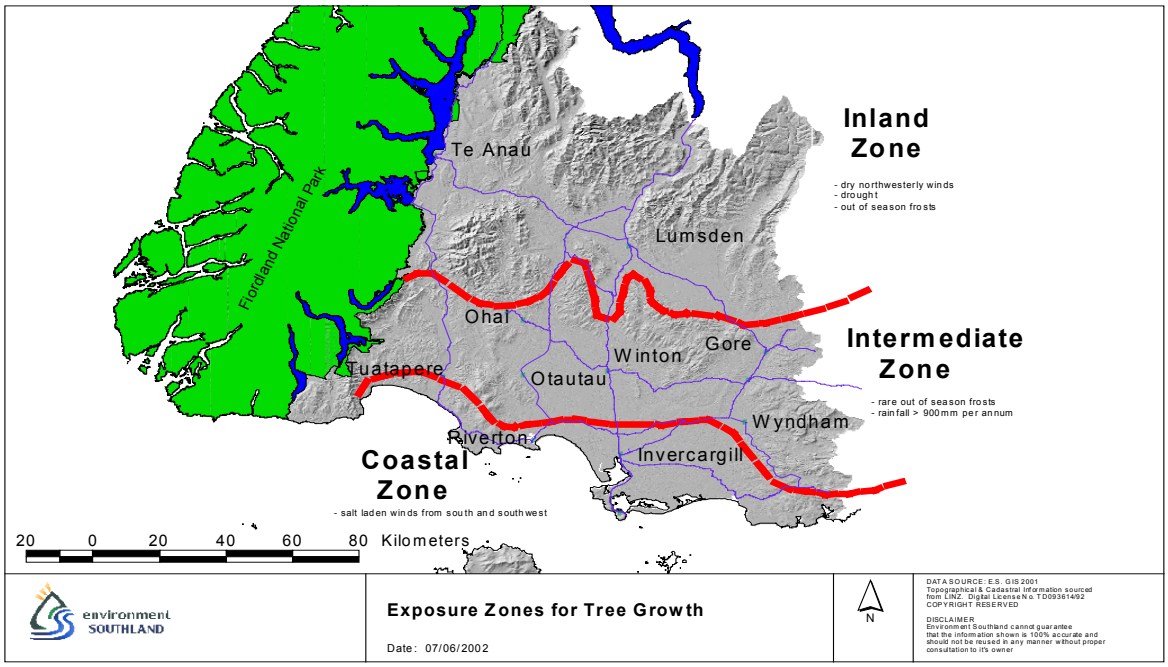
- peats
- swampy soils
- soils with impeded drainage
- soils with hard pans preventing root establishment
- deep gravels formed on old river beds.

The limitations of these problem soil types must be recognised and catered for by properly preparing the site before planting. Then selecting the species most tolerant of the problem in question.

To get more information on the soil types on a particular property, contact Venture Southland or Environment Southland (see the 'Useful Contacts' section at the end of this document) and ask for Topoclimate Information. They have detailed soil and climate maps for most of the intensively farmed land in Southland.

5.0 Climatic zones

According to CGR Chavasse ("Farm Trees for Southland" NZ Forest Service Invercargill, February 1965) the climatic zones of Southland are often more important than the soil type in determining the choice of shelter species. Three zones can be distinguished: Coastal; Intermediate; Inland.



5.1 Coastal Zone

The Coastal Zone is subjected to fairly constant cold salt-laden winds from the south and west. This restricts the range of species that can be used for primary shelter. Other species with less salt tolerance can be grown in the lee of primary shelter. Good examples of this can be seen in areas such as Queens Park in Invercargill.

Because of contour, severe coastal conditions are restricted to a narrow zone of two to three kilometres in Western Southland; but on the plains around Invercargill and to the east this zone extends up to 35 kilometres inland. Isolated pockets subject to salt damage do occur further inland than the map indicates.

5.2 Intermediate Zone

The intermediate zone has a generally temperate climate with few severe frosts. It is subject to both south-west and north-west winds. Rainfall is generally adequate. A large number of species can be grown successfully.

