Guidelines for Shelterbelt Planting in the Falkland Islands

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contents

This booklet was prepared by Dr Alan Low and Dr Jim McAdam and was produced by the Department of Agriculture, Stanley and the United Kingdom Falkland Islands Trust.

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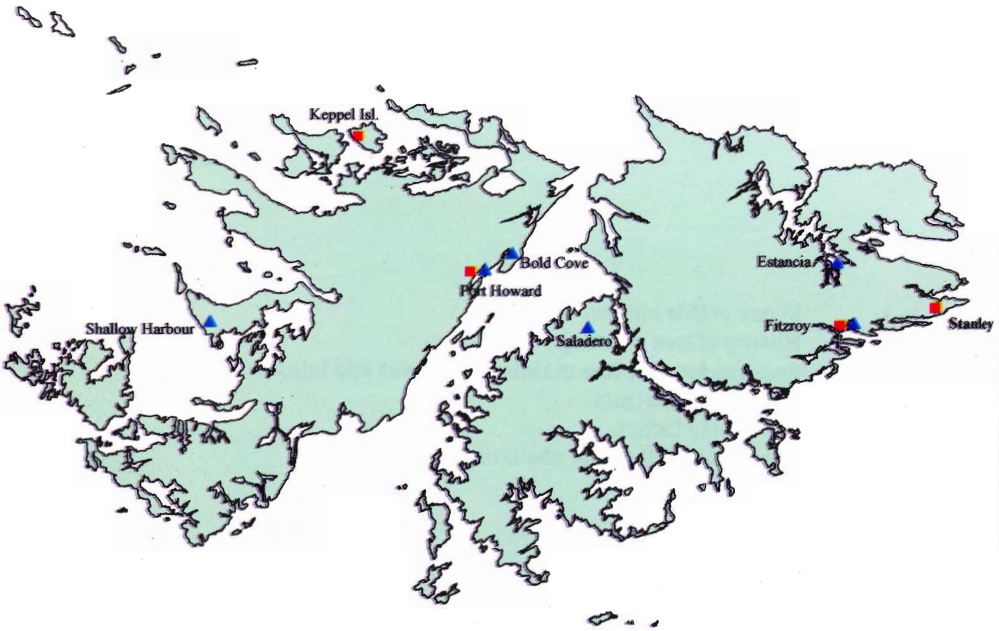

Department of Agriculture (▲) and United Kingdom Falkland Islands Trust (■) tree trial sites on the Falkland Islands (1999)

The authors acknowledge helpful comments from Malcolm Beatty, Forest Service, Department of Agriculture for Northern Ireland, Grant Munro and Aidan Kerr, Department of Agriculture, Stanley.

Guidelines for Shelterbelt Planting in the Falklands

1. Scope of this booklet

There is a great interest in tree growing in both Stanley and the camp in the Falkland Islands. Both of the authors have in various ways been closely involved in the assessment of the potential for tree growing and more latterly in the promotion of tree planting in the Falkland Islands since the late 1970's. There have been numerous attempts to grow trees before that of course and the results can be seen in various locations. Some pointers to successful tree growing can be gained from these previous efforts and these are outlined in the booklet. However, the booklet is essentially a practical guide, summarising the best available knowledge (based on somewhat limited experience, it most be pointed out!) on tree planting and shelterbelt establishment. Finally some practical information on further contacts and useful addresses is added, particularly to support the use of products or materials mentioned in the text.

The primary purpose of this booklet is to provide guidance on establishing shelterbelts in the camp. It is therefore targeted particularly towards landowners and farmers. However, it may also assist many other people in the islands who wish to grow trees, even if only around their homes and in gardens. Many of the basic planting principles will be equally applicable, but the individual attention and careful site protection possible in gardens enable a much wider range of tree species to be grown. This may result in a need for more specialist advice on

particular aspects of tree growing. It is not the purpose of this booklet to provide such advice, as the range of situations to be covered would be too great. The information required can usually be found in specialist gardening books and manuals and the Department of Agriculture may be able to help with some aspects.

