TREE PLANTING AND ESTABLISHMENT IN THE FALKLAND ISLANDS

Report on Additional Work 1993/94

Summary

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To date the project has shown that, provided ground preparation and nutrition are attended to, trees can grow and be valuable in a wide variety of situations in the Falkland Islands. Individual tree shelters are beneficial in early establishment. There are varieties of willow and Eucalyptus which merit further trial and enhancement of local *macrocarpa* stocks may be possible.

Growing trees is a long process and these trials have been largely concerned with initial establishment. Further assessment work of a longer term nature will be required.

A series of experiments were planted to investigate aspects of tree planting and establishment in the Falkland Islands. Experiments have been planted at 3 sites to investigate planting technique, tree nutrieiton and artificial shelter, at two sites to aid provenance selection and an experimental woodland plantation has been established.

Results are presented for two sites (Stanley and Fitzroy) for three years and one site (Keppel) for four years. Some preliminary conclusions on tree planting in the Falklands can be made but caution must still be exercised in interpreting results in what is, by necessity, a long term project.

Sitka spruce appears to do well on wet, deep peat, Lodgepole pine on drier peaty sites. Provided trees survive the first year of establishment, subsequent chances of survival seem high. Pit planting will likely prove essential on all sites and is definitely essential on dry sites. Once trees which have been slit planted established, they seem to subsquently grow satisfactorily. The benefits of kelp compost added at planting are being felt in the second full year. The growth promotery benefits of applying liquid kelp extract as a foliar feed are starting to be seen on a nutrient-poor site. Paraweb netting did not have an immediate beneficial effect, but there is an indication that benefits may come later.

Improved New Zeland bred, varieties of *Cupressus macrocarpa* the traditional tree for the Falklands can grow faster and provide better shelter than local stock while still remaining a traditional feature of settlements etc. On first assessment they can be rapidly established in a more substantial shelter belt/farm woodland situation than on the small plot trials.

1. Background - the need for trees

Falkland Islanders have been interested in growing trees in Stanley and in the camp for many years. Although it would be undesirable to clothe large areas in coniferous woodland and tall forest giants will not be grown in the Falklands, there is a need for shelter for stock and gardens and to improve the visual appearance of Stanley.

Now that flocks are smaller and the national sheep flock is going to be substantially upgraded from improved stock imports, the need to reduce losses is all the more important. Strategically placed shelter around clippy pens or in ewe camps could be used over the critical times of lambing and shearing to make a very significant impact on lamb survival and on sheep recovery after stress.

Stanley is developing rapidly, and with new housing and small industries appearing there is a need to landscape the town. Trees are widely recognised as the most natural way to achieve this. With many new small settlements appearing, trees have a further shelter and landscape role. There is also an interest in erosion control and rehabilitation of eroded areas. Research has shown the erosion process to be a direct result of the windy climate.

Trees can form an important role in this context and further trials are necessary.

A wide range of reports and scientific papers were reviewed prior to commencing the programme (see Interim Technical Report - Year 1).

2. Introduction and Objectives

The objectives of the project (commenced in 1990) were as follows:

1. To determine the most suitable method for planting and establishing trees on a range of camp types in the Falkland Islands.

2. To provide information on species suitability for various situations in the Falkland Islands.

It is assumed that, initially, results would be more applicable to strategic tree planting situations - in the agricultural context around settlements, paddocks, clipped-sheep pens etc and in the landscape context, around gardens and public places in Stanley.

This report follows on from two interim technical reports and one final report on the project and contains a summary of follow up work and a continuation of measurements from the trials reported in the earlier reports. Results following sampling and measuring are available from three trial sites. Following the absence of a permanent resident on Keppel Island, regrettably only minimal measurement and tree management was possible. A further measurement of the remaining trees was carried out in early 1994. Other experiments on varietal selection (Willows and Eucalyptus) and seed introduction and germination have been terminated with trials on provenenaces of *Macrocarpa*. All the field trials in connection with this project are now planted. However, as many of the trials are still in the establishment phase, detailed conclusions cannot be made at this stage. Available results are presented and conclusions drawn where practicable.

