AGR/FOR/1#29

AGR 131

CLASSIFICATION Unclassified

GROUP Agriculture

SUB-GROUP General

SUBJECT Forestry

AGR 131/3

V.1

OFFICER DEALING AS

FILE OPENED 9.8.7

FILE CLOSED 31-3-87

ARCHIVES

ED FILES 6711/31/4 - Agronomy

1.

C.S.,

1. The letter at (1) submitted please.

2. We could invite Mr McAdam of the GTU to comment?

[initials] 9. 8. 77.

2.

C.S.

(8) I don't think we wish to be represented or to provide papers, and recommend we so reply, pl.

[initials] 23. 9. 77.

3

AS

Mr McAdam may visit the UK delegation to take up a point or two?

[initials] 29/9

4.

By 28. 11. 77. (7)

C.S.,

(12). I wonder if this matter was mentioned by Howard Pearce during his recent visit here? If not, perhaps we should enquire the present position?

[initials] 8. 2. 78

5

[initials] 10. 2. 78

AS

Mr Pearce did not raise the topic with me, but may have done so with Mr. Kerr. Perhaps you would check that & let me know?

2. In general I would hope that we could establish that we could effectively

A.S. 8

for ? pl.

I have approved Mr. Kent's draft for issue. I note you have told Richard Gozney the position at F (17) & we should of course continue to keep him informed of progress. Thanks.

JS 30/IV.

8

Reg Pt. Bill in one week (for F (25)).

JS 19/I

9

Reg: (22) sent to Steve Whiteley. CMS 21/I

10

Reg. Pt Bill in 3 weeks

(to check on visit of Forestry Advisers)

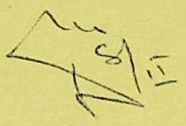
JS 10/VII

11

DCS(P) There have been reports to a proposed visit by a Forestry Adviser – a Dr. Low has been mentioned of the Forestry Commission I think. Would you pl. check on where we are with this so that I can mention in my reply – our note

JS 29/VIII

handle seedlings here before we establish any arrangements for their importation. How does Dr. Kerr envisage arrangements for this?



6

Note: Spoke Mr C.D. Kerr. This matter was raised with him by Mr Pearce in January, who still awaits a reply from the Argentine Forestry Institute (see also para 3 of p. 12).

There would be no difficulty in handling the seedlings which would already have been hardened-off and would merely require planting out in the plantations.

22.3.78

7.

Bly. 2.5.78
(KIV)

C.S.

Pages 1-7 and 12-18 pt. You will note that, following a suggestion by Lord Shackleton that there should be shelter belts of trees in the Colony and being aware of an increasing interest here in forestry, ODM approached the British Embassy in BA with a view to establishing a link with the Argentine Forestry Institute. The current position is set out at (15). I referred to matter to C.I.U. Campbell Kerr now wishes to send a letter to SOH and has submitted a draft (at p.19) for your consideration pt.

27.4.79.

A.S. 8

for 7 pl.

I have approved Mr. Kent's draft for issue. I note you have told Richard Gozney the position at F (17) + he should of course continue to keep him informed of progress. Thanks.

JS 30/IV.

8

Reg PC. Bill in one week (for F (25)).

JS 19/I

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Reg f. PC Bill in 3 weeks

(to check on visit of Forestry Advisor)

JS 10/VII

11

DCS(P) There have been responses to a proposed visit by a Forestry Advisor – a Dr. Low has been mentioned of the Forestry Commission I think. Would you pl. check on where we are with this so that I can mention it in my briefing - our note

JS 29/VII

Reference.....

12

Reg

Please B/U 5/8/83 to check reply to memo of 1/8/83 opposite.

1/8/83

CS

Your minute of 29 July, and my memo of 1 August to Dr Ferguson refers.

I spoke with Dr Ferguson today who gave me the following information:-

Dr Low - Depart UK 7.9.83 (approx.) now 9.9.83
* Returns UK 7.10.83 "

Purpose of visit: To advise FIARDC and FIG on steps which may or may not be taken regarding forestry for the Falkland Islands. He is to ascertain whether or not there is enough information here to make recommendations and, if his findings indicate insufficient information in certain areas, to advise what steps should be taken to obtain that information.
He is not here to advise people on planting of trees, etc.

He is to visit most of the islands. Landrover will be made available to him in the west.

2.8.83 * now 30.9.83

Reg

Please CANCEL B/U for 5.8.83

2.8.83

Registry 29/8/83

Please B/U to me 28.9.83 re (33) opposite.

16/8/83

CODE 18.77

(1)

Ministry of Overseas Development
Eland House Stag Place London SW1E 5DH

Telephone 01-834 2377 ext

REPLY AT (2)

A J P Monk Esq
Chief Secretary
Stanley
Falkland Islands

CHIEF SECRETARY 25 JUL 1977 FALKLAND ISLANDS

Your reference

Our reference CLA 56/274/01

Date 8 July 1977

Dear Arthur,

1. Mr Murray Hunter, a former head of Latin America Department in the FCO, who is now with the Scottish Forestry Commission has written to Richard Jones expressing interest in forestry in Falklands.

2. It is obvious that his interest arose from reading the Lords' Debate on 20 April on the Shackleton Report and he says in his letter

> "On the whole, we would consider that the conclusion on the relevance of forestry stated by Lord Shackleton in Column 249 was correct in the circumstances. But in fact when dealing with the feasibility of growing trees in such latitudes, both Lord Shackleton and Viscount Massereene and Ferrard were unduly pessimistic, and Viscount Thurso much more nearly right, assuming that the aim is shelter and not primarily to secure an economic return.

To simplify considerably, the Forestry Commission has long standing experiments in Orkney and Shetland which tend to show that lodgepole pine (Pinus contorta) of suitable provenance will grow there satisfactorily; it is of course already being grown on a commercial scale in the far North of Scotland. It is very probable that lodgepole would make a good element in shelterbelts, and possibly also Sitka Spruce, our main commercial species. This possibility is suggested by a notable private estate at Kergord in Shetland where shelterbelts have been grown with considerable success, including Sitka which has produced a utilisable crop of timber (Forestry, Vol XXXV, No 1, 1962-OUP). On a very much smaller scale Lord Birsay has successfully grown a small block of lodgepole pine on his croft in Orkney. It could incidentally be a useful addition to our own research information if anyone were able to provide some further silvicultural data about the planting at Hill Cove mentioned by Lord Shackleton.

Unfortunately, we may not be able to contribute much silviculturally; it is doubtful whether we could translate our lodgepole pine experience into the southern hemisphere. The Argentines may have some more relevant experience. One of our present Commissioners who attended the Seventh World Forestry Conference in Buenos Aires in 1971, went on the southern tour arranged by the Argentine Forestry Service, and got as far as Esquel in the Province of Chubut. He saw there some areas where pine was being grown for shelter, though these were fairly arid and probably

did not present problems of terrain and exposure as severe as would obtain in the Falklands. One of the species used however was Pinus contorta, which we are using in the Scottish far north and the Northern Isles, but our people did not learn whether it was of the very hardy Alaskan provenance which we have found copes best with conditions in the Northern Isles. The booklet "Argentina Forestal" which the Argentines handed out at the Seventh World Forestry Congress, unfortunately does not mention this activity or species. But it does mention native species growing in Tierra del Fuego, which is as windswept as the Falklands, so it is possible that they might have some useful contribution to make in the way of technical advice on growing trees in the Falklands, if such an idea were ever to prove relevant to mutual economic arrangements for the development of the Islands."

3. We have referred this letter to our Principal Forestry Adviser who accepts that the aim in this forestry context must be for shelter and not an economic return, although if additional forest products value was eventually obtained so much the better. He also thinks that the Forestry Commission should have considerable experience which could be very relevant to the Falkland Islands, and suggests that they be asked to provide as much information as possible. On the other hand, there could be even more relevant information available from the Argentine.

4. In the circumstances I am copying this letter to Howard Pearce in Buenos Aires to ask if he will be kind enough to make some enquiries of the Argentine Forestry Authorities on your behalf.

Mrs M C Rosser

(2)

Chief Secretary's Office
The Secretariat
Stanley
Falkland Islands

Ref: AGR/31/7

10 August 1977

Mrs M C Rosser
CLA
Ministry of Overseas Development
Eland House
Stag Place
LONDON SW1E 5DH

REPLY AT (6)

FORESTRY (1)

Thank you for your most helpful letter containing Mr Murray Hunter's views conveyed in a letter to Richard Jones.

2. This coincided with a revival of interest in forestry in the Falklands and I shall show your letter to Jim McAdam who has already done a fair amount of private investigation into silviculture here.

3. We have also identified recently the need to obtain more advice from our neighbours in South America on agricultural and related matters, and this seems to be an ideal area in which we could gain from such advice.

4. If anything emerged from these proposals do you think ODM would pay for, say, McAdam to pay a visit to the Argentine counterparts of our forestry commission?

A J P Monk
Chief Secretary

JB

AGR/31/3

(3)

ATTACHED

10 August 1977

J H McAdam Esq
G T U
Stanley

(1)

I attach a copy of a letter sent to me by Mrs Rosser which includes an extract from a letter by a Mr Murray Hunter to Mr Richard Jones, who is the head of the Latin America Dept in ODM.

2. I have written briefly to Mary Rosser acknowledging her letter and telling her I shall seek your views on Mr Hunter's proposals and also enquiring whether ODM might make funds available ~~fn~~ in the event that we believed ~~there~~ it was worthwhile to establish contact with the Argentine counterpart of the Forestry Commission.

3. Would you kindly therefore let me have your views on Hunter's proposal and whether we should try and establish contact with the Argentine forestry services, and any other information you feel useful.

A J P Monk
Chief Secretary

encl

m.

Our Ref: AGR/13/3

Your Ref: .....

Grasslands Trials Unit,
Stanley,
Falkland Islands,
South Atlantic.

12th August 1977

A.J.P. Monk Esq.,
Chief Secretary.

Dear Mr. Monk,

Thank you for your correspondence of 10th August concerning Mrs. Rosser's letter. I am extremely keen on the possibility of growing trees in the Falkland Islands and consider that much serious thought should be given to Mr. Hunter's proposals.