Assessing tree planting possibilities in the Falkland Islands is inevitably dominated by the need to consider the effects of the three major environmental factors wind, rainfall and soil. In relation to tree growth, the windiness of the Falkland Islands climate imposes severe limitations, and its effects are made worse by the low annual rainfall and the nature of the soil (shallow peat over compacted clay) covering much of the land area. Together, these factors seem to rule out the possibility that large scale tree planting for wood production will ever be economically worthwhile in the Islands. However, there are reasonable grounds for concluding that the use of suitable establishment techniques in combination with appropriate choice of trees species and seed origins make it feasible to create effective shelterbelts for stock and garden protection.

2. History of Tree Planting

The earliest recorded tree planting in the Falkland Islands took place more than 150 years ago. Since then, attempts to grow trees for amenity and shelter have continued intermittently. Tree planting has often been successful in the vicinity of farm settlements and Stanley, where a wide range of tree and shrub species can be found growing in such situations. However, only a few of the locations where trees have been successfully established have site conditions at all similar to those typical of open camp. In drawing up these guidelines we have had to make substantial use of tree planting experience in cool windy maritime climates elsewhere in the world.

In 1989 the United Kingdom Falkland Islands Trust (UKFIT) commenced a limited series of trials to investigate planting techniques for conifers at a range of sites. These demonstrated that conifers could be established and would grow at a reasonable rate but this work needed to be carried forward on a much larger scale. The Department of Agriculture shelterbelt trial programme, which began in 1997, is examining the practicality and economics of large scale shelterbelt establishment. However, it will be several years before results from these trials enable the provisional guidelines in this leaflet to be confirmed or modified.

3. Reasons for Past Tree Planting Successes and Failures

An important step in drawing up guidelines for shelterbelt design and establishment has been to examine the reasons for the success or failure of earlier tree planting attempts in the Falkland Islands. Identifying specific reasons was often made difficult by the general lack of adequate records. Reliable information on such factors as type and source of planting stock, plant handling and planting method, season of planting, protection measures, unusual climatic events and general growth history is seldom available. However, from observations made on site, combined with such information as could be obtained from existing reports and from local sources, it has been possible to deduce what have been the most common factors contributing to planting success or failure. These are listed below more or less in order of importance. It must be emphasised that at most locations where planting took place several of the listed factors had an important influence on the results achieved; and it was possible for favourable factors to outweigh unfavourable ones or vice versa.

a. Beneficial Factors

1. Selection of a moisture-receiving site with some topographic shelter and above-average nutritional status. (Usually achieved by planting in sheltered hollows or small valleys near settlements which in turn are generally found in the climatically more favoured locations.)

2. Provision of artificial shelter to supplement or substitute for topographic shelter. (By erecting wooden shelter fences, making earth banks, creating gorse hedges or using plastic shelter netting.)

3. Careful long-term protection by fencing against browsing by domestic stock and hares.

4. Planting of trees in sufficiently wide blocks or belts to obtain the benefits of mutual shelter development and canopy closure.

5. Intensive ground preparation prior to planting. (Many of the older sites used had a history of previous agricultural or garden cultivation; pit planting, with prior preparation and loosening of the soil to some depth, was also widely used.)

6. Planting in late autumn or early winter (April - June) rather than in spring. (In the "back end" of the growing season soil moisture tends to be higher than in spring, desiccating winds are less likely and yet soil temperatures are probably still sufficiently high to permit some root growth.)

FIGURE 1. 6 YEAR OLD, PIT PLANTED COASTAL LODGEPOLE PINE GROWING WELL IN UK FALKLAND ISLANDS TRUST TRIAL, FITZROY FARM.

7. Selection of the most wind-resistant tree species available, particularly for planting along the windward (usually west) edge of a plot.

8. The development of effective mycorrhizal associations (see section 4h) between tree roots and appropriate fungus species. (At several locations, hearsay evidence suggests that a marked improvement in tree growth coincided with the appearance of fungal fruiting bodies - "toadstools" - in the vicinity.)

b. Adverse Factors

1. Incorrect plant handling during transit and at the planting site. (This included lengthy storage in unsuitable conditions or containers, and excessive exposure of roots to drying out by sun or wind during the planting operation.)

2. Inadequate protection against browsing damage, both immediately after planting and in the longer term.

3. Use of excessively large and top-heavy planting stock with poor root/shoot ratio. (This is liable to lead to heavy losses in a windy climate with low rainfall; it was often done in the past in the mistaken belief that shelter would be obtained more quickly if large trees were planted.)