3. Experimental programme

a. Tree planting and establishment trials.

The major thrust of the project was geared towards determining tree planting and establishment techniques on a range of sites. The key issues involved are planting technique, shelter provision and tree nutrition. An experiment was designed involving the following treatments:

- Tree species - 2 (Lodgepole pine and Sitka spruce - largely selected because of local availability)
- Planting technique - Slit plant (quick and simple - standard UK Forestry technique)
  - Pit plant (as implied - small pit dug to disturb the soil)
- Nutrition - No fertiliser; phosphate only; kelp compost (in the pit); foliar feed of locally produced kelp extract)

The experimental design incorporated all combinations of three treatments in a fully replicated (3 reps per treatment) design. Each treatment plot contains 5 trees, representing a total of 600 trees per site. The experiment was planted at 3 sites:-

(i) Keppel Island - hard, dry "diddle-dee" camp
(ii) Fitzroy (Britannia) - soft whitegrass camp
(iii) Stanley (Mkt garden) - impoverished, shallow, wet peat

The Keppel Island site was planted in August 1989 and the other two sites in August 1990.

b. Production of liquid kelp extract.

One aspect of the experiment detailed above is an assessment of the value of locally produced liquid kelp extract. Previous trials (conducted by the UK FI Trust) had shown that bacterially activated, aerobic digestion is the simplest and cheapest way to produce kelp extract. Over the duration of the project, liquid seaweed extract was produced from the digester and was applied to some trees in the main establishment trial. It has not been possible to operate the digestor during the 1993 season. The plant has now been shipped to Port Howard where it will be started up again to produce liquid kelp extract.

c. Macrocarpa provenance. *Cupressus macrocarpa* - locally known as 'macrocarpa' - is one of the most successful trees found growing in the Falklands and one which might be regarded as a 'traditional' component of the landscape (though it is of course not native to the Falklands). In exposed conditions however macrocarpa grows very slowly. The species also grows well in New Zealand where it is a valuable forestry tree and the Forest Research Institute of the Ministry of Forestry in New Zealand has, for many years, been selecting seed from and breeding 'elite' trees. These show rapid growth and good growth characteristics. To enhance the macrocarpa stocks in the Falklands and to see if these improved strains will do well locally, seed of the best selections from the macrocarpa bred in New Zealand were purchased. Seedlings from these have been raised at Stanley for comparison with 'local' macrocarpa (ex Hill Cove) and UK purchased (ex Forestry Commission seed. Seed germination was good and approximately 2,500 plants of all three types of macrocarpa were potted out. These have been further assessed and approximately 500 plants have been established in Phase 1 of a Farm Woodland trial at Port Howard. A further 350 trees have been planted in Phase 2.

4. Results

a. Tree planting and establishment (Keppel Island, Fitzroy, Stanley)

On all 600 trees at each site the following measurements have been made - tree height; a subjective assessment of general tree health (on a 0-5 scale); number of branches counted; foliage samples taken for chemical analyses of leaf nutrient levels. Measurements have been taken as follows:

	1989 (Jun)	1990 (Jun)	1990 (Oct)	1991 (May)	1991 (Nov)	1992 (Jul)	1992 (Nov)	1994 (Jan)
Keppel	/	/	/	/		/		/
Fitzroy			/	/	/		/	/
Stanley			/	/	/		/	/

The effects of planting technique, shelter, foliar spraying and species on tree height, health and survival are presented in Tables 1-8. Data are presented for two sites in most cases.