I would certainly share Mr. Hunter's views that people have been unduly pessimistic about the feasibility of growing trees in the Falkland Islands. I can back up my criticism of this pessimism by data obtained from some of my experiments and observations carried out in the field here.

I have been extremely interested in the effects of the weather on plants and have been carrying out a series of exposure measurements in the Islands over the past 15 months using a technique adopted by the Forestry Commission in Northern Scotland. This simple technique involves measurements on the rate of tatter of standard flags and much data is available on this subject for sites in the North of Scotland. The exposure index figures I have been obtaining here would tend to indicate that the Falklands are on a par with the Orkney Islands from a climate point of view. I have personally visited the Commission's trial sites on Orkney and can confirm that the trees have been planted on a much worse type of soil than one would consider planting here. We have the unique advantage here of the absence of competition for land between different farm enterprises - hence no one objects to the setting aside of a few hundred acres of good quality (relatively speaking) land for planting.

As Viscount Thurso stated, the aim is shelter and not primarily to secure an economic return. However, nowadays economists are finding the benifits accruing from shelter, when quantified, are a much more attractive proposition than was once realised.

I am certain that Lodgepole pine (Pinus contorta) and Sitka spruce (Picea sitchensi are very suitable species for here and I have also been interested in the possibility of growing trees indigenous to Southern Argentina and Chile (notably Nothofagus).

I would agree that the Forestry Commission's experience would be very valuable here, although I would suggest that it's value may lie more in advice on ground treatment and planting procedures rather than in supplying trees. It is in this latter content that I believe we could make use of the Argentines. The growing of trees from seed is a slow business requiring considerable skill and would need to be carried out either by Government or in special nurseries on each farm. It would be much more convenient if 3 year old transplants ready for planting out were purchased from the coast and the time and the labour saved would be considerable. You may remember that last winter Vice-commodore Carnelli had some trees flown in from the Forest Nursery at Esquel. I planted a large number of these trees in camp and they seem to be surviving reasonably well.

The next move I feel we should make is (on receipt of a report of Howard Pearce's investigations) to write to the Forest nursery in Esquel enquiring of them the possibility of purchasing large numbers of transplants. If they do not have the type of trees we want, there is the possibility that they might raise seed supplied by us on a sort of contract basis. This has been done in other parts of the world and would enable us to make use of the considerable expertise necessary in running a Forest Nursery without having to go into large capital investment ourselves.

In summary, therefore, my proposals on the development of a forestry-for-shelter industry would be as follows:-

1) Expertise, in the form of advice to be supplied by the Forestry Commission (this would not necessarily mean the sending of an officer to the Falklands - G.T.V. has much data which would be useful)
2) Trees should be purchased from the Argentine either directly from their stock or else ordered to meet our requirements possibly with us supplying the seed.
3) Some form of collective ordering and buying should be carried out. If Government is unwilling to involve itself in this, I would suggest that the S.C.A. would be a suitable intermediary body.
4) It may be necessary for Government to introduce a small "Planting Grant" - such as has been done in U.K. - to help offset the initial high cost of purchasing and planting.

I hope these comments are of value to you. I am certain that forestry could be fitted into the agricultural programme here as all the labour demands are 'out of season'. As you may have realised from my "Agribusiness" talks on the local radio, nothing would give me greater pleasure than to see the people of the Falklands take a real interest in forestry and tree growing - hence my satisfaction on receipt of your letter.

Kind regards,

Jim McAdam

J.H. McAdam.

(6)

Ministry of Overseas Development
Eland House Stag Place London SW1E 5DH

Telephone 01-834 2377 ext 127

A J P Monk Esq OBE
Chief Secretary
Stanley
Falkland Islands

CHIEF SECRETARY -8 SEP 1977 FALKLAND ISLANDS

Your reference AGR/31/3

Our reference CLA 56/274/01

Date 25 August 1977

Dear Arthur

I was pleased to see from your letter of 10 August (2) that there has been a revival of interest in Forestry. We had surmised as much from the series of letters and telegrams which we have seen between John Wyatt-Smith and Trevor Pepper/Jim McAdam.

2. We are writing to Howard Pearce in Buenos Aires to see if he has been able to obtain any useful information from the Argentine forestry people (paragraph 4 of my letter of 8 July (1) to you is relevant). I do agree that it would be wiser to wait and see what sort of response we get from them before sending Jim McAdam to the Argentine but, subject to this, would be prepared to fund such a visit from TC funds.

Yours ever
Mary

Mrs M C Rosser

25. 8. 77

CHIEF SECRETARY
8 SEP 1977
FALKLAND ISLANDS

with compliments

Chris Johns

MINISTRY OF OVERSEAS DEVELOPMENT
ELAND HOUSE, STAG PLACE
LONDON SW1E 5DH

Ministry of Overseas Development
Eland House Stag Place London SW1E 5DH

Telephone 01-834 2377 ext 127

(7)

A J S Pearce Esq
British Embassy
BUENOS AIRES

Your reference

Our reference CLA 56/274/01

Date 25 August 1977

FALKLAND ISLANDS: FORESTRY

In the final paragraph of Mary Rosser's letter of 8 July to Arthur Monk (copied to you) she asked if you would make some enquiries of the Argentine Forestry Authorities as to whether they could assist with technical advice on growing trees in Falklands.

From a letter which Mary has recently received from Arthur Monk it would seem that there has been a revival of interest in Forestry in the Falklands. In the circumstances we should be grateful to learn whether you have managed to obtain any relevant advice from the Forestry people.

Mrs C B Johnson

Our Ref: AGR/31/3

Your Ref: .....

(10)

Grasslands Trials Unit,
Stanley,
Falkland Islands,
South Atlantic.

CHIEF SECRETARY
- 5 OCT 1977
FALKLAND ISLANDS

4th. October, 1977

Mr. R. Browning,
Secretariat.

Dear Rex,

Thank you for your letter (9) of 30th September concerning the Eighth World Forestry Conference.

I cannot forsee that the Falkland Islands could contribute anything to the congress or glean much from it.

However, if you are writing to the Forestry Commission you could mention the two main points listed below:-

(1) Should forestry development occur on a small scale in the Falklands would the Forestry Commission be prepared to give advice ans a limited amount of assistance.

(2) The possibility of cooperation with a forest nursery in Southern Argentina to either raise seedlings on a contract basis or purchase young trees directly.

Point No. 2 may have political implications and it would be of value to the Colony if you could ask the U.K. delegation to deal with the problem of international cooperation within the Forestry industry.

I hope the comments are of value.

Yours sincerely,

Jim McAdam

J.H. McAdam.

(11)

AGR/31/3

11th October 77

Mr. G. A. Perry,
Forestry Commission,
231 Corstorphine Road,
Edinburgh EH12 7AT.

Dear Sir,

Eighth World Forestry Congress:
Indonesia 16th - 28th October 1978

Thank you for your letter (8) FAO/17/6 of 28th June 1977, which was received here on 19th September 1977.

2. It is not proposed that this Colony should be represented at the Congress nor that it will be providing papers for it.

3. There is a growing interest in forestry here and I should like to mention the following, en passant -

i. should forestry development occur on a small scale in the Falkland Islands, could we look to the Forestry Commission for advice and perhaps a limited amount of assistance;

ii. if there is to be any forestry development in the Colony, there would have to be co-operation with nurseries in Patagonia either to raise seedlings on a contract basis or to purchase young trees directly. This would entail international co-operation within the forestry industry, and such could well be a matter for consideration at the Congress.

Yours faithfully,

CHIEF SECRETARY

us

(12)

R + P

10 XI

BRITISH EMBASSY

BUENOS AIRES

3 November 1977

CHIEF SECRETARY
11 NOV 1977
FALKLAND ISLANDS

C D Kerr Esq
Grasslands Trials Unit
STANLEY

FORESTRY AND POTATOES

no copy in CSO.

Many thanks for your letter of 5 October. It was a great pleasure to see you again recently. I hope you and your family had a good trip to Stanley and have now settled back into Island life.

I sought advice from our commercial section on the possibility of Argentina being a market for certified seed potatoes from the Falklands. Our Commercial Section commented that when the Argentine crop is bad, Argentina does import potatoes from elsewhere (eg Holland and USA). There is therefore a possibility of business, although this year they have more than they need. On seed potatoes, the prospects may be better, dependent on the price.

I am still pursuing the enquiries about forestry. The Argentine Forestry Institute have told me that they see no practical problems with the suggestion that seeds provided by the Islands be raised in their nursery at Esquel for subsequent transplanting to the Falklands. However, they are still awaiting the final OK from their Under Secretary. I shall get in touch with John Massingham when we have their written reply to our enquiry.

H J S Pearce

cc: J D Massingham, Esq, Chief Secretary, Port Stanley.
Miss C B Johnson, ODM, Eland House, Stag Place, London.

(14)

M 22/XII

BRITISH EMBASSY

BUENOS AIRES

19 December 1978

R Browning Esq
Assistant Secretary
The Secretariat
PORT STANLEY

CHIEF SECRETARY
21 DEC 1978
FALKLAND ISLANDS

Dear Reg,

FORESTRY AND POTATOES

(13)

1. Many thanks for your letter (AGR/31/3) of 23 November about a link with the Argentine Forestry Institute's nursery at Esquel.

2. As you imagined there have not yet been any developments to follow up the tentative link established last year but I am contacting the Institute again and will let you know what transpires.

Yours sincerely,

Richard Gozney

R Gozney

PS. With very best wishes for Christmas.

AGR/31/3

(15)

BRITISH EMBASSY

BUENOS AIRES

152/492/1

21 February 1979

CHIEF SECRETARY
26 FEB 1979
FALKLAND ISLANDS

R Browning Esq
Assistant Secretary
PORT STANLEY

Dear Rex,

(14)

1. In my letter of 19 December (not to ODM) I said that I was contacting the Argentine Forestry Institute again about the provision of tree seedlings from their nursery at Esquel.