4. Use of trees species or seed origins which did not have good resistance to wind exposure. (eg Scots pine and inland origins of Lodgepole pine.)

5. Poor choice of planting site. (eg wind exposure excessive or soil too dry to support tree growth.)

6. Occurrence of cold, desiccating winds soon after planting (particularly after spring planting).

7. Failure to plant trees in sufficient numbers for the development of mutual shelter. (eg the planting of single lines of trees "hedge" fashion in open situations - failure is very probable and, at best, establishment and subsequent growth are slow.)

8. Inadequate or unbalanced nutrition, particularly deficiency of phosphate.

9. Inappropriate maintenance causing damage to young trees during control of weed growth (eg using a strimmer close to unprotected tree stems) or lack of adequate weed control around the young tree.

FIGURE 2. A FAILED PLOT OF "MACROCARPA". THE SITE IS PROBABLY TOO WET, IN A FROST HOLLOW AND THE TREES MAY HAVE BEEN TOO LARGE WHEN PLANTED OUT.

4. General Guidelines for Shelterbelt planting

There appear to be reasonable prospects of successful shelterbelt planting, particularly in the wetter parts of the Islands, given care in site selection, adequate belt width, correct species choice, sufficiently high resource input when preparing the ground for planting, careful plant handling and planting, effective protection against browsing damage, and patience. However, shelterbelts take time to become effective and it is important to remember that the more difficult the basic environment is for tree growth, the longer this time becomes. Even if the guidance given below is applied correctly, it is likely to be at least 10 and probably 15 years after planting before significant shelter benefits will be obtained under Falkland Islands conditions. Thereafter, if healthy growth continues, the zone of effective shelter can be expected to increase substantially over the years as the tree height increases.

Establishing a shelterbelt involves a considerable amount of work and it is important to keep this in mind when making plans. Experience in Department of Agriculture trials suggests that 25 man-days are needed for ground preparation, fencing and planting a shelterbelt 300m long and 30m wide.

a. Siting

In general, satisfactory results are much more likely if shelterbelt planting is aimed at supplementing some existing topographic shelter, rather than at attempting to create shelter from scratch in the most exposed and windswept areas. For example, siting a belt slightly below the crest of a ridge (and on its lee side) will offer a much better chance of success than positioning it on the crest. Trees are at their most vulnerable immediately after planting and during the early years thereafter. Prospects for survival and growth are likely to be substantially better if the site provides even limited shelter at this initial stage. Recognition of this point in the past is demonstrated by the gorse hedges or shelter fencing associated with many early attempts at shelter planting. Although expensive, the addition of "Paraweb" screening or "Netlon" shelter netting to the windward fenceline of any new belt can be expected to improve survival and early growth, as has been demonstrated in recent UK FIT trials. High elevation, fully exposed or very dry sites should be avoided. Success seems more likely where the peat layer is of greater than average depth (30 cms or more) but waterlogged sites should be avoided.

The actual siting of belts within a farm must obviously depend on the owner's preferences and method of stock management, as well as on local conditions. The most valuable locations are likely to be in the vicinity of paddocks used for lambing or for holding sheep immediately after shearing. The fact that the predominant wind direction is westerly suggests strongly that a north-south belt orientation will normally provide most shelter benefit. On some farms, however, the periodic occurrence at critical times of very cold south or south-westerly winds may make it sensible to consider east-west orientation as well. A belt with L- or T-shaped configuration will provide shelter from most wind directions. For the present, anyone considering shelterbelt planting should not be over-ambitious and should avoid choosing a site which is obviously very exposed or very dry.

b. Size

UK experience (supported by Falkland Islands information) indicates that on windy sites belts should consist of at least 10 rows of trees, and that 15 or 20 rows are desirable. Such a width makes possible the development of mutual shelter by trees within the belt, leading to improved tree growth and shortening of the interval until the belt begins to provide some effective shelter to leeward. The windward rows of trees will often suffer considerable crown damage and possible periodic leader loss, but behind these rows relatively normal crown growth should occur. The spacing between rows and between trees should normally be 1.5 m and should not exceed 1.8 m. Published work on shelterbelts indicates that a minimum length of 200 m is required in order to ensure that, in the longer term, shelter is provided over a substantial area of ground. In view of the very extensive nature of sheep management in the Falklands and the expected slow growth of shelterbelt trees, it seems sensible to consider greater lengths and 300 m should probably be the minimum length contemplated - whether for a single straight belt or for each of the arms of an L-shaped belt.

c. Species

The number of tree species currently found growing somewhere in the Falkland Islands is substantial, but only a very few show any real potential for use in shelterbelt planting on camp sites. Information from other sources suggests that there are few other temperate forest species which are worth considering for shelter planting in the Islands.