However, since the trees on Keppel Island are no longer tended regularly (the island is now uninhabited) losses have increased. In July there were 250 trees still alive, a decrease in survival from 62% to 38% between May 1991 and July 1992 and these were measured. In January 1994 there were 101 trees still alive, twice as many Lodgepole pine (mean height 75 cm) surviving than Sitka spruce (mean height 51 cm) (Table 6). One tree was 180 cm tall. Overall the Lodgepole pine has grown 25 cm since 1992, the fastest growth of any site (Table 6).

(i) Species selection (Table 6)

Lodgepole pine is clearly the best species for the Fitzroy and Keppel sites. At Fitzroy in 1992 both were approximately the same height with equal survivals. Over the next growing season the Sitka spruce did not grow and mortality was high (88-68%). Over the same period, Lodgepole pine grew, on average, 14 cm and most plants survived. On Keppel, Lodgepole pines surviving were now 75 cm tall.

Sitka spruce are performing best on the Stanley site in terms of overall survival, although both species have comparable growth rates. Growth rates of 17 cm per season must be considered very acceptable, particularly as the corresponding figures for 1991-1992 were 7 cm and 4 cm respectively. Clearly the trees are now establishing and starting to grow well. As trees become better established there is evidence (from the remaining Keppel trees) that growth rates will increase.

(ii) Planting method.

Individual trees remaining on Keppel could not be ascribed to individual treatments as time available on the island was limited. However, most of the survivors were clearly pit planted as three years after planting pit planted trees (Keppel site) were on average 21 cm taller and were more healthy (by 0.9 units) than slit planted trees. Only 17% of trees planted by the slit method had survived at Keppel whereas 52% of those planted by the pit method were surviving at the end of year 3. On the Fitzroy and Stanley sites, those trees which were pit planted survived better and have grown significantly more than those slit planted (Table 1). Both sites are showing the same trends with mean growth (1992-1994) from slit planted

trees being less on both Fitzroy (11.5 vs 15.5 cm) and Stanley (9 cm vs 15.5 cm) sites. Percentage survival is also significantly better in pit planted trees than slit planted trees (by 11% in both 1992 and 1994) at the poorer Fitzroy site (Tables 1 and 2). This, along with superior survival of Lodgepole pine on this site has obvious economic implications. Slit planted trees which survived initially have now picked up slightly in terms of height and health on both sites (Table 2). Hence it seems that once trees have an established root system, they can grow well and overcome the lack of a dug pit, but their initial chances of survival will be a lot worse if slit planted than if pit planted.

(iii) Fertiliser at planting

Slit planted trees benefitted substantially from the application of phosphate fertiliser at planting (Table 3) on the Stanley site.

(iv) Foliar fertiliser application

Tree height and health are now apparently responding to liquid kelp extract in the Fitzroy site (Table 1). Although there has been only minimal effect following an application at both sites, the trees are probably not well enough established for any effect to be recorded.

(v) Shelter netting

Overall there is still no significant effect of shelter netting on tree survival, height growth and health at any site (Table 5).

b. Tree shelters

By 1994, four years after planting, only one of the trees planted without tree shelters on this windy, exposed site were remaining. Trees protected by a tree shelter (square section plastic tube) were now 121 cm tall. These trees have grown by 37 cm over the two years since the last measurement (Table 7). Trees in the shelters were bushy, green and healthy and almost 80% were still surviving. Where tubes have been removed the trees are stable but have lost all their bottom leaves. The trial demonstrates clearly that tubes can help early establishment and growth of pine but may not the be the best in the long term. (Table 7).

c. *Macrocarpa* trial (Table 8)

Over 2,500 (2640) *Macrocarpa* trees were raised from seed and pot planted ready for trials. Of the 3 varieties grown, growth of the plants from the New Zealand hybrid seed is better than from the other two varieties (Table 8). The plants will be grown on in pots for eventual planting out as part of an additional tree project.

5. **Conclusions from establishment experiments**

- Species selection may be site related, Sitka spruce preferring wet peaty sites and Lodgepole pine drier sites.

- Loss rates may have stabilised to an acceptable level (10%) after the first establishment year ie provided trees can survive the first year, their subsequent chances of survival seem high, although regular attention and maintenance is important.