2. I finally got to see the Head of the Institute's Nurseries, an Ing. Ottone, yesterday who remembered well the enquiries which Howard Pearce was making in 1977. I do not know why those enquiries ran into the ground at the time but hope that we can now achieve some results. Ing Ottone said that the Forestry Institute can offer for sale seedlings of the following species:

Pinus ponderosa

Pinus oregon

Picea sitchensis (the sitka spruce)

The nursery had however, only a few lodge pole pine seedlings (Pinus contorta) and no Nothofagus. On the basis of Argentine experience he suggested that your best bet in the Islands would be the sitka spruce which I believe was the species tried by Vice-Comodoro Carnelli in 1976.

3. Current prices for the sitka spruce seedlings are as follows:

26	pesos	each	for	1	year	old	seedlings
43	"	"	"	2	"	"	"
52	"	"	"	3	"	"	"
63	"	"	"	4	"	"	"

In Argentina the normal time for planting out seedlings is apparently June which would give us 4 months to arrange a purchase and shipment to Port Stanley. As far as shipment was concerned Ing Ottone said that the nursery could deliver the seedlings to LADE in Esquel from which there are flights to Comodoro Rivadavia.

/4.

4. I did not with Ing Ottone go into the question of the Falklands supplying seeds to be grown by the Forestry Institute's nurseries but if the seedlings available are not what Campbell Kerr would like to try then I would go back to the Institute to see if they would raise seedlings from seed provided by yourselves.

5. Ing Ottone did say that a sale would be contingent upon agreement being given by a more senior official than himself within the Ministry of Agriculture but he did not imagine that there would be problems here.

6. I am sending a copy of this letter to Mary Rosser in the ODM since it was her initiative originally (her letter CLA 56/274/01 of 8 July 1977 to Arthur Monk) which started consideration of tree seedlings being obtained from Argentina.

7. Perhaps Campbell Kerr or yourself could let me know whether you wish to place an order with the Forestry Institute.

Yours sincerely

Richard

R Gozney

cc Campbell Kerr Esq
GTU
PORT STANLEY

Miss M Rosser
LAD
ODM

(16)

AGR/31/3

28th February 79

Mr. C. D. Kerr,
Grasslands Trials Unit,
Stanley.

Dear Campbell,

Would you please refer to Richard Cozney's letter (15) to me of 21st February 1979 dealing with the provision of tree seedlings from the nurseries of the Argentine Forestry Institute at Esquel, and copied to you.

2. Perhaps you would advise me in due course on how you feel we should deal with this matter.

Yours sincerely,

CHIEF SECRETARY

us

AGR/31/3

(17)

152/492/1 11th April 79

Mr. R. Gozney,
British Embassy,
Buenos Aires,
Argentina.

d/o

Thank you very much indeed for your letter of 21st February 1979.

2. The Grasslands Trials Unit are now going into the whole matter of tree-planting in the Falkland Islands and I think you can fairly expect a further letter on the subject in due course, after Campbell Kerr and his team have completed their investigations.

3. In the meantime we are most grateful for the efforts you have made on our behalf.

CHIEF SECRETARY

c.c. Mrs. M. C. Rosser, ODM.

us

ACR/31/3

11th April 79

V/C E. J. Canosa,
LADE Office,
Stanley.

Dear Vicecomodoro,

There is a possibility that sometime in the reasonably near future, the Grasslands Trials Unit will be importing tree seedlings from the Argentine Forestry Institute at Esquel, on behalf of Government.

2. It would be very useful to know the approximate freight charges beforehand, if this is possible. It is appreciated that the charges may well be based on volume rather than weight.

Yours faithfully,

CHIEF SECRETARY

us

THIS INFO ASSEMBLED BY RICHARD GURNEY

FOR APPROVAL BY CHIEFSEC

(19)

DRAFT LETTER TO EXECUTIVE SECRETARY, SHEEPOWNERS' ASSOCIATION (From GTU)

TREE PLANTING

Approved

It seems enquiries made by the British Embassy in Buenos Aires have led to the availability of seedling trees from Argentina's Forestry Institute nursery at Esquel.

2. The varieties offered are:-

PINUS PONDEROSA

PINUS OREGON

PICEA SITCHENSIS (SITKA SPRUCE)

and the current prices for the SITKA SPRUCE (which on present knowledge we would recommend) seedlings (February 1979) are:-

26 pesos each for 1 year old seedlings

43 pesos each for 2 year old seedlings

52 pesos each for 3 year old seedlings

63 pesos each for 3 year old seedlings

3. It will, of course, be necessary to know the altitude and climate of origin of the seedlings (provenance).

4. It is possible to deliver seedlings ordered at Esquel to LADE, who fly there, for despatch to Port Stanley.

5. My colleagues at G.T.U. and I have discussed this matter and we feel that unfortunately we do not have sufficient scope within our remit to permit us to indulge in any large scale scheme for tree planting. However, we would in our spare time be willing to give any advice on a private basis, and could recommend procedures.

6. We hope that your Members will be interested in this information and this letter will be prepared in such a way that it can be circulated to all Members if you wish.

Original returned

to Mr C.D. Kerr.

30.4.79

(20)

PUERTO STANLEY 27 de abril de 1979

Mr R BROWNING
Asistente de la Secretaría
Stanley

CHIEF SECRETARY
-4 MAY 1979
FALKLAND ISLANDS

Estimado señor Browning:

Tengo el agrado de dirigirme a usted con referencia a su nota AGR/31/3.

Le informo que las cargas se cobran por peso o volumen de acuerdo con la siguiente equivalencia:

1 Kg = 5.000 cm3

Asimismo los valores de flete desde Esquel a Stanley son: £ 2,81 x Kg

Saludo a usted

Eduardo Canosa

Vicecomodoro Eduardo Canosa

AGR/31/3

7th May 1979

(21)

Chief Secretary

Mr. C. D. Kerr,
Grasslands Trials Unit.

Aiffreight on tree seedlings: Esquel/Stanley

I have been advised that tree seedlings would be carried from Esquel to Stanley at the rate of £2.81 per kilo weight or measurement, 1 kilo reckoned to be equivalent to 5,000cm^3.

CHIEF SECRETARY

AGR/31/3

4 January 1983

Development Officer

Veterinary Officer GTU

Forestry

I have a paper by P J Stewart on 'Trees for the Falkland Islands' Commonwealth Forestry Review 61 (3) '82. You probably have it but if not you may wish to see it.

John Reid
Development Officer

LC

AGR/3/3

Economic Forestry Group

FB 187

E.F.G. (Nurseries) Ltd.
Fordham, Nr. Ely
Cambridgeshire, CB7 5LH
Telephone: Fordham 455/6
Telex: 817165

AWJ/JEW

5th January, 1983.

F.E. Baker, Esq., O.B.E.,
Chief Secretary,
Falkland Island Government,
Port Stanley,
FALKLAND ISLANDS,
South Atlantic.

Dear Sir,

We have received enquiries from residents of the Falkland Islands to purchase living plants for forestry and screening purposes.

We understand that written permission is required from your Government to export and now write to obtain this permission and any permit necessary to export to the Falkland Islands and await hearing from you in order that we may proceed with the matter as soon as possible.

If you require any further information please let us know.

Yours sincerely,
for E.F.G. (Nurseries) Ltd.,

A.W. JOYNES
Chairman & Managing Director

(25)

AGR/313 ✓

18 January 83

Mr R S Whitley
Grasslands Trials Unit
Stanley

D10

I attach a photocopy of a letter received yesterday concerning the importation of plants for forestry and screening purposes.

I wondered if you were acquainted with the "Economic Forestry Group" and also, from your own experience in the encouragement of tree planting in the Islands, whether you have any particular points you would wish to raise concerning the conditions under which we should allow the importation of such plant material.

F E Baker
CHIEF SECRETARY

Reg Pc. B/L on AGR/31/3

GRASSLANDS TRIALS UNIT

Port Stanley, Falkland Islands, South Atlantic.

21st January 1983 19

Your Ref. .....

Our Ref. 0165/RSW.

Mr F E Baker,
Chief Secretary,
Secretariat,
Stanley.

Dear Dick,

25

Very many thanks for your letter of Jan 18th on the subject of trees. I shall be delighted to help if I can, but you must excuse what may be the "ignorance" of an interested amature.

I happen to have a friend who works for the Economic Forestry Group in their northern region and so am aquainted with their set-up. They seem an entirely reputable firm and I'm sure will be most helpful.

The letter from the E.F.G. is pretty vague on two subjects. Firstly, who has made the enquiries and, secondly, what species of tree are being suggested an in what form would they travel ?

As far as I am aware, FIG has few, if any, phytosanitary regualtions other than a general "all plants and seeds must be declared to the Customs Officer". However we must remember that there are at least two diseases of trees which occur in the Islands (The Green spruce Aphid - Elatobium Abies - which makes all the sitka spruces around Stanley look so poorly and moth eaten, and Microplophorous magellanicus - a worm which attacks antarctic beeches and other trees). These parasites must, by definition, have been imported.

With the recrudescence of interest in trees, perhaps now is the time to set things on the right footing and to organise some proper and suitable regulations and procedures. With this in mind I would like to suggest that the Forestry Commission (Alice Holt Lodge, Wrecclesham, Farnham, Surrey GH10 4HL) should be contacted and their advice sought.

In general, it is much safer to grow trees from seeds as many of the diseases are transmitted by active tissues or in soil or on leaves. If it is planned to import growing plants then we must have arrangements for taking appropriate action over soil cleanliness etc.

You will be aware of the articles which have recently appeared in Commonwealth Forestry Review by Mr P J Stewart of Oxford University in which he outlines some of the procedures ~~in~~ which may be necessary. He is another person who could be approached for advice.

As an example, I enclose photocopies of a section of the Plant Health Import Legislation Guide for Importers which refers to Forest Trees and you will see that not all trees and not all countries are treated equally. Also enclosed are two examples of UK phytosanitary certificates which may be of interest.

Please let me know if I can be of any further assistance as I'm only too willing to help. I still maintain that a nursery is the best means by which to get trees grown on any large scale here.

Yours Sincerely

R.S. Whitley.