On present evidence, there are two key species for shelterbelt planting - the conifers *Cupressus macrocarpa* (Monterey cypress or "Macrocarpa"), preferably raised from local seed or cuttings, and *Pinus contorta* (Lodgepole pine) originating from the Pacific coast of North America between Washington and Alaska. Both species have demonstrated a high tolerance to wind exposure and the ability to grow on typical camp soils with a 20 - 30 cm layer of peat over clay. Lodgepole pine can also be expected to perform acceptably on wetter, deeper peat soils, for which Macrocarpa is not suitable. (Note that inland and so-called "intermediate" (Skeena) origins of Lodgepole pine are **not** considered suitable for shelterbelt use on any Falkland Islands sites).

FIGURE 3. "MACROCARPA" (FOREGROUND, LEFT) AND SOUTH COASTAL LODGEPOLE PINE AT FITZROY.

Other coniferous species which show some promise for shallow peat sites are *Pinus radiata* (Monterey pine), *Pinus nigra var. nigra* (Austrian pine), *Pinus muricata* (Bishop pine) and the hybrid cypress X *Cupressocyparis leylandii* (Leyland cypress), which has Monterey cypress as one parent.

Two broad-leaved species which are also worth considering are the South American southern beeches *Nothofagus antarctica* (Ñirre) and *N. betuloides* (Coihüe or Coigüe). Both are wind resistant, although Coihüe may require better nutritional and moisture conditions than are provided by many camp soils. Seed should be obtained from dry, windy locations in Tierra del Fuego or southern Patagonia.

In the past, *Picea sitchensis* (Sitka spruce) has often been suggested for shelterbelt use in the Falklands. However, the frequent severe loss of foliage due to attack by Green spruce aphid *(Elatobium abietinum)* in both East and West Falkland locations strongly suggests that Sitka spruce should not now

be planted, even on moist soils. The mild Falkland winters unfortunately favour a build-up of aphid populations.

FIGURE 4. MONTEREY PINE (LEFT) AND AUSTRIAN PINE (RIGHT) ARE WORTH TRYING IN THE FALKLAND ISLANDS.

In most circumstances, the windward edge of a belt should consist of at least four rows of Lodgepole pine originating from coastal Alaska, the north coast of British Columbia, or the Queen Charlotte Islands. Although relatively slow-growing, these origins are very wind resistant and remain well-foliaged to ground level in exposed conditions. Subsequent rows can be planted with one or more of the other species listed above, including more southerly coastal origins of Lodgepole pine if these can be obtained. Most have the capacity in the longer term to grow taller than the Alaskan and other north coastal origins of Lodgepole pine but there is a risk that they may topple in strong winds. On very exposed sites it is probably a sensible precaution to use only Alaskan Lodgepole pine and Macrocarpa cypress, although other species might be planted in 50-50 mixture with Alaskan Lodgepole pine (as an insurance against their possible failure).

d. Ground preparation

Careful ground preparation prior to planting is a key requirement for success. The most appropriate treatments to use depend on site conditions, available equipment and the proposed scale of planting. Advice can be obtained from Department of Agriculture staff. For full-scale shelterbelts, mechanisation will normally be essential. The following prescriptions are based on agricultural implements known to be available within the Islands. Ground preparation should preferably be completed by late summer or early autumn, several weeks in advance of planting, and there is no reason why operations such as ripping, rotovation, flail mowing or ploughing should not be done several months in advance if this would fit in better with farm work schedules.

Except on deep peat sites (peat depth greater than 50 cms), it is preferable to rip along the length of the belt to a depth of 50 - 60 cms using a heavy-duty agricultural tine ripper. A suitable ripper is available on loan from the Department of Agriculture. Ripping at the proposed plant spacing (1.5 - 1.8 m) will disrupt the upper layers of the clay sub-soil (including any pan*), increase the moisture-holding capacity of the soil and encourage deeper tree root development in the future. Cross ripping at right angles and at the same spacing will help to improve conditions still further.