- Pit planting is essential for adequate tree survival on dry, hard sites. No conclusion can be drawn from the wet sites. Once trees which have been slit planted have established they seem to subsequently grow satisfactorily.

- Where trees are pit planted, kelp compost should be used, its beneficial effects are carried into the second year after establishment and beyond

- The growth promoting benefits of liquid kelp extract are starting to be shown on a nutrient-poor site.

- The benefits of paraweb netting as a minimal shelter provision are still not demonstrated.

- Although tree shelters considerably enhance growth, survival and performances of trees and are useful when small numbers of trees are being planted, when the shelters are removed trees lose many leaves and may not recover well.

6. Woodland Plot at Port Howard

Almost five hundred Macrocarpa of New Zealand and Falkland Islands origin were planted using the pit and kelp technique at Port Howard. Minimal shelter was provided. Survival over the first year is acceptable (90%) and mean tree height is 49 cm (Table 9). These trees will be closely monitored.

7. Advice

Five farmers have been given on-site advice on tree planting.

8. Further work

a. it is important to continue the programme of maintenance and measurement on the two tree establishment and Port Howard woodland sites. Tree growth can be a slow process so the ongoing nature of the work initiated by the Trust and funded by FIDC must be built on.

b. Additional trials using hedging plants, well proven for windy, coastal climates, will commence in 1995. Rehabilitation of cut-over peat banks on Stanley Common is planned. It is hoped to integrate some of the trials with a programme of erosion control planned by the Department of Agriculture.

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Kelp Extract Planting Technique	Fertiliser	SITE			
		Fitzroy		Stanley	
		Applied	Zero	Applied	Zero
a. Height (cm)					
Slit	Zero	32.1	32.8	40.7	40.4
Slit	Phosphate	34.8	29.9	59.1	66.5
Pit	Zero	39.8	35.6	48.2	44.6
Pit	Phosphate	38.2	34.8	54.4	56.3
Pit	Kelp Compost	41.1	39.8	47.5	50.1
Mean		37.2	34.6	50.0	51.6
sem			2.76		2.61
b. Health					
Slit	Zero	2.8	2.6	3.3	3.3
Slit	Phosphate	2.9	2.5	4.3	4.6
Pit	Zero	2.9	2.4	3.9	3.8
Pit	Phosphate	2.7	2.8	3.9	4.1
Pit	Kelp Compost	3.0	2.8	4.0	4.0
Mean		2.9	2.6	3.9	3.9
sem			0.17		0.30
c. % Tree survival					
Slit	Zero	67	55	78	75
Slit	Phosphate	72	72	75	70
Pit	Zero	80	85	75	87
Pit	Phosphate	77	75	72	72
Pit	Kelp Compost	77	82	80	72
Mean		74	74	76	75
sem			7.1		6.3

Table 1: The effect of planting technique, fertiliser at planting and kelp extract spray on tree height, health and survival (both species) at the Fitzroy and Stanley sites, January 1994

		Planting Type		
		SLIT	PIT	MEAN
a. Tree height (cm)				
Stanley	Mean (May 1991)	23.7	24.6	24.2
	Mean (Nov 1991)	27.2	27.2	27.2
	Mean (Jan 1994)	51.7	50.2	50.8
Fitzroy	Mean (Nov 1991)	23.9	29.0	26.5
	Mean (Jan 1994)	32.3	38.2	35.9
b. Tree health				
Stanley	Mean (Nov 1991)	3.7	4.0	3.8
	Mean (Jan 1994)	3.9	4.0	3.9
Fitzroy	Mean (Nov 1991)	2.5	3.2	2.9
	Mean (Jan 1994)	2.7	2.9	2.8

Table 2: The effect of planting type on tree height and health for comparable fertiliser levels at planting (for both species) at two sites (Stanley and Fitzroy) in November 1991 and January 1994, three years and 2 years after planting respectively.