RECENT TREE PLANTING TRIALS AND THE STATUS OF FORESTRY IN THE FALKLAND ISLANDS

By J.H. McADAM*

SUMMARY

Data on exposure and its effect on tree growth in the Falkland Islands are presented and analysed. It is concluded that sparsity of trees in the Islands is due to a combination of undeveloped soils and lack of advice and encouragement. An updated list of species currently growing on the Islands is presented along with a description and analysis of the important plantation at Hill Cove. Details of observations and trials laid down since 1976 are given and results, where available, are discussed.

It is concluded that trees can be grown successfully and that shelter belts have a significant role in the development of agriculture in the Falkland Islands.

RESUME

L'auteur présente et analyse des données sur l'incidence du vent et sur ses effets sur la croissance des arbres dans les Iles Malouines; il en conclut que la carence d'arbres est la conséquence de l'état peu developpé des sols, associé à un manque de conseils et d'encouragement. Une liste des essences actuellement établies sur les îles est fournie, ainsi eu'une description analytique de l'importante plantation à Hill Cove. L'auteur ajoute des renseignements détaillés sur des observations et des expériences effectuées depuis 1976, et il en discute les résultats disponibles. Il tire la conclusion que des arbres peuvent tres bien être cultivés et que les brise-vent ont un rôle utile à jouer dans le développement de l'agriculture.

Introduction

The relatively treeless status of the Falkland Islands has been carefully analysed as far back as 1919 (Dallimore) with the situation reviewed recently in this Journal (Stewart 1982). The principal components of "treelessness" in this instance may be a combination of three factors: climate, soils and the lack of suitable advice and encouragement. McAdam (1977) has shown that the relevant meteorological data do not indicate conditions which would preclude the growth of trees for shelter and Stewart's (1982) analysis of the climate suggests nothing too harsh for trees. It is apparent that the soils of the Falklands are still in a relatively undeveloped and virgin state (King *et al* 1969; Stewart 1982) and these peaty soils are the principal factor contributing to the limited development of tree planting. However, lack of encouragement and misinformed advice cannot be discounted entirely. During the relatively short history of the Colony, many 'experts' have visited the Islands for short periods of time and have left reports which often failed to mention the importance of the provision of shelter, or have generally lent credence to the view that tree growing was not feasible. The repetition of this idea over the years has led to a gradual acceptance, almost as fact, within the Islands that trees cannot be grown and, but for a few notable exceptions e.g. that of the Blake family at Hill Cove, this attitude has persisted until relatively recently.

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In this paper data are presented which will support the view that tree growing is a feasible proposition in the Falkland Islands and suggestions on the suitability of certain species will be presented, based on observation and trial. Stewart (1982) has stated that there is no updated account of the status of trees in the Islands. The information presented here will provide an update on the situation and shed some more light on the path to follow in the future with respect to forestry in the Falklands.

Exposure

It is apparent that none of the individual components of the climate in themselves are of a magnitude which would preclude the growth of trees. However, exposure – the whole complex of factors which make up the weather including the speed, constancy and gustiness of the wind and the effects of the associated temperature and humidity of the wind – can greatly affect the growth of coniferous trees. It has been found (Lines and Howell 1963) that the rate of tatter of standard cotton flags may well be governed by that combination of atmospheric influences which inhibits plant growth and it is in this context that flags may be better indicators of exposure than would purely wind measuring devices (Savill 1974). Tatter flags were flown over a two year period at Stanley, Goose Green and Salvador on East Falkland. A full analysis of this data has been published elsewhere (McAdam 1980). The mean tatter rate over the three sites was 9.76 cm^2 day^{-1}. This was higher than rates recorded for Shetland (9.16 cm^2 day^{-1}). Orkney (7.32 cm^2 day^{-1}) (Lines and Howell 1963) and exposed forestry sites in N. Ireland (7.96 cm^2 day^{-1}). On two N. Ireland sites Savill (1974) found a significant correlation between exposure (as measured by rate of tatter) and tree growth (expressed as effect of exposure on predicted yield class of Sitka spruce). On deep oligotrophic peat where tatter rates were 10 cm^2 day^{-1} a yield class of six for Sitka spruce could be expected whereas on a site with more favourable soil conditions and improved nutrient status a yield class of seventeen could be expected.

Hence, although estimates of exposure based on tatter flag data are high, they do not preclude the possibility of tree growth and none of the soils on which tree planting is likely to occur in the Falklands have as low an available nutrient status as those in the N. Ireland trial (McAdam, J.H. unpublished data). Caution must, however, be exercised in the interpretation of tatter flag data (Rutter 1966) and an analysis of the factors contributing to tatter at Port Stanley (McAdam 1980) indicated that in contrast to the situation in the British Isles rainfall was not a primary component of tatter in the Falklands, where wind factors accounted for most of the tatter.

Soils

The soils of the Falklands appear never to have gone through a period of development. Analysis of pollen from peat cores on East (Roberts D. unpublished data) and West (Barrow 1970) Falkland confirmed that there has been no period of significant climatic amelioration and the vegetation has changed little over the quaternary period with no indication of any substantial quantity of tree pollen appearing at any time.

It is significant to note that any site where trees are growing well in the Islands there has been some previous history of cultivation. The Hill Cove trees, for example, were planted on ground used for growing swedes for cattle fodder. Similarly the Government Forest at Port Stanley was planted on ground adjacent to the Government House garden and which had been previously well fertilized or cultivated (Williams D. personal communication).

Forestry advice given in the past

In the past, advice regarding forestry has not been encouraging to farm managers and individuals considering tree planting. None of the three extensive and significant reports on the development of agriculture in the Islands (Davies 1939; Davies *et al* 1971, Lord Shackleton 1976) has mentioned the role which trees could play in the provision of shelter. This may have acted as a positive damper on any enthusiasm shown by farmers to consider the development of a shelter/forestry aspect of agriculture in the Islands.

Fitzherbert (Forestry Commission, South Wales Conservancy) published in 1967 a short note of advice on the potential of tree planting to farmers for inclusion in the proceedings of the local grassland conference. The present author, who was enthusiastic about the prospects and merits of tree planting in the Islands, relayed advice given by N.R. Lines (Silviculturalist, Forestry Commission) in 1976, published a practical guide on tree planting (McAdam 1977) and in May and June 1977 presented a series of programmes on Forestry topics over the Falkland Islands Broadcasting Service (the only true 'media' source in the Islands at that time).

List of trees currently growing in the Islands

Although the Falklands are classed as treeless there is a surprising range of species to be found growing outdoors; however, most are present only in small numbers, the most numerous being the *Picea* spp. at Hill Cove and *Cupressus macrocarpa*. A relatively comprehensive list of identifiable species, updated to 1981, is presented in Table 1.

The Hill Cove-Plantation

A detailed study of the plantation of spruce trees growing at Hill Cove settlement on the north coast of West Falkland is of importance because this plantation represents the only existing 'large scale' attempt at forestry in the Islands and because the trees in it are the tallest and fastest growing in the Islands and would seem to present a suitable yardstick to follow in a situation where there are few examples on which to base advice.

The plantation, (approximately 1.42 hectares in size) is triangular in shape and is situated 2 km to the north of a low ridge (altitude 275 m) with no shelter from the prevailing westerly winds. The 2400 trees are planted at 1 m spacings in rows 3.7-4.8 m apart.

The history of the Hill Cove plantation has been documented by Stewart (1982) although the issue concerning the species present is unresolved. Dimitri (1975), who was part of an Argentinian scientific survey, lists the trees as *Picea sitchensis* and he illustrates a 7 cm cone typical for Sitka spruce. In the opinion of the N. Ireland Arboretal Forester who examined material sent to him in 1977, the red second year bark, lack of a deep keel on the ventral needle surface, needle size (1.3 x 0.15 cm) needle arrangement on the shoot and the small cones (< 5 cms) are not typical of *Picea sitchensis*. The gardener at Hill Cove, who is responsible for the maintenance of the plantation, has recently suggested (Reeves, R. 1982, personal communication) that there may be two different environmentally and edaphically induced forms of the one species or two distinct species within the

plantation. Either suggestion may explain the anomaly which has arisen over the identification of the Hill Cove trees.

The trees produce large quantities of viable seed and seedlings have been recorded up to 10 m from the edge of the plantation.

The rainfall at Hill Cove (16 yr mean – 580 mm) is usually less than that at Stanley (32 yr mean – 610 mm) although both sites have more rainfall than the average for the Islands (520 mm). Hours of sunshine are higher at West Point (42 km from Hill Cove) than at Stanley (155 km from Hill Cove) by an average of 0.5 hours per day. Temperatures are on average 0.5°C higher at Hill Cove than at Stanley and are comparable to the mean for the Islands.

The highest trees are in the SE corner of the plantation and have been recently (August 1982) measured at 18.9 m (62 feet) with the best specimens having a diameter at breast height (DBH) of 0.67 m. The leader tips at present are growing 45–60 cm per annum and none of the trees has been windblown within the past 30 years.

The sudden increase in growth of the trees in the plantation in the late 1950's referred to by Stewart (1982) has been attributed to two reasons by Dimitri (1975)

1. The trees eventually became infected with suitable mycorrhizal fungi.
2. The roots had passed through a hard layer of subsoil and their overall nutritional status was considerably improved.

The trees appear to have a healthy mycorrhizal association and many fruiting bodies of the fungi appear each autumn. The plantation has created an extremely favourable microclimate and at the eastern, sheltered side excellent crops, vegetables and other trees such as *Nothofagus betuloides, N. antarctica, Pinus sylvestris* and *Populus alba* can be seen growing. White clover growth is exceptionally good around the perimeter of the plantation.