5.3 Inland Zone

The inland zone lies in the northern region of Southland. Species in this area need to be able to cope with out-of-season frosts and dry hot north-westerly winds. Frosts are severe in winter and snow can also be troublesome, especially in hilly areas on south-easterly aspects. In some parts soil conditions can pose severe problems for tree establishment as soil erosion is common.

6.0 Creating a shelter plan

A shelter plan defines the location, design, establishment and management of the various plantings on the property. It can be drawn up in four stages:

- preparing the property plan
- siting the shelter belts
- design
- establishment and management.

6.1 Property plan

A map of the property needs to be drawn up (ideally from an aerial photograph) showing:

- north point
- tracks and lanes
- existing fences and proposed fences
- direction of the prevailing wind
- power and telephone lines (including underground cables)
- water courses and open drains
- terraces and swamps
- boundaries of soil types
- buildings and yards
- drainage tiles
- existing shelter belts and woodlots.

6.2 In which direction should the Shelter Run?

Likely locations of shelter belts can be marked on the property plan. The wind barrier should be sited directly across the most harmful wind to give maximum protection. The direction from which this wind comes varies with the location of the land. In general most of the damaging winds in Southland come from either the northwest or the southwest. Therefore, **running a shelterbelt north-south will provide protection from both**.

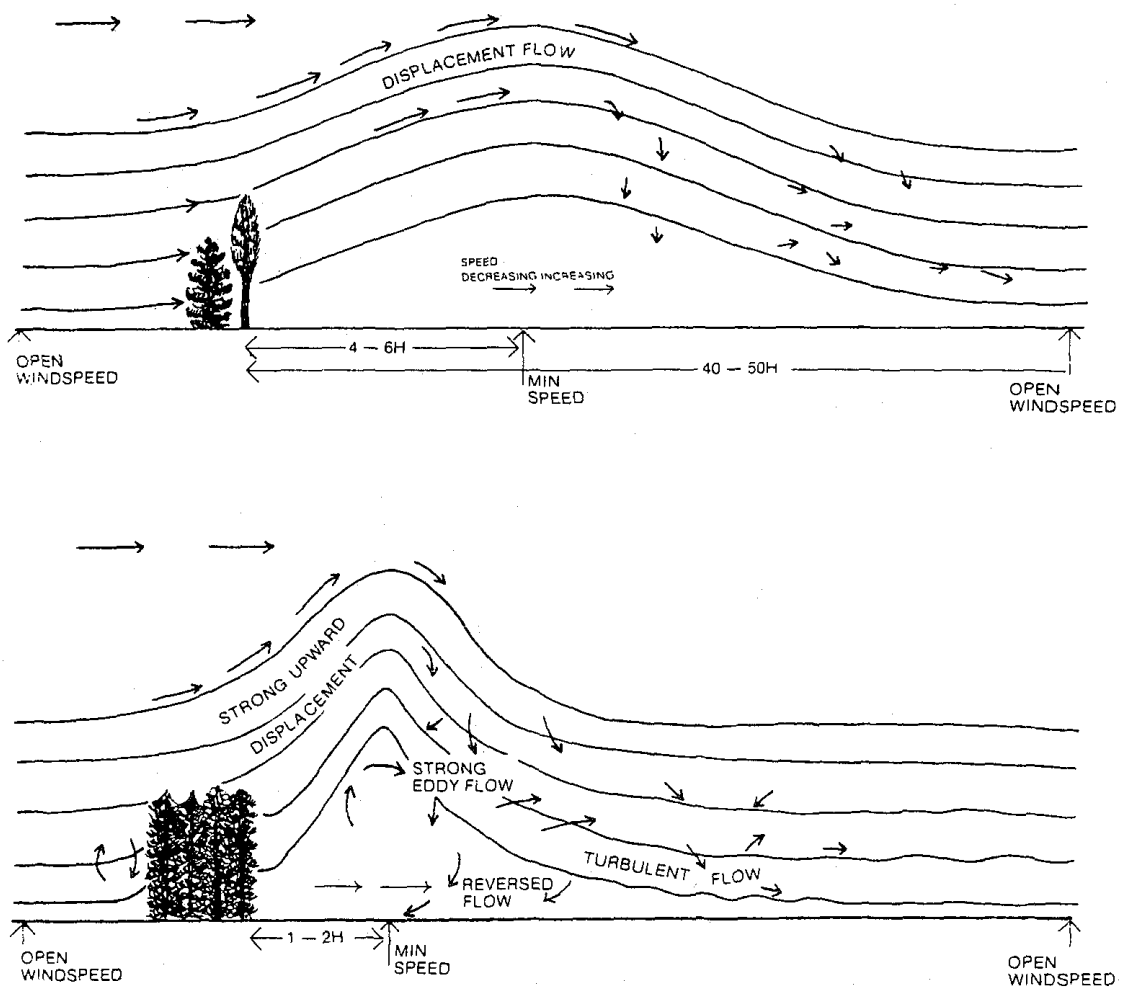
If east-west belts are required they should be planted with low-growing evergreens or deciduous species to minimise the winter shading of pastures. On rolling country contours can affect the direction and strength