An important step is to control the ground vegetation and level out tussocks, etc. For this task, there are two possible approaches. The first is to use shallow (5 - 8 cm deep) rotovation to break up the vegetation mat. Alternatively, use flail mowing to remove accumulated dead foliage (particularly of whitegrass), wait until there is obvious regrowth of ground vegetation and then apply "Roundup" herbicide by sprayer or "Weedwiper". The flail mowing option should be selected if ploughing is to be done (see below).

Before planting takes place and preferably before any cultivation is done, a phosphatic fertiliser should be broadcast over the area at a rate providing 60 kg P per hectare (eg 425 kg per hectare of ground rock phosphate or 300 kg per hectare of triple superphosphate).

* a pan is a hard, impervious layer formed between two soil types which can seriously impair drainage and prevent roots growing down into the more nutrient-rich mineral subsoil below.

Spaced furrow ploughing with a robust single-furrow unit along the length of the belt can be used to create additional early shelter for the young trees. The plough must be capable of turning out and inverting a 15 - 20 cm thick turf ridge on the leeward (usually east) side of the furrow (with planting later to be done on the east side of the ridge). Furrow spacing should correspond to the tractor rear wheel spacing. However, note that if a site is ploughed in this way, it may well not be possible to use a tractor-mounted post hole borer to make planting pits (see below). In view of this, spaced ploughing is probably best used only on very windy locations where the early shelter provided by the ridges may make the difference between establishment success and failure.

FIGURE 5. TRACTOR MOUNTED POST-HOLE BORER MAKING PLANTING PITS, PORT HOWARD.

Shortly before time of planting, planting pits should be prepared at a spacing of 1.5 to 1.8 m both along and across rows. Pits should be approximately 30 cm in diameter and no more than 35 cm deep. Pits can be dug by hand but

using a tractor-mounted post hole borer is the quickest and easiest means of creating them. A hand-held post hole borer provides a further option if for any reason (eg presence of ploughing) it is not practical to operate a tractor-mounted unit. If practicable any clay brought up during digging should be returned to the bottom of the pit and not mixed with the loosened material from the peat layer, which should also be loosely replaced until time of planting. If the site has been ploughed, pits should be located in the lee of the ridge but not in the waterlogged area at the bottom of the furrow. Planting should never be done on top of plough ridges.

e. Planting stock

Sturdy, healthy, well-balanced young trees with compact fibrous root systems are required for good results. Seedlings should normally be no more than 30 cm in height, and in the case of pines other than Monterey pine 20 cm is preferable. There is no advantage in using larger plants, particularly if they are top-heavy; the most likely result in Falkland Islands conditions will be heavy losses and delayed establishment.

When assessing the suitability of planting stock, hold up a bare-rooted tree and shake out the roots which should preferably be as bushy and long as the tree shoot is tall. It is important that the root system is fibrous, dense and well developed in relation to the size of the shoot.

FIGURE 6. BARE ROOTED TRANSPLANTS OF LODGEPOLE PINE FROM UK 'LINED OUT' AT STANLEY GROWERS LTD, STANLEY.