Trials on trees

1. A Government Forest Officer appointed in the 1920's (probably on the advice of Dallimore 1919) planted some trials in soft whitegrass (*Cortaderia pilosa*) 'camp' near Mt. Low, East Falkland but nothing remains of this trial today.
2. As well as the successful work by the Blake family at Hill Cove there are good stands of trees at some of the other settlements. The most notable of these are of *Cupressus macrocarpa* (Monterey cypress) at Weddell Island. Carcass Island, Port Stanley (Government House) and at Hill Cove, of *Pinus sylvestris* (Scots pine) at Roy Cove and Teal Inlet (where a wide range of tree species are grown) and *Pinus radiata* (Monterey pine) at West Point Island.
3. From 1957–1959 the Falkland Islands Company tried several thousand seedlings of *Picea* spp. (Spruce), *Cupressus macrocarpa, Pinus pinaster, P. mugo* and *P. sylvestris* at Fitzroy settlement. East Falkland (Clement 1967). Unfortunately these seem to have been planted at the wrong time of year and their roots were left exposed to the strong desiccating winds before planting. Very few survived and this may have caused some discouragement on the part of the Falkland Islands Company with respect to tree planting although *Pinus radiata* has been persisted with at Darwin.
4. On a limited scale, householders with an interest in gardening have tried many species for shelter and ornament, the most successful of these being gorse, broom and willow together with one of the only two native shrubs, *Hebe elleptica* (native box). Almost all the introductions have been from the British Isles, few trees being of South American origin. This may have been because before the air link was established in 1972 the Islanders travelled by sea from Uruguay to the Falklands, missing out the potentially rich source of suitable indigenous trees from Southern Argentina and Chile.
5. Those interested in forestry in the Islands are coming to the opinion that in view of the slow growth of seedlings, more success and rapid results can be had using rooted cuttings. *Cupressus macrocarpa* grown from 30-45 cm cuttings at Hill Cove and Stanley have grown 1.7 m in 2 years and *Populus alba* cuttings at Hill Cove are now growing approximately 65 cm per year. They were planted in 1976 are now almost 3 m tall. In an experiment, Hill Cove spruce cuttings rooted in 1980 grew 10-12 cm in 1981 while seeds planted at the same time had only produced seedlings 3 cm tall.
6. Most recent trials with broad leaved trees have proved unsuccessful. *Quercus robur* (Oak) seedlings planted in 1978 had only grown 12 cm by 1981. Poplar and willow (*Salix viminalis*) appear to do well whereas birch, alder and hazel do not.
7. In 1977 the following species were tried at Port Stephens, North Arm, Port Howard, Hill Cove, Goose Green and Chartres settlements:–
   Hippophae rhamnoides, Rhododendron ponticum, Escallonia macrantha, Phormium tenax, Alnus cordata, A. glutinosa, A. incana, A. viridis, Picea sitchensis, Pinus mugo, P. nigra-austriaca, P. peuce, P. radiata, P. contorta, P. thunbergii, P. muricata, Abies procera, Acer pseudoplatanus and *Eucalyptus globus.*
   Seeds of the above-listed species were germinated and planted out into small nursery beds in the gardens of the respective settlements. It is hoped that some follow up to this trial may provide a valid comparison among a wide range of species.
8. In conjunction with the Sheep Owners Association (a body to which almost all the farm managers belong) a scheme was organised in 1977 whereby 2 kgs of Lodgepole pine seed (Washington coastal provenence) was purchased from the Forestry Commission and 100 g lots distributed to those farmers interested in participating. This scheme is progressing and the Association is willing to act as distributing agent for tree seed. Some farms now have lodgepole pine seedlings planted out on the 'camp'. A recent governor (Mr. J.R.W. Parker) has suggested the establishment of an arboretum and tree nursery in the substantial gardens at Government House, Stanley.
9. In 1977 *Nothofagus pumilio* transplants (50-60 cm tall) were flown in from a well established forest nusery in the Southern Andes at Esquel, Argentina. By prior agreement with the nursery, the roots of these plants had been well washed and they were planted out within 12 hours of leaving the nursery. Twelve trees were planted at each of four sites which had been fenced off for an agronomy experiment on the southern slopes of Mount Usborne, East Falkland. Details of the site and results from the trial are presented in Table 2. At this early stage, in what is essentially a long-term trial, the only conclusions which can be drawn are that this species can grow on relatively exposed sites, the growth rate being faster at lower altitudes and on the better soil types. Thus the importation of hardy trees from well established forest nurseries on the

mainland of southern South America should not be discounted although adherence to a strict phytosanitary procedures must be maintained. The whole process of establishing a forest nursery is a complicated one involving a large input of labour and expertise neither of which are readily available on the Falklands but are available on the mainland under environmental conditions which are probably no less severe than those to be found on the Islands.

10. The following species were tried on an exposed coastal site near Port Stanley to assess their suitability for shelter – *Rhododendron, Acer pseudoplatanus, Phormium tenax, Hippophae rhamnoides* (male plants only), *Escallonia* and *Olearia macrantha*. Only the New Zealand flax plants survived into the second year and they have continued to do well.

11. Stewart (1982) has suggested a wide range of trees which merit trial in the Islands. It has generally been found that conifers do well and although the nitrogen-fixing properties of Alders and Sea Buckthorn have much to be commended only gorse and broom seem to be successful.

Monterey cypress, the Hill Cove spruce trees and Lodgepole pine are undoubtedly the most successful trees growing in the Falklands at present. From the author's own observations and practical experience and in line with some of Stewart's (1982) suggestions it would be very prudent to consider introducing trees from Southern Chile especially *Nothofagus* species.

Conclusions

As the various trials reported here have indicated, trees can be grown reasonably successfully in the Falkland Islands. It is also apparent that tree growth will never be substantial on any but a few sites. However, the integration of properly designed and protected shelter belts into the existing farming structure could be of extreme benefit. The adverse effects of climate on livestock in the Falklands, notably the unacceptably high death rate of young lambs and freshly shorn sheep has been documented (Davies *et al* 1971). The careful positioning of shelter belts on paddocks where such classes of stock are grazed would enhance both pasture growth and sheep production.

In planning shelter belts it is desirable that 'sacrifice' rows of hardy trees or shrubs should be planted at the edge of the plantation. Suitable species might include Gorse, *Olearia, Phormium tenax*, Berberis, Tussac grass (coastal) or some of the smaller, hardier *Nothofagus* species. More upright, hardy trees such as *Pinus mugo, Pinus contorta* and *Cupressus macrocarpa* could be planted next to the leeward with possibly Hill Cove spruce, and *Nothofagus* species forming the main body of the shelter belt. The prevailing winds are very consistently westerly and the siting of shelter belts to allow for maximum effect should present no problems. If the proposed development of the agricultural industry of the Islands is to proceed in a manner which would involve some fragmenting of the large farms and limited intensification on a small scale, the prospects for forestry would seem to be favourable.

Acknowledgements

The author is indebted to Mr. Ron Reeves for recent information on the plantation at Hill Cove and for observations on the growth of rooted cuttings. The research programme in the Islands was financed by the Overseas Development Administration.

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Reg Pl. initiate b/u on file
FB 26/I

AGR13/13

12.1.1983

(27)

UNIVERSITY OF OXFORD

DEPARTMENT OF AGRICULTURAL AND FOREST SCIENCES

SIBTHORPIAN PROFESSOR OF RURAL ECONOMY
AND HEAD OF DEPARTMENT
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TELEX: 83147 FOROX

Dear Mr Baker

Thank you for your letter of 23rd August (!). I should be interested to know what progress there has been since you wrote. A second paper has now been published, and I enclose a copy. You probably know the author. He differs from me in one important respect: he talks about forestry, whereas I was definitely talking about tree-planting (as a part of agriculture).

Among my proposals, the one I am most attached to is that of treating minefields by ~~fencing~~

them off indefinitely and leaving them to be seeded naturally from mother trees planted on the windward side. I don't know the extent or location of minefields, but presumably they constitute a category of land that cannot economically be used for anything in the foreseeable future.

I do indeed know Martin Bennett, in fact I was at prep' school with him thirty-five years ago (the Hall School, Hampstead). We meet occasionally, when his work brings him to this institute.

With all good wishes for 1983

Yours sincerely,

Philip Stewart

AGR/31/3

14 February 83

Mr A W Joynes
Chairman and Managing Director
EFG (Nurseries) Ltd
Fordham Nr Ely
Cambridgeshire CB7 5LH

Dear Mr Joynes,

I must apologise for not having replied earlier to your letter of 5th January concerning the importation of living plants for forestry and screening purposes but, in the absence from our establishment of an agricultural officer for the moment, I have had to seek advice from other quarters. We are hoping to recruit a replacement Agricultural Officer in the near future and in the meantime I have consulted the staff of our Grasslands Trials Unit, and in particular Mr R S Whitley who tells me he has a friend who works for your organisation in the northern region. Mr Whitley, while being our Veterinary Officer, is extremely interested in forestry and has been involved in schemes to encourage the growing of trees throughout the Islands. I had wondered whether he would wish to add any particular advice to our existing requirements concerning the importation of plant materials but in fact he had nothing in particular to point out except that, like me, he would like to see our legislation on this subject improved in the near future.

However, pending this, we only have a fairly general set of Regulations made under our Plant Disease Regulation Ordinance and I enclose a copy of this for your guidance. If you would kindly have an application (or applications) sent as laid down in Regulation No 8 I shall ensure that it receives speedy consideration and that the necessary permit is issued as soon as possible, so long as there are no problems.

I look forward to hearing from you again soon.

Yours sincerely,

F E Baker

CHIEF SECRETARY

JB

AGR/31/3

1 August 1983

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Deputy Chief Secretary(Personnel)

Team Leader, FIARDC

Visit of Dr A Low (Forestry Commission)

I attach a copy of the "Outstanding Vacancy List" (30.6.83) relating to forestry from which it would appear that Dr Low will begin his short term assignment (3-4 weeks) in early September.

Have you by any chance received any correspondence which would indicate the proposed arrival date (approx.) for Dr Low and the purpose of his visit? The information is required for "handing-over" notes being prepared by the Chief Secretary.

(Mrs) E S Smart
Deputy Chief Secretary(Personnel)

DISK: 4/26/TC49 (33)

TC49

SHORT TERM TECHNICAL COOPERATION ASSIGNMENTS

This form should be completed and signed by the Accountant immediately a short-term Technical Cooperation Officer leaves post and should be forwarded by the quickest means available (by bag or by airmail) to [1] C. J. LAMPARD AM 319 Overseas Development Administration, Personnel Services Executive, Abercrombie House, Eaglesham Road, East Kilbride, Glasgow G75 8EA.

Please ensure that all ten sections of this form are completed before despatch. Failure to do so delays settlement of the officer's entitlements.

'Nil', 'none' or 'not applicable' should be entered where appropriate.