of the wind. The problem areas are through saddles and at the tops of slopes. Aim to take advantage of and augment existing natural shelter. Sharp changes in the direction of continuous belts should be avoided for they obstruct normal farm management activities and, more importantly, they make the trees more vulnerable to storm damage.

6.3 Principles of shelter

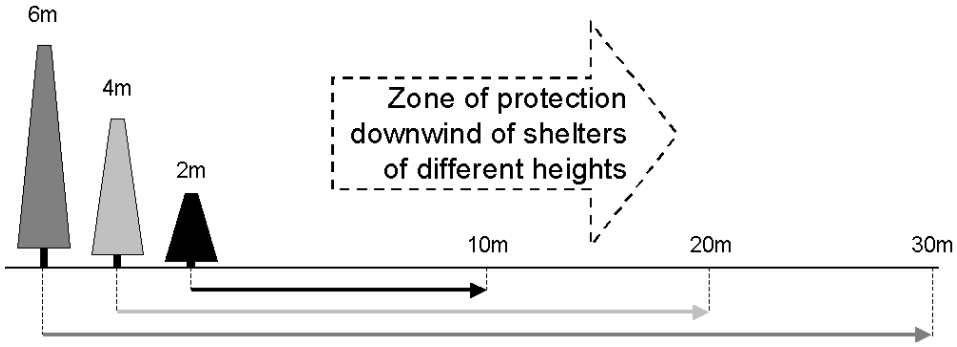
To put it simply, shelterbelts must be designed as a wind filter not as a complete wind barrier. Ideally, aim for 40–60% permeability to slow the wind down.

Wind hitting a solid barrier moves up and over the top of the obstruction creating an area of low pressure on the lee side of the obstruction. Wind then eddies back, goes into a reverse flow, potentially dumping down in this zone. Any plants and/or stock in this area can be badly affected. The diagram below shows wind flow around a well-designed permeable shelterbelt (top) compared with that around a more solid barrier (bottom).



How far out the zone of calmer air extends on the lee side of a shelter is a direct function of the height of the shelter. As rule of thumb, the zone

should extend about 5 times the total height of the shelterbelt. After this distance the wind speed picks up and the sheltering effects are reduced. Beyond approximately 15x the height all sheltering effects are greatly reduced. Keep this rule in mind when deciding how far apart to place shelterbelts.



The length of a shelterbelt also has a significant bearing on its effectiveness as a barrier against a consistent prevailing wind. To obtain the full benefit from the height of a shelterbelt **its length needs to be at least twelve times its height**. For example, a 10 metre high shelterbelt needs to be at least 120 metres long. Against cross winds that deviate, the ratio should be more than double this.

Lack of continuity of shelter is one of the major faults of many older shelterbelts. All species have a limited life and must be replaced before they become over-mature. To obtain continuity it is preferable to have two species of trees with differing lengths of rotation, i.e., a fast growing and a slow growing species. Continuity can also be achieved by planting new belts to take over the role of shelter 10–15 years before a mature belt comes down.

Landowners need to know the life expectancy of their existing trees and plan for future requirements. Use a denser slow growing species on the windward side and place the faster growing trees on the leeward side. In addition, the double planting of the two different species can be used to give a more effective filtering type shelter in its upper canopy. When mature, the fast growing leeward row can be felled and replanted.