Site	Planting Technique	Fertiliser at Planting: Zero	Phosphate	Kelp Compost
a. Height and Growth (cm)				
Stanley	Slit	40.5	62.8	
(1989-1994)	Pit	46.4	55.3	48.8
Fitzroy	Slit	32.5	32.3	
(1989-1994)	Pit	37.7	36.5	40.8
b. Health				
Stanley	Slit	3.3	4.4	
	Pit	4.4	4.1	4.0
Fitzroy	Slit	2.7	2.7	
	Pit	2.6	2.8	2.9

Table 3: The effect of fertiliser at planting and planting technique on tree growth and health (both species) from two sites (Fitzroy and Stanley) in January 1994

Planting Method	Site	% Survival since planting (Nov 1991)	% Survival (Jan 1994)
Slit plant	Stanley	85	77
	Fitzroy	85	61
	Mean	85	68
Slit plant & fertiliser	Stanley	82	73
	Fitzroy	88	72
	Mean	85	72
Pit plant	Stanley	93	81
	Fitzroy	98	83
	Mean	96	82
Pit & fertiliser	Stanley	82	72
	Fitzroy	93	76
	Mean	88	74
Pit & kelp compost	Stanley	83	76
	Fitzroy	93	79
	Mean	88	78

Table 4: The effect of planting method on tree survival at Stanley and Fitzroy in November 1991 and January 1994

	Keppel		Stanley		Fitzroy	
	Sheltered	Unsheltered	Sheltered	Unsheltered	Sheltered	Unsheltered
Tree height (cm)	52.4	62.8	51.5	50.1	34.4	37.4
Tree health	-	-	3.9	3.9	2.7	2.7
Tree Survival (%)	17	29	70	81	76	72
Growth 92-94 (cm) Keppel	10.0	20.3				

Table 5: The effect of artificial sheltering on tree growth, health and survival at Fitzroy, Stanley and Keppel Island, three and five years after planting respectively and on tree height increment in the fourth full year of growth, Keppel Island

	Sitka Spruce	Lodgepole Pine
Height (cm)		
Stanley (1994)	56.3	45.3
Fitzroy (1994)	26.9	44.9
Kepple (1994)	50.8	75.4
Growth (cm)		
Stanley (91-90)	17	17
Keppel (91-90)	16	25
Fitzroy (1992-1994)	0	14
Actual survival		
Stanley (Jan 1994)	93	58
Keppel (1991)	59	64
Keppel (1992)	39	41
Keppel (1994)	11	23
Fitzroy (1994)	68	80
Loss rate (% per year)		
Stanley (94-90)	1	9
Fitzroy (94-90)	7	2

Table 6: The response of Sitka spruce and Lodgepole pine at Keppel, Stanley and Fitzroy

	Tree Support/Protection		
	No Protection	Stake Only	Stake & Tree Shelter
Height (cm)	88	-	121.1 (+37)
% Survival	7 (-20)	0	80 (-7)

Table 7 The effect of tree support and protection at planting on height and survival of Lodgepole pine four seasons after planting (the change over the past year in each parameter measured is shown in brackets)

	Seed Source Local (Falkland Is)	Forestry Commission	NZ Hybrid
Height (cm)	34.0	29.8	44.1
Stem diameter (mm)	6.2	5.1	7.9

Table 8: The size of transplants of *Cupressus macrocarpa* grown from 3 seed sources

Row	No of Trees	% Dead	Mean Height (cm)	Mean Health
1	78	11	52.03	4.2
2	83	5	47.1	3.9
3	57	12	54.9	4.0
4	77	9	52.9	3.9
5	78	14	50.7	4.0
6	81	6	52.7	4.0
7	15	-	44.7	3.7
8	12	25	39.2	3.7
Total	481	10	49.3	3.9

Table 9: Details of rows of *Macrocarpa* trees planted in the woodland at Port Howard