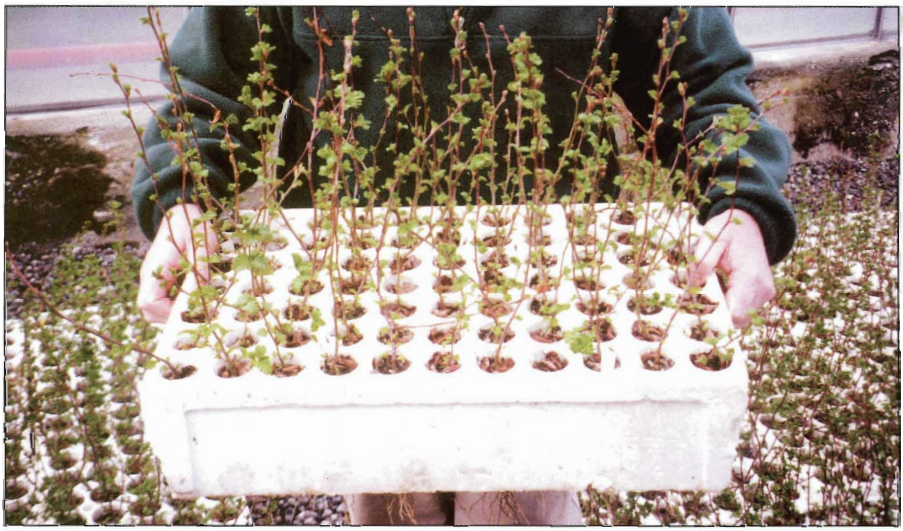

FIGURE 7. ONE YEAR OLD LENGA (SOUTHERN BEECH) SEEDLINGS GROWN IN STYROBLOCK CONTAINERS, PUNTA ARENAS, CHILE.

FIGURE 8. ROOTRAINER GROWN STOCK ARE HIGHLY RECOMMENDED.

FIGURE 9. GOOD QUALITY MACROCARPA IN POLYPOTS, SHALLOW HARBOUR. ALTHOUGH LESS THAN 1 YEAR OLD, THESE ARE READY FOR PLANTING OUT.

Up to the present, the type of planting stock normally used in the Falklands has been what is termed bare-rooted transplant stock. This is produced by transplanting young trees into an open nursery area where they are left to grow on for 1 or 2 seasons before being lifted just before planting time. Transplant stock will probably remain in common use at least in the short term, but alternative methods of producing planting stock in various types of container are likely to be used increasingly from now on. Container systems can make it possible to produce planting stock of appropriate size and quality in less time than is required if open nursery transplanting is used.

If transplants are involved, then immediately after being lifted from the nursery lines they must be packed in moisture-proof containers to protect them from desiccation. Bags made from co-extruded white and black polythene, as commonly used to hold peat composts, are very suitable. Containers should be transported as soon as possible to the planting location and stored in a cool shaded place until needed for planting. Container-grown plants require to be packed in boxes or crates rather than in bags. Some types will remain in their containers until planted out, while others are removed from their containers at the nursery and are packed as "plug" plants - so called because of the plug of soil which surrounds and is held together by the roots.

FIGURE 10. GOOD QUALITY CONTAINERISED 1 YEAR OLD TRANSPLANT, SHALLOW HARBOUR. PLANTS BIGGER THAN THIS WILL SOON BECOME POT BOUND AND LESS SUITABLE FOR PLANTING OUT.

f. Planting

Planting should normally be done in late autumn or early winter (May - June) because at this time soil moisture tends to be higher than in spring, desiccating winds are less likely and yet soil temperature may be sufficiently high to permit some root growth immediately after planting. If there has been recent heavy rain, so much the better. Exposure of tree roots to drying by sun and wind must be avoided at all times during transport to the planting site and while planting is taking place. Immediately prior to planting, trees should be removed in small numbers from the transport/storage container and packed loosely, with roots downwards, in a large knapsack-style planting bag or a large bucket. An advantage of using a bucket is that for bare-rooted transplants it offers the option of keeping roots moist and so reducing the risk of drying-out in sunny, windy weather. During planting, only one tree at a time should be taken **gently** from the bag or bucket. When transplants are being used, enough soil should be removed from the previously prepared pit to allow the root system to be spread out with the root collar (the base of the stem just above the roots) at or slightly below the soil surface. The broken-up soil is then back-filled around and over the roots and firmed with the toe of a boot while holding the shoot gently to prevent the tree sinking too far into the ground but without breaking the roots with excessive pressure. If container-grown plants are being planted, the planting hole must be large enough to accommodate the entire root ball or "plug", and no attempt should be made to spread out the root system. Soil should be back-filled and firmed around the root ball.

It is particularly important with pine species to make sure the roots are not coiled, bunched up or otherwise restricted in their room for development. Where soils are liable to settle after planting the trees should be inspected frequently to ensure they remain well firmed in.