6.4 Establishment and management

Competing vegetation must be controlled around newly planted trees as this competes for nutrients and water. Successful shelter requires 100% establishment and survival of planted trees. Chemical sprays can be used, either before or after planting. However, many tree species – particularly the natives – are sensitive to chemicals, so pre-plant spraying may be preferable. Seek advice on the best products.

6.4.1 Fencing off shelterbelts

Shelterbelts must be fenced off before planting. The recommended minimum distance from a non-electric fence to a row of trees is two metres. A typical spacing distance between rows of trees is around three metres. This means that a two-row shelterbelt needs to have seven metres between protecting fences on either side. This spacing ensures that livestock damage does not occur, and it affords adequate room for tree development. The gap between trees within a row depends a little on the species selected. As a rule a two-metre gap is adequate.

6.4.2 Ripping before planting

Tree establishment can be improved on most soils by ripping the tree lines prior to planting. Ripping should be undertaken in summer (when soils are dry) to give maximum effect. This timing also allows the soil to settle back and provide a moist tilth at planting depth. Ripping should be done with a winged ripper as this creates a maximum shatter zone. It is the most cost-effective operation you can do to ensure good establishment.

It is most important to plant only top quality tree stock and to plant correctly to avoid root strangulation and later toppling. Pay particular attention to:

- correct depth
- upright stem
- topsoil firm around the seedling.

6.4.3 Nutrient requirements

A fertiliser such as DAP (50g/tree) can be used at planting to maximise tree growth. Once the trees are well established fertilisers are not needed. When applying fertiliser after planting do not place it directly next to the trunks of the trees. This will only restrict root development while encouraging large tops, so trees will become unstable. Rather, spread the fertiliser out around the tree to encourage roots to spread and colonise a larger volume of soil. Specially formulated tree fertiliser tablets are also available.

6.4.4 Training young trees

Tree training or pruning regimes depend on the tree species chosen. As a basic rule for *Leylandii* and *Macrocarpa*, prune side growths off (especially on *Leylandii* 'Leightons Green'). You will most likely need to prune the lee side before the windward side. Take the tip out of the tree in the second year and then allow it to grow up. This will give a good side span growth towards the other trees in the row. Failure to do so will disadvantage the root anchoring ability of the tree, especially in windy conditions. It also wastes headland space. Talk to your shelter professional for detailed advice on your specific site.

6.4.5 Maintenance

Winbreaks need regular maintenance, including side trimming to maintain their porosity and stability. Naturally dense trees such as cypresses and radiata pine will require regular pruning and/or side trimming, while trees with an open canopy such as eucalypts and poplars require less.

- **Side trimming**
  Tree trimming machines provide a fast and economical method of trimming side branches. By carrying out a regular side trimming the cost per kilometre is much less than if you leave it until branches are heavy and more difficult to remove. Fast growing species tend to crowd out the slower trees with overhanging branches and should be removed by side trimming or pruning to avoid damage to fences.
- **Topping**
  Well-designed and maintained shelterbelts should not need topping unless power lines are threatened. It is an expensive exercise and reduces the shelter effectiveness and timber value of the trees. However, in some horticultural situations where shelterbelts are closer together, topping may be appropriate. In these situations, where species with very invasive root systems are planted, side pruning of roots, using a mechanical trencher or ripper may also be required.
- **Fan pruning**
  Branches other than those pointing in the same direction as the row are hand pruned at an early stage. This technique is an alternative to side trimming and will reduce later maintenance but maintain shelter value.

6.4.6 Vertebrate pest control

There are chemical deterrant products available that can be sprayed on trees at or after planting, but they probably have limited value in high rainfall areas such as Southland. Plastic horticultural tree protector sleeves seem to be an effective alternative for minimising damage by rabbits and hares.

7.0 Planting around ponds

Plantings should always be made to shelter the pond from the prevailing wind. Note: wild duck generally fly into the pond against the wind. Tall trees growing on the wrong margin of the pond not only obstruct entry but also exclude sun.

With the exception of one or two overhanging willows or native *Carex* species, all plantings should be kept at least 6m back from the pond edges. A sunny, sheltered loafing margin for wildfowl is most important.