1. TCO's NAME (block letters) Dr A J LOW POST Forest Officer

2. Dates of: arrival 10.9.83 departure 30.9.83

3. How was the TCO accommodated? (eg hotel, guest house, privately)

Upland Goose Hotel

4. Did the TCO meet all the costs of his:-

a. accommodation? Yes

b. board? --

If not, please give full details --

5. Did the TCO receive any financial contribution of any sort from the local government/organisation? No.

If so, how much and what has the TCO done with it? --

6. Did you pay the TCO anything in respect of honorarium? Yes.

If so, please give dates, amounts and exchange rates.

29.9.83 £240

7. Did you pay the TCO anything in respect of subsistence allowance? No

If so, please state:-

Date(s) of payment(s) --

Amount(s) paid --

Exchange Rate(s) -- = £1

8. Please complete the following details (columns 1-4 in all cases, plus columns 5-6 if payments have been made)

Date From	Date To	No of Nights	Place	Daily Subsistence Rate	Amount Paid

9. Have you made on behalf of the TCO any payments which are not admissible from ODA funds? No

If so, please give full details and amounts --

10. Have you received the Local Cost Form for this assignment? No

11. Are any local contributions still due in respect of this assignment? No

If so, have steps been taken to effect recovery? --

Signed WClaus
(Accountant)

Official Stamp

Date 30 September 1983

THE TREASURY
29 SEP 1983
FALKLAND ISLANDS

Reg pl. file AGR/31/3 or DO 1/9

(34)

GRASSLANDS TRIALS UNIT

Port Stanley, Falkland Islands, South Atlantic.

31/8 1983.

Your Ref. .....

Our Ref. .....

Dear John,

Following my brief chat the other day would you please confirm that you will be available to speak to Dr. Low (Forestry advisor) on the morning (10 o'clock) of the 15th of September in your office.

If these arrangments are unsuitable would you please notify me. Thank you.

Yours sincerely

Austin Davies.

Reg re circulate of b/u to Mrs Smart DCS(O) [illegible] 11/VIII

ON AQR/31/3 To DCS(P) [illegible] 16/8/83

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OVERSEAS DEVELOPMENT ADMINISTRATION
Abercrombie House, Eaglesham Road, East Kilbride, Glasgow G75 8EA

Telephone: East Kilbride (03552) 41199 ex. 3278

Mr Baker
Government Secretary
PORT STANLEY
Falkland Islands

Your reference

In reply please quote our reference APP/UR/LO

Date 29 July 1983

CHIEF SECRETARY 11 AUG 1983 FALKLAND ISLANDS

Dear Mr Baker

1. I enclose a copy of the Letter of Appointment relating to Mr A J Low's forthcoming short-term Technical Co-operation assignment. He has been issued with an open-dated return ticket and I should be grateful if you would make the homeward booking at the end of the visit. Please let me know by teleletter or telegram his date of departure and expected date of arrival back in the United Kingdom.

2. Payment of the honorarium will be made in full by this office after the officer has returned to the United Kingdom and therefore no payments of honorarium should be made locally.

3. I also enclose two copies of form TC49 on which details of the officer's accommodation and payments and entitlements should be reported. It is essential that you complete and return one copy of this form to me as a matter of urgency on completion of the visit. We can make no payments to the officer until we receive it and delay in returning it to us therefore causes embarrassment.

Yours sincerely

C. J. Lampard

C J Lampard
Personnel Services Executive

ENC

amcl

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OVERSEAS DEVELOPMENT ADMINISTRATION
Abercrombie House
Eaglesham Road
EAST KILBRIDE
Glasgow G75 8EA

Telephone: East Kilbride (03552) 41199
ex 3278

Reference: APP/UE/LO

Date: 29 July 1983

Dr A J Low

Sir

1. I am directed by the Secretary of State for Foreign and Commonwealth Affairs to offer you appointment under Technical Co-operation arrangements as a Forester on loan to the Government of the Falkland Islands. The appointment will consist of an assignment in the Falkland Islands and thereafter the preparation of your report thereon. The assignment will be for a period of 3 weeks residential service from the date of your emplaning by the direct route for the Falkland Islands until the date of your arrival back in the United Kingdom by the direct route, or until such other date as may be decided by this Administration or by the local British Representative on behalf of this Administration.

During your assignment you will advise ODA on:-

(a) The successes and failures of previous attempts to grow trees and the reasons for the failures insofar as these can be ascertained.

(b) The possibility of systematic tree planting, the species to be tried and the techniques necessary for establishment.

(c) The resources necessary for trial plantings in terms of staff, equipment and the overall cost for investigation into

(i) Shelter Belts

(ii) Wood Lots

(iii) Amenity Forestry

(iv) General Agro-Forestry.

Within one week following the end of the period of the assignment you will prepare and submit a comprehensive written report thereon to Mrs E Stirton in the Falkland Islands Department of this Administration.

2. In consideration of your carrying out this assignment:

a. You will be paid an honorarium of £80 per complete week (and thereafter pro rata for part of a week at one-sixth of the weekly honorarium for each odd day) for the period of the assignment, £132 of which will be paid to you after the execution of an undertaking in respect of the repayment thereof and the balance of which will be payable to you on receipt of your satisfactory comprehensive written report. The honorarium will be subject to United Kingdom income tax which will be deducted by this Administration at the appropriate percentage rate. You will also be liable to pay Class 1 National Insurance contributions (ie the contributions appropriate to an employed earner) for the period in respect of which honorarium is paid. These contributions will be deducted from the honorarium unless by the time payment is made you have obtained from the Department of Health and Social Security and submitted to this Administration a certificate of deferment of payment of employee's Class 1 contributions. Since this is a contract of service the foregoing applies even if you are normally regarded for income tax and National Insurance purposes as self-employed.

b. You will be provided with a return passage between the United Kingdom and the Falkland Islands by the direct route.

c. On receipt and acceptance by this Administration of a claim from you, supported by vouchers, you will be reimbursed the costs of your travel at public transport rates in the United Kingdom to the airport or air terminal on departure and from the airport or air terminal on return.

d. You will be paid a non-taxable outfit allowance of £60.

e. A fee equivalent to your basic salary plus the employer's share of National Insurance and Superannuation contributions in respect of the period of the appointment will be paid by this Administration to the Forestry Commission who will be responsible for the payment to you of such salary and for the due payment of such contributions.

3. In respect of the period of assignment in the Falkland Islands:

a. You will receive a subsistence allowance at the rate or rates appropriate to British civil servants. Subsistence rates are kept under review and are liable to vary up or down. The standard rates of subsistence currently applicable are:

FALKLAND ISLANDS

Stanley - 26.45 FI pounds a night

Elsewhere - Actual reasonable expenditure on three meals, services, and taxes (within a limit of 75% of Port Stanley) plus 3.35 FI pounds a night.

The amount of subsistence payable to you will be reduced from the standard rate or rates if you are provided with accommodation at no, or reduced, cost. No subsistence at all will be payable if you are provided with accommodation and board at no cost. If you are provided with board or accommodation at a concessionary rate or at elsewhere than an hotel, you are required so to inform

the office of the local British Representative. If you receive any payments on account of board or accommodation from other than the British Government, you will pay to the British Government an amount equivalent to such payments; you will make such payment either to the office of the local British Representative before you leave the country of assignment or direct to this Administration immediately on your return to the United Kingdom.

b. You will be reimbursed the cost of any necessary medical attention or treatment on the scale approved for British civil servants serving there, but you will be required to pay to the office of the local British Representative before you leave the country of assignment or direct to this Administration immediately on your return to the United Kingdom any amounts which you would have been required to pay in respect of such treatment or attention had it been obtained in the United Kingdom under the National Health Service arrangements.

c. The Government of the Falkland Islands will meet the costs of your travelling on duty within that country.

d. Section 2(1) of the Superannuation Act 1972, concerning pensions, allowances or gratuities to civil servants and others who are incapacitated or die as the result of an injury sustained, or disease contracted, in the discharge of their duties, will apply to you. Your service will not, however, be treated as service as a civil servant for any other purpose of the Superannuation Act 1972.

You will be notified separately of the amount of salary which will be taken in your case as the basis for any injury benefits granted under Section 2(1) of the Superannuation Act 1972.

e. You will be eligible for sick leave on full honorarium subject to a maximum of one week's sick leave for every completed four weeks of effective service, but the period of your appointment will not be extended to enable you to be granted any paid sick leave for which you might otherwise have been eligible.

4. You will continue to be bound by the provisions of the Official Secrets Acts which cover, inter alia, the communication to unauthorised persons of information which has been obtained owing to your position as the holder of an appointment under Technical Co-operation arrangements.

5. If, prior to your departure from the United Kingdom, the Government of the Falkland Islands refuses or indicates that it does not desire to accept your services or if in the opinion of the British Government it is desirable in the light of events arising beyond the control of either the Government of the Falkland Islands or the British Government, the latter may terminate this appointment forthwith, and thereupon all obligations of the British Government in relation to this appointment shall cease except that, without commitment, this Administration will consider claims submitted by you for expenses or losses reasonably incurred in anticipation of your departure from the United Kingdom to take up the appointment. Further, this appointment is subject to the condition applicable to persons in the service of the British Government that it may be terminated at the pleasure of the Crown.

6. Although you will be in the whole-time service of the British Government, which will be ultimately responsible for your receiving the various entitlements referred

to in this letter, you are being employed for the benefit of the Government of the Falkland Islands and you are expected to use your best endeavours in the interests of that Government. The local British Representative is authorised to issue instructions on behalf of the Secretary of State for Foreign and Commonwealth Affairs in all matters affecting this appointment, and while you are serving overseas you are required to address any correspondence on such matters either to the office of the local British Representative or through that office, to this Administration.

7. Your contract of employment with the British Government, which is constituted by this letter, shall in all respects be governed by English law. If you wish to accept this appointment on the terms set out in this letter the acceptance at the foot of the enclosed copy of this letter should be signed and returned to this office as soon as possible before your departure from the United Kingdom.

I am, Sir
Your obedient Servant

P W Little
Personnel Services Executive

ACCEPTANCE

I accept the appointment referred to in the above letter on the terms set out therein.