FIGURE 11. PLANTING ON THE LEEWARD SIDE OF PLOUGHED FURROWS, ESTANCIA.
IF DEATHS DURING THE FIRST 2-3 YEARS RESULT IN SIZEABLE GAPS OR AMOUNT TO MORE THAN 5% OF THE TOTAL PLANTED, THE DEAD TREES SHOULD BE REPLACED BY PLANTING NEW TREES (IDEALLY OF THE SAME SPECIES) AT A SIMILAR TIME OF YEAR.

g. Protection

Grazing animals must be completely excluded by appropriate fencing which must be regularly inspected and maintained indefinitely if effective shelter to ground level is to be retained during the life of the belt. Use of a high initial fence specification will keep down later maintenance costs as well as minimising the risk of stock breaking in. Where hares are known to be present, as in East Falkland, netting will be necessary to exclude them until tree leaders are well above potential damage level (at least 5 years after planting). Frequent inspection is required, especially if there has been heavy snow, to deal promptly with any hares that may find their way into the fenced area. One hare can cause enormous damage in a single night. Fences must

be completed before any planting is done, but for ease of working are best erected after all mechanised site preparation has been completed. Where horses and cattle are present in the vicinity particular care must be taken with the fence specification and addition of an electrified wire may be necessary.

As mentioned earlier, the addition of plastic shelter netting or screening to the windward (and possibly also to the leeward) fence line can provide valuable shelter to the young trees during the establishment stage. Although an expensive option, the extra shelter will improve survival and early growth of the young trees and is likely to bring forward by 2 - 3 years the stage at which the belt begins to provide worthwhile shelter. Old pallets can also be used successfully to form a shelter fence. Individual short (30 cm) plastic tree shelters, held in place using canes, can be used to minimise wind desiccation during the **first** winter, but must be removed in early spring before new shoot growth begins. These shelters can then be re-used several times for new plantings.

FIGURE 12. FENCING FOR STOCK AND SHELTER, SHALLOW HARBOUR.

If there is vigorous re-growth of ground vegetation, the young trees may suffer severe competition, particularly for soil moisture. The herbicide glyphosate (Round-up) can be used to control vegetation growth, either in 1 m circles centred on trees or in 1 m bands. The herbicide must not be allowed to come into contact with the trees. Application of the herbicide by means of a hand-held "Weedwiper" is the safest method to use and should be done when vegetation is still relatively short. The windy Falkland Islands climate makes it difficult to use sprayer application after planting without risking damage to trees due to spray drift. The granular herbicide propyzamide (sold as 'Kerb' granules) is a possible alternative for use in late winter through to January to control grass weeds on sites where the peat is shallow and not too wet. Although it does not work best on these types of sites, discussion with the manufacturer and early observations are encouraging.

Maintaining a vegetation-free zone around the trees may also reduce the risk of damage to their roots by "grass grub" - larvae of the weevil *Malvinius compressiventris*. If serious grass grub damage occurs, it may become necessary to spray a permethrin or chlorpyrifos-based insecticide around the bases of affected trees, but advice from Department of Agriculture staff should first be obtained. Examine the base of the tree stems for signs of damage to bark - usually a 'track' around a stem is the first indication. Remove any weevils by hand during inspection and seek **urgent** advice if significant damage is found. Again, frequent inspection is advised.

FIGURE 13. SPOT SPRAYING WITH "ROUNDUP" BEFORE PLANTING, SHALLOW HARBOUR.

It is also necessary to protect the site indefinitely from damage by fire. If the risk is thought to be high, the most practical approach is to maintain a 5 metre wide firebreak round the belt by regular rotovation or flail mowing and grazing to keep down the vegetation.

h. Encouraging mycorrhizal development

It is widely recognised that most temperate tree species will grow better, particularly on infertile soils, if their roots become mycorrhizal - that is, form a mutually beneficial association with certain species of fungus which help the trees to absorb nutrients from the soil. There is circumstantial evidence to suggest that in typical open camp situations where trees have never grown before, suitable fungal species are likely to be absent or present at very low levels. This prevents or delays mycorrhizal development and tree growth is poorer than it would otherwise be.

In order to encourage early mycorrhizal development in a new plantation, it may well be worthwhile collecting top soil and litter from beneath an existing healthy plantation of similar species and at least 10 years old. This material will very probably contain fungal spores and other small fragments of fungal growth, and should be scattered widely within the limits of the new plantation.

5. Aftercare Schedule

Once trees have been planted they must not be forgotten and regular, frequent and thorough checking and maintenance are essential. Of particular importance at the end of the first season is replanting any sizeable gaps where trees have failed ("beating up"). This should be repeated as necessary in the early years. Fencing should be checked regularly and thoroughly as stock will rapidly exploit any weaknesses and hares must be removed. Depending on the site, an additional application of herbicide may be required in year 3 and possibly again in year 5.