Tall growing trees such as poplar or some species of eucalypts, interspersed with native toetoe and flax, are an attractive combination, excluding draught and creating good nesting cover.

In the past the traditional practice has been to fence off trees around a pond and allow stock access for drinking water. In the interests of more sustainable farming systems and more care for waterways, it is now considered better practice to completely fence ponds. If the pond is a source of stock drinking water, it should be pumped to troughs.

8.0 Planting stream banks

It is important to protect stream margins from several points of view:

- protection from erosion
- conserving water resources
- fisheries
- wildlife
- aesthetic values

On-site stock water supply will be important in dry weather. Certainly clean down-stream water supply for rural, urban and industrial users is becoming increasingly important. Do not plant too close to stream channels or ditches, which restrict root run. Allow at least three metres between stream margins and establishing trees.

For further information on riparian management, contact Environment Southland.

9.0 Plant species for each climatic zone in Southland

The climatic zones outlined in Section 5.0 give only a broad indication. It is important to match species to site at a farm level. Within each farm there may be wet sites, dry sites, frost pockets (usually valley floors), areas of high wind run and areas badly affected by pest damage. You need to take this into account when designing shelter.

The following list is merely a rough guide and is not comprehensive. There are many other species which can also find a place in an appropriate zone/site. Much will depend on the site (soil type, wind direction, rainfall etc) and the preference of the landowner. It is very important to assess the suitability of the site in all cases. The following points might help:

- The number of suitable species is severely limited in the more exposed parts of the Coastal Zone on account of salt-laden winds.
- The number of suitable species for the Inland Zone is limited by frost (to some extent) and drought can cause failures.
- The more difficult the site the fewer the suitable species. This applies especially to wet sites.
- In all zones the number of species that can be grown can be increased greatly by providing suitable shelter.

Species suitable for different climatic zones in Southland

Species	**Coastal Zone**	**Intermediate Zone**	**Inland Zone**
Conifers	*Cupressus macrocarpa* (Macrocarpa) *Pinus radiata* (Radiata pine) *Pinus pinaster* (Maritime pine) *Pinus nigra* (Corsican pine) *Cupressocyparis leylandii* (Leyland cypress)	*Pinus radiata* (Radiata pine) *Pinus nigra* (Corsican pine) *Cupressus macrocarpa* (Macrocarpa) *Cupressocyparis leylandii* (Leyland cypress) *Thuja plicata* (Western red cedar) *Cupressus arizonica* (Arizona cypress)+ *Pseudotsuga menziesii* (Douglas fir)# *Pinus coulterii* (Bigcone pine) *Pseudotsuga menziesii* (Douglas fir)# *Larix decidua* (European larch)^*	*Pinus nigra* (Corsican pine) *Pinus radiata* (Radiata pine) *Pinus ponderosa* (Ponderosa pine) *Pinus mugo* (Mountain pine) *Cupressus macrocarpa* (Macrocarpa) *Cupressocyparis leylandii* (Leyland cypress) *Cupressus arizonica* (Arizona cypress) *Sequoiadendron gigantea* (Wellingtonia) *Thuja plicata* (Western red cedar) *Pseudotsuga menziesii* (Douglas fir)# *Pinus coulterii* (Bigcone pine) *Larix decidua* (European larch)^*
Eucalyptus	*Eucalyptus cordata* (Silver gum) *Eucalyptus kitsoniana* *Eucalyptus delegatensis* (Alpine ash)* *Eucalyptus gunnii* (Cider gum)*	*Eucalyptus gunnii* (Cider gum) *Eucalyptus delegatensis* (Alpine ash) *Eucalyptus nitens* (Shining gum)# *Eucalyptus rodwayii* (Swamp peppermint)	*Eucalyptus rodwayii* (Swamp peppermint) *Eucalyptus gunnii* (Cider gum) *Eucalyptus delegatensis* (Alpine ash) *Eucalyptus nitens* (Shining gum)# *Eucalyptus perriniana* (Spinning gum)