_____
(Signature of A J Low)

Date _____

cc TCO
Post
Funding Department
Accounts Department
Float

JG

TREE PLANTING IN THE FALKLAND ISLANDS

A report on an advisory assignment in the Falkland Islands during September 1983

by

Dr A J Low

Principal Silviculturist (North)
Forestry Commission

CONTENTS

1. INTRODUCTION

There has recently been considerable interest in the possibility of initiating a tree planting programme in the Falkland Islands aimed at creating agricultural shelter, producing wood and improving the amenity of settlement areas. In the Falkland Islands Economic Study 1982 (the "Shackleton Report") the suggestion was made that advice on tree planting should be obtained from suitably qualified Forestry Commission personnel. One of the recommendations made by Mr A W Peers (Agricultural Adviser, Overseas Development Administration) following a visit to the Falkland Islands early in 1983, was that a short visit by a forestry adviser was necessary to assess the prospects and resources required for successful tree planting in the Islands.

When approached by the Overseas Development Administration (ODA), the Forestry Commission (FC) agreed to make available a suitably qualified officer to undertake the recommended advisory visit. As a result, the author was appointed to carry out a short term assignment in the Falkland Islands, the object of which was to advise the ODA (and through them the Falkland Islands Government) on:-

a. The successes and failures of previous attempts to grow trees and the reasons for the failures insofar as these can be ascertained.

b. The possibility of systematic tree planting, the species to be tried and the techniques necessary for establishment.

c. The resources necessary for trial plantings in terms of staff, equipment and the overall cost for investigation into

i. Shelter Belts
ii. Wood Lots
iii. Amenity Forestry
iv. General Agro-Forestry

During September 1983, three weeks were spent in the Islands examining the results of the limited tree planting done in the past; considering the impact of climatic and other site limitations on tree growth; and trying to assess the extent to which these limitations could be overcome by using modern forestry techniques developed for difficult upland sites in northern Britain. Thanks to a very effective programme arranged by Dr J A Ferguson and Mr A Davies of the Falkland

Islands Agricultural Research and Development Centre (FIARDC), it was possible to inspect almost every location within the Islands known to have significant tree growth. Although based in Stanley, the author travelled widely to visit many of the farm settlements not only on East and West Falkland but also on a number of the smaller islands. In the course of doing so, a good overall picture was obtained of the terrain and site conditions in most parts of the island group. Most travelling was done by air, using the excellent service provided by the Falkland Islands Government Air Service (FIGAS). However, also included was the valuable experience of two lengthy overland journeys by Landrover - one in East Falkland involving a return trip from Stanley to Goose Green and North Lafonia, and the other in West Falkland from Fox Bay East via Chartres to Roy Cove.

In the course of the programme, opportunities were presented to discuss the possible benefits, problems and impact of tree planting with a range of interested parties. These included farm managers, the secretary of the Sheep Owners' Association (SOA) the Government Development Officer, FIARDC staff and military representatives. Just before the end of the visit, a meeting with the Civil Commissioner, Sir Rex Hunt, provided an opportunity for outlining to him the provisional findings and recommendations.

2. THE FALKLAND ISLANDS ENVIRONMENT

Environmental conditions in the Falkland Islands have been described previously in some detail by Skottsberg (1945), Pepper (1954), Moore (1968) and McAdam (1980a). The present brief review will concentrate primarily on environmental factors of relevance to tree growth and tree planting in the Islands.

Location

The Falkland Islands lie in the south Atlantic Ocean, between latitude 51° 00' and 52° 30' S, and longitude 57° 40' and 61° 30' W, some 500 km east of the southern tip of South America. The archipelago consists of two large islands - East Falkland and West Falkland - and over 200 smaller islands of varying sizes, with a total land area of about 12000 km^2.

Topography

Much of the land area is hilly, particularly in West Falkland and in the northern half of East Falkland. The principal mountain areas extend across the northern parts of the islands, rising to 705 m in East Falkland (Mt Usborne) and 701 m in West Falkland (Mt Adam). The southern part of East Falkland consists of the low lying undulating plain of Lafonia. Most of the coastline is deeply indented with many long inlets and sounds. Small rivers, streams and shallow ponds are common.

Climate

The only location for which reliable long term climatic data exist is the town of Stanley near the eastern extremity of East Falkland. Limited information is available for a few of the farm settlements.

Because of their situation, the Islands generally experience a cool temperate oceanic climate characterised by a narrow mean temperature range, relatively low rainfall and high average windspeed. The winters are mild and the summers cool, with mean monthly temperatures in Stanley of 2.2°C and 8.8°C for July and January respectively. Air temperature rarely rises above 20°C or falls below -6°C, and ground frost can occur in any month. There is some evidence that both summer and winter temperatures are appreciably higher in the western part of the island group.

Annual rainfall is far from uniform throughout the islands and at sea level is thought to range from about 300 mm to over 650 mm. For Stanley which lies in one of the wetter areas, the mean annual rainfall is 640 mm. The drier locations generally lie in the southern parts of the archipelago while those with higher rainfall are usually situated to the north and east of higher ground. Monthly figures are lower in the spring months of September, October and November, and at Stanley a soil water deficit may occur from October to March. During the winter months, snowfall is seldom heavy and normally does not lie for long.

The most notable feature of the climate is its windiness. There is a high frequency of strong winds, although the proportion of gales is low. At Stanley, the average wind speed is 8.5 m/s or 17 knots, and about 50 per cent of the winds are between south west and north west. Although seasonal variation is not great, wind speeds tend to be higher in October and November (spring), at a time when air humidity is below average, leading to increased desiccating potential.

McAdam (1980) investigated the use of tatter flags as a means of assessing "exposure" in the Falklands. For sites at Stanley, Goose Green and Salvador (all in East Falkland) the average tatter rate was 9.8 cm^2/day; and tatter was more rapid in summer than in winter. Similar (and in some cases even higher) tatter rates have been recorded for experimental plantation areas on very exposed sites near the north and west coasts of Scotland, and on islands in Shetland, Orkney and the Hebrides (Forestry Commission data). However, McAdam rightly advises caution in making direct comparison because of apparent differences in the climatic factors contributing to flag tatter in the Falklands and in the British Isles.

Soil

Throughout much of the island area and particularly at lower elevations, the soil appears to consist of a relatively shallow layer (25-35 cm) of dark brown fibrous peat overlying a compacted clay subsoil. The transition from peat to clay is often abrupt and there may be some iron deposition between the two. The clay may be sandy or silty, depending on the underlying geology, and may include a shallow (5-10 cm) upper zone containing some incorporated organic matter or with ochreous staining. There is usually dense root development throughout the peat layer, but rooting seldom penetrates more than a few centimetres into the compacted clay. In the north and north east of East Falkland (and particularly in the Stanley vicinity) there are sizeable areas where the peat layer is much deeper than elsewhere, with depths of 1 m or more.

Not surprisingly the soils are acid, with pH typically 4.0 to 5.0. From an agricultural viewpoint they are regarded as being of low fertility. Phosphorus (P) levels are generally very low, although potassium (K) and magnesium (Mg) levels are considered adequate (Ferguson, 1980). Unexpectedly, only limited growth response has followed application of P fertiliser in recent FIARDC grass reseeding trials.

Vegetation

The natural vegetation communities have been described by Skottsberg (1945), Moore (1968), Davies et al (1971) and McAdam (1980b).

Most of the land area is covered by communities classed as "oceanic heath". By far the most extensive communities are those dominated by Cortaderia pilosa (whitegrass) and which cover very large areas of the more gentler slopes and of undulating or level ground (such as Lafonia). Empetrum rubrum (diddle-dee) is normally the dominant species in the dwarf shrub association which is the only other really extensive community, and which occurs on drier slopes and shallower peat than the whitegrass.

The treeless nature of the Falkland Islands vegetation has been emphasised in most scientific reports over the years (see eg Dallimore 1919, Skottsberg 1945, Moore 1968 and McAdam 1982). The only native woody species capable of growing to a height of 1 m or more are the shrubs Chiliotrichum diffusum or "fachine" and Hebe elliptica or "native box" (see Moore 1968). The former is a relatively insignificant bush found in sheltered moist valley locations; the latter is restricted in the wild to coastal locations in West Falkland but is widely used as a garden hedging plant throughout the Islands. In addition to these two native species, the European shrub Ulex europaeus (gorse) has become more or less naturalised in various locations having been widely planted in the form of hedges round paddocks adjacent to settlements. It is considered to have been introduced to the Islands in 1848 (Dallimore, 1919).

3. BRIEF HISTORY OF ATTEMPTS TO INTRODUCE TREES

From the early days of settlement, the absence of indigenous trees and a desire to create shelter resulted in various attempts to introduce a wide range of tree species either from South America or from Europe. Dallimore (1919) describes these attempts and their outcome in the following words:-

> "From the time when the earliest emigrants entered the country the absence of trees appears to have made the greatest impression upon newcomers, and from the middle of last century successive Governors and a few of the more progressive settlers have considered the possibility of establishing trees either for ornament or profit. Planting schemes, usually of a half-hearted character, have been suggested from time to time, but whether from apathy, lack of general sympathy or the disinclination to risk money on a project that could only be considered in the light of an experiment, they have not materialised and the introduction of young trees or tree seeds has not gone beyond the individual efforts of a few settlers and a few attempts by government officials to procure trees and shrubs for the garden at Government House. Unfortunately in the few efforts that have been made the persons interested have not possessed sufficient technical knowledge to enable them to give the young trees the special attention necessary to enable them to overcome the unfavourable conditions which prevail, neither have they made proper reports upon the behaviour of the various species tried ..."

The remarkable extent to which Dallimore's words sum up the present (1983) situation (as will become apparent from later parts of this report) justifies quoting him at some length.