6. Summary And Key Planting Tips

- Tree planting can be used to create shelter in the Falkland Islands if care is taken and resources devoted to the job.
- Trees grow best in large groups - belts should be wide and long with closely planted trees.
- Avoid very exposed and very dry sites.
- Exclude all grazing animals by erecting, inspecting and maintaining a high quality fence.
- Good ground preparation is important.
- Handle planting stock carefully and never expose roots to drying out by sun and wind.
- Use the correct species and place of origin.
- Select sturdy planting stock with compact fibrous root systems (almost as much root as shoot).
- Apply phosphatic fertiliser to the site.
- Use herbicide to reduce competition between trees and ground vegetation.
- Inspect plantations frequently for wind-loosened plants, hares and grass grub, particularly soon after planting.

7. Further Reading And Sources of Information

Publications

There have been many books and guides on tree planting in many parts of the world but these have not been widely available in the Falkland Islands.

The key reports and papers written on tree planting are listed below. In most cases these should be either in the Stanley Town Library or at the DoA Offices. This booklet is largely a condensation of these reports and the accumulated experience of the authors.

McAdam, J.H. (1977) Trees for shelter in the Falkland Islands, a practical guide. Grassland Trials Unit, Stanley.

Low, A.J. (1983) Tree planting in the Falkland Islands. A report to FIG.

McAdam, J.H. (1985) The effect of climate on plant growth and agriculture in the Falkland Islands. Progress in Biometeorology 2, 155-176.

McAdam, J.H. (1996) The potential role for trees and forestry in the Falkland Islands. A report to the UK Falkland Islands Trust.

Low, A.J. (1997) Tree planting for shelter in the Falkland Islands.
A report to FIG Department of Agriculture, Stanley.

The Forestry Commission in UK produce an excellent series of books on all aspects of silviculture. Some appropriate titles still in print are

1. Forest nursery practice. FC Bulletin 111.
2. Seed manual for forest trees. FC Bulletin 83.
3. Forestry practice. FC Handbook 6.

These can all be obtained from any HMSO bookshop.

The G.B. Forestry Commission and the N. Ireland Forest Service produce popular leaflets specifically targeted towards farmers.

1. Forestry Commission, Policy and Practice Division, 231 Corstorphine Road, Edinburgh EH12 7AR. (Tel: +44 131 334 0303 Fax: +44 131 334 3047).
2. Forest Service, DANI, Dundonald House, Belfast, BT4 3SB, N Ireland. (Tel: +44 2890 520100 Fax: +44 2890 524570)

Tree Seed

Two reputable sources of tree seed are:

1. Forestart, Church Farm, Hadnall, Shrewsbury SY4 4AQ.
(Tel: +44 1939 210638 Fax: +44 1239 210563).
2. Seed Trading, Forestry Commission, Alice Holt Lodge, Wrecclesham, Farnham, Surrey, GU10 4LH. (Tel: +44 1420 22255 Fax: +44 1420 22846).

Herbicides

ROUNDUP
Monsanto Crop Protection, PO Box 53, Lane End Road, High Wycombe, Bucks HP12 4HL (Tel: +44 1494 474918 Fax: +44 1494 474872).

KERB
Pan Britannica Industries Ltd., Britannica House, Waltham Cross, Herts AEN8 7DY (Tel: +44 1992 623691 Fax: +44 1992 626452).

Forest suppliers

Root trainers, tree guards and general tree care products.
T. Toms Ltd., Grigg Lane, Headcom, Ashford, Kent TN27 9XT
(Tel: +44 1622 891111 Fax: +44 1622 890783).
Tubex Ltd., Aberaman Park, Aberdare, CF44 6DA UK
(Tel: +44 1685 883350 Fax: +44 1685 873952).
Ronaash Ltd., (Rootrainers) Kersquarter, Kelso, Roxburghshire, TD5 8HH
(Tel: +44 1573 225757 Fax: +44 1573 225807).

Other information

1. Forestry Commission G.B. (see address earlier).
2. Forest Service, DANI (see address earlier).
3. INFOR, Instituto Forestal, Punta Arenas, Chile
(Tel: 56 61 210838).
4. Dept. of Agriculture, Stanley (Tel: 27355 Fax: 27352)