		Eucalyptus cordata (Silver gum) *Eucalyptus johnstonii* (Yellow gum) *Eucalyptus subcrenulata* (Alpine yellow gum)	*Eucalyptus stellulata* (Black sally) *Eucalyptus glaucescens* (Tingiringi gum) *Eucalyptus coccifera* (Tasmanian snow gum)
Natives	*Phormium tenax* (Flax) *Cordyline australis* (Cabbage tree) *Cortaderia richardii* (toe toes) *Hebe elliptica* (Koromiko) *Hebe salicifolia* (Hebe)* *Olearia traversii* (Chatham Island ake-ake) *Olearia avicennifolia* *Olearia dartonii* (Twiggy tree daisy) *Olearia paniculata* (Golden ake-ake) *Pittosporum tenuifolium* (Black Mapou)* *Podocarpus cunninghamii* (Hall's totara) *Griselinia littoralis* (Broadleaf)* *Leptospernum scoparium*	*Phormium tenax* (Flax) *Phormium cookianum* (Mountain flax) *Cordyline australis* (Cabbage tree) *Cortaderia richardii* (toe toes) *Hebe elliptica* *Olearia traversii* (Chatham Island ake-ake) *Metrosideros lucida* (Southern rata) *Pittosporum tenuifolium* (Black Mapou)* *Podocarpus cunninghamii* (Hall's totara) *Griselinia littoralis* (Broadleaf)* *Leptospernum scoparium* (Manuka) *Chinochloa rubra* (Red tussock) *Dacrycarpus dacrydioides* (Kahikatea) *Plagianthus regius* (Ribbonwood)	*Phormium tenax* (Flax) *Cordyline australis* (Cabbage tree) *Cortaderia richardii* (toe toes) *Hebe elliptica* *Olearia traversii* (Chatham Island ake-ake) *Pittosporum tenuifolium* (Black Mapou)*# *Podocarpus cunninghamii* (Hall's totara) *Griselinia littoralis* (Broadleaf)* *Leptospernum scoparium* (Manuka) *Chinochloa rubra* (Red tussock) *Chinochloa spp.* (Snow tussocks) *Olearia paniculata* (Golden ake-ake) *Coprosma spp.* (Mingi mingi–small leaved)

	(Manuka)* *Metrosideros lucida* (Southern rata) *Chinochloa rubra* (Red tussock) *Fuchsia excorticata* (Tree Fuchsia)* *Olearia solandri* (Coastal tree daisy) *Hoheria glabrata* (Mountain ribbonwood)* *Coprosma repens* (Taupata) *Brachyglottis rotundifolia* (mutton-bird scrub)	*Carpodetus serratus* (Marble leaf) *Nothofagus menziesii* (Silver beech) *Nathofagus fusca* (Red beech) *Pseudopanax crassifolius* (Lancewood) *Coprosma lucida* (Karamu) *Coprosma spp.* (Mingi mingi – small leaved)	
Poplars^	Yeogi (Korean silver poplar)*	Veronese Tasman Argyle (*P.deltoids x P.nigra*) Androscroggin Trichocarpa	Androscroggin Trichocarpa Veronese# Tasman# Argyle#
Willows^@	Moutere (*Salix matsudana x S.alba*)* *Salix matsudana* (Matsudana willow)* Shrub willows (Glenmark, Pohangina)	Moutere (*Salix matsudana x S.alba*) *Salix matsudana* (Matsudana willow) Tangoio willow (*Salix matsudana x S.alba*)	Moutere (*Salix matsudana x S.alba*) *Salix matsudana* (Matsudana willow) Tangoio (*Salix matsudana x S.alba*) Shrub willows (Glenmark, Pohangina) Golden willow (*Salix alba* var. vitellina)

		Shrub willows (Glenmark, Pohangina) Golden willow (*Salix alba* var. vitellina)	vitellina)
Others	*Arbutus unedo* (Strawberry tree)* *Sorbus aria* (Whitebeam)* *Alnus glutinosa* (Black alder)@*	*Betula pendula* (Silver birch)^ *Cedrus atlantica* (Atlas cedar)+ *Cedrus deodara* (Deodar)+ *Alnus rubra* (Red alder)@ *Alnus glutinosa* (Black alder)@ *Picea spp* (Spruce) English boradleaved trees (Oaks, ash, lime, elm, planes, chestnuts, English beech, walnut etc.)	*Abies spp.* (Firs) *Picea spp* (Spruce) *Sorbus spp* (Rowan) *Betula pendula* (Silver birch)^ *Cedrus atlantica* (Atlas cedar)+ *Cedrus deodara* (Deodar)+ English boradleaved trees (Oaks, ash, lime, elm, planes, chestnuts, English beech, walnut etc.)

* can come up only under sheltered conditions (less exposed areas)
^ deciduous
+ only in dry sites
# only in frost free sites
@ damp and wet sites

10.0 Artificial shelter

Artificial windbreaks provide immediate shelter and are perhaps more suited to small areas than to large-scale farm operations. The standard height of artificial shelter is 2 metres, although higher shelters can be made if required. Using the rule outlined in Section 6.3 a 2m high shelter will provide adequate shelter for a distance of 10–12m. After this another shelter is required. This is especially important when sheltering high value horticultural crops such as cut flowers.

Traditional strainer assemblies should be used at the ends of these fences with a 20cm (8–10 inch) strainer. Deer posts are suitable for use within the fence. The distance apart for these posts can vary from 4 to 8m depending on the expected wind strength at the site. Construction is best left to a professional, although advice on the best way to do this is available from the Crops for Southland New Crop Centre.

11.0 Restrictions on placement of shelterbelts

A number of Acts and Regulations can impose limitations on the establishment of trees. These can vary depending on your property. For the most up to date advice contact the Southland District Council (03 218 7259) or Environment Southland (03 215 6197).

12.0 Wind erosion

Environment Southland has collected a large amount of resource information relating to shelterbelt design, establishment and maintenance. While subsidies are presently not available, Environment Southland Land Sustainability Officers provide free advice to any landowner thinking of tree planting and will arrange for an on-farm visit, along with the preparation of a shelter plan for an individual property.

It is important to make the correct decisions before starting a shelter planting programme:

- matching tree species to site
- identifying shelter priorities
- using the correct methods of establishment

13.0 Windbreak records

13.1 Introduction

It is a good idea to keep records of your windbreak plantings. This enables you to monitor the plantings and their progress. You will soon build up a good database on which to base future plantings. Good records will include information on location, preparation practices, species and management.

Recording your shelterbelts on an aerial photograph or map quickly shows the location and extent of the individual plantings.

Copy and use the form on the back cover of this booklet to keep a record of your shelter plantings.

13.2 Information to be recorded

- Objective – a simple statement of why the shelterbelt is being planted (e.g., to shelter newborn lambs, to shelter a hazelnut plantation).
- Species – record the species in each row (row 1 being the windward row). Include the nursery source of the trees; the type of stock, i.e., root trainers or open rooted; tree spacing between and within rows.
- Ground preparation – e.g., ripping. Include relevant information on type of ripper, ground condition, time of year.
- Mortality – after a period of time count up the dead trees. Make a note of any known causes, e.g., frosts, rabbit damage etc.
- Blanking – details of any blanking (replacement of dead trees) carried out after initial planting.

14.0 Sources of information and advice

Some of the best advice a farmer can get is to visit neighbours who are interested in shelter and find out what trees are doing well in the locality.

Other useful organisations include:

Southland Farm Forestry Association
P 0 Box 78
Winton

Southland Men of the Trees
47 David Street
lnvercargill

Topoclimate information
Nick Round-Turner
Venture Southland
PO Box 1306
Invercargill

Phone 03 211 1413

e-mail nick@venturesouthland.co.nz

Environment Southland
Gary Morgan & Bala Tikkisetty
North Road
Invercargill

Phone 03 215 6197

Murray Harris
Land and Forest Consultancy
7 Harden Street
Glenleith
Dunedin

Phone 03 467 9257

Windbreak Recording Sheet

Date of planting _____

Objective			
	Species	**Source and type of tree stock**	**Spacings**
Row 1			
Row 2			
Row 3			
Row 4			
Ground preparation			
Spray record			
Pre-planting chemical (date and rate):			
Post-planting chemical (date and rate):			
Post-planting chemical (date and rate):			
Post planting chemical (date and rate):			
Mortality (reasons and numbers):			
Blanking species		**Source and type of tree stock**	
General comments			