Probably in the early 1890s, Mr Robert Blake began what Dallimore (writing in 1919) regarded as "the most determined attempt that has yet been undertaken to establish a plantation of trees" at Hill Cove in West Falkland. This included some Nothofagus plants (probably N. betuloides) imported from Tierra del Fuego, Austrian pine (Pinus nigra var nigra) imported from Britain, Austrian pine and Scots pine (P. silvestris) raised locally from seed and a poplar (probably Populus alba) raised from cuttings obtained from a tree in Government House gardens. Mr Blake appears to have been well aware of the need for sensible site selection, good ground preparation, provision of early shelter (by using gorse hedges) and protection from browsing mammals. What is almost certainly the result of his efforts remains today as an irregularly shaped mixed woodland area in a

hollow beside the Hill Cove settlement manager's house. Very useful photographs of this area, probably taken in 1925, appear in the 1927 Kew Bulletin (Anon, 1927).

In 1919, staff at Kew Gardens were asked to provide advice on tree planting in the Falklands, and this resulted in Dallimore's paper. He gave detailed guidance on how best to establish trial plantations and many of his far-sighted prescriptions remain valid today. An important result of Dallimore's recommendations was the appointment of Mr James Reid, who had trained in forestry at the Royal Botanic Garden in Edinburgh, to the post of Forest Officer in the Falkland Islands (see Dallimore, 1920) - a post which he held from 1920 to 1925.

In 1920, Reid took with him from Britain seedlings and transplants of various temperate coniferous and broadleaved tree species, including pines, spruces, alders, birch, sycamore and elm, as well as cuttings of numerous poplar and willow species (see Dallimore, 1920). Seedlots of many coniferous and broadleaved species were also sent out in 1919-21. A description of Reid's activities and early results obtained is given in the 1927 Kew Bulletin (Anon, 1927). He established a small nursery in the gardens of Government House in Stanley and succeeded in raising substantial numbers of trees from seed (particularly Scots pine and Sitka spruce (Picea sitchensis)). In general, the planting stock brought out out from Britain did not do well. His initial planting trials were made on the south side of Mt Low, near Sparrow Cove in East Falkland. The results obtained were so poor that further attempts at afforestation there were abandoned. Reid then concentrated his activities at Hill Cove where a 10 acre paddock near the settlement had been made available by Mr Blake for trial work. It is reported that "... in the autumn of 1925 ground was prepared for planting. Ditches were cut at 15 yards interval and led into a natural stream which flows through the middle of the paddock. Holes were prepared 3 feet apart, turf being removed and the soil and clay broken up to a depth of 14 inches. In several cases the moor pan was found to be only some four inches below the ground surface and this necessitated breaking up with crowbars and pickaxes. Six acres so prepared have already been planted out with 30,000 conifers of which the Scots pine and Sitka spruce give promising results. All the trees planted were raised at Port Stanley except 1,000 Scots pine which were raised at Hill Cove, West Falklands. The nursery at Government House, Port Stanley, has been stocked with 40,000 seedlings, part of which it is proposed to plant out at Hill Cove next spring and the remainder in the following year". Also of interest is the fact that in 1923, Reid apparently obtained plants of Nothofagus antarctica and N. obliqua

from Punta Arenas in Chile. There is unfortunately no indication of where these were planted, but the likelihood is that some at least went to Hill Cove.

After 1925, intermittent tree planting attempts continued but it is difficult to obtain a clear picture of what occurred because of lack of records covering the next 30 years or so. It is likely that the first introduction of Monterey cypress (Cupressus macrocarpa) to the Islands occurred around 1930 at Weddell Island. It is unfortunate that the source of plants used cannot be identified because most if not all of the Monterey cypress trees and hedges established throughout the Islands seem to have originated as seeds or cuttings taken from the inital plot beside the Weddell manager's house. There is also no clear indication of when Monterey pine (Pinus radiata) was first planted. A plot on Carcass Island dates from the late 1940s, but two large specimen trees at Government House in Stanley were thought by the gardener to have been planted in the 1920s.

In 1957-58 the Falkland Islands Company (FIC) imported from Britain several thousand transplants of various coniferous species which were used to create small plantations at Fitzroy and Goose Green. Planting was done in fenced enclosures on spaced furrow Cuthbertson ploughing. Mishandling of the plants during transit and particularly at time of planting led to failure at Fitzroy (see Clement, 1967). At Goose Green results were only marginally better due to failure to maintain exclusion of stock from the plots.

Finally, McAdam (1982) records three further recent attempts to extend tree planting. He raised from seed a wide range of temperate tree and shrub species and in 1977 distrubuted the young plants to various settlements. In the same year, he imported Nothofagus antarctica transplants from Esquel in Argentina and planted them at four sites on the southern slopes of Mt Usborne. Initial growth of the Nothofagus was encouraging, but the trees are thought to have been destroyed by browsing in 1982. Also in 1977, the Sheep Owners' Association purchased a quantity of Lodgepole pine (Pinus contorta) seed from the Forestry Commission. This seed, of Washington coast origin, was distributed to interested association members, some of whom have since raised and planted out young trees (eg at Teal Inlet).

4. PRESENT LOCATION AND NATURE OF TREE GROWTH

From the preceding review it will be apparent that efforts over the years to establish trees in the Falklands have been limited in scope and that failures have been common. Successful planting has been confined very largely to the vicinity of farm settlement areas and to the town of Stanley. There have been very few attempts to establish trees on sites in the "camp", and even fewer successes. In consequence, the present day landscape remains essentially treeless throughout the Islands, except in the vicinity of habitation.

A list of the tree and major shrub species found growing in the Falklands at present is given in Appendix 1, which also provides brief notes on frequency of occurrence and performance. This list cannot be regarded as exhaustive, because time did not permit a detailed examination of all garden areas, but it almost certainly includes all species of any real significance.

Stanley

In Stanley, sizeable trees, shrubs and hedges are conspicuous features of gardens throughout the town area. Most gardens have substantial evergreen hedges reinforcing the shelter effect of slatted wooden perimeter fencing and there are numerous individual trees and shrubs. By far the most common tree species present is Monterey cypress (Cupressus macrocarpa), both as individual specimens and as hedging. Lodgepole and Austrian pines are also fairly common; many other tree and shrub species are present in small numbers, including Sitka spruce, Pinus radiata, various willows (Salix spp), elder (Sambucus nigra), Berberis spp, Ribes spp and Hebe spp. The native Hebe elliptica is frequently used as hedging. Tree heights up to 6 m are common, tending to be taller in the lee of buildings. Crowns frequently show conspicuous signs of wind pruning on their west sides, but for the most part are well foliaged and appear healthy.

Farm Settlements

Very few farm settlements do not possess at least some trees or shrubs (albeit often very windswept if few in number) in the vicinity of houses and gardens. Usually the manager's house at least will have some adjacent tree growth and evergreen hedges to improve garden shelter. Frequently very sheltered garden areas have been created by the establishment of large hedges or shelter strips of trees several metres in height. Wooden shelter fences or gorse hedges have

often been used in the past to help establish tree growth for shelter purposes. As in Stanley, Monterey cypress is by far the most common tree species found, but various pines, Sitka spruce and White poplar have also been used to some extent for shelter planting. Where some degree of shelter (whether artificial or natural) has been available a wide range of other, and particularly broadleaved tree and shrub species may be found with willows, Sorbus spp and Ribes spp the most common. A high concentration of birdlife was a very noticeable feature associated with the presence of tree and shrub growth.

Most settlement planting over the years has been intended to provide shelter and amenity for gardens and houses, and in consequent has usually been very limited in extent. Only at a very few locations has tree planting been on a sufficient scale, and survival and growth been sufficiently good, to have led to the development of anything approaching woodland conditions. These important "woodland" sites are at Hill Cove and Roy Cove in West Falkland, Teal Inlet and Stanley in East Falkland, and on Weddell, Westpoint and Carcass Islands. Evidence from these locations is of particular value in assessing the potential for future tree planting in the Islands and each is described separately below. Particularly during the past 30 years, there have been some attempts to establish belts or blocks of trees aimed at providing shelter in stockholding paddocks near settlements. Examples can be seen at Fitzroy, Goose Green and Hill Cove. For the most part these attempts have failed, and at best the results have been less than satisfactory, for reasons such as faulty plant handling prior to planting, incorrect species choice and inadequate protection against browsing damage.

Hill Cove

At Hill Cove, on the north coast of West Falkland, the main plantation lies 200 m north west of the settlement manager's house. It is easily the most impressive area of trees growing in the Falklands today, and is of particular importance in providing the only example of anything approaching large scale forestry planting in the Islands. Fortunately it is also one of the very few locations for which the early history is reasonably well documented (see Anon, 1927) although information on later stages of growth is sketchy.

The total area involved is just over 1 ha and takes the form of a narrow elongated triangle some 260 m in length, with its long axis aligned slightly west of north. The maximum width from east to west is about 75 m. The site lies 8-20 m above sea level and is exposed to the west and north although sheltered from the south

sea level and is exposed to the west and north although sheltered from the south by substantially higher ground.

The tree crop consists of pure spruce (nominally Sitka spruce (Picea sitchensis) but see below) growing at approximately 1 m spacing in rows 3.0-3.5 m apart. The general vigour and health of the trees was very impressive, with most having prominent erect leaders and excellent foliage retention. On the exposed western edge the crowns of the outer row of trees had been damaged by wind above the level of a 2 m high gorse hedge. However, growth and foliage retention appeared to be relatively normal 2-3 rows inside the plantation. Apart from the outer 1-2 rows, the trees had been completely brashed, revealing very uniform stocking, more or less complete canopy closure and no sign of dead or windblown trees or of trees removed. Growth appeared to have been consistently more vigorous in a 40 m wide strip at the southern end of the plantation, and a 0.03 ha temporary sample plot (20 m x 10 m) was laid out within this area. Measurement of all trees in the plot indicated a mean diameter at breast height (dbh) of 21 cm, a basal area of 109.1 m^2/ha and a stocking density of 3100 trees/ha. The largest tree in the plot had a dbh of 37 cm, but on the plantation edges tree diameters in excess of 60 cm were found. Hypsometer measurement of tree heights proved possible only at the plantation edges and even there problems were created by the long branches extending to ground level. The tallest tree found, which had a height of 17 m, was on the eastern edge in a slight hollow (NB: McAdam (1982) reported a maximum height of 18.9 m in August 1982, but this was almost certainly an overestimate). More typical trees on the south east edge outwith the hollow had an average height of 15.5 m, and visual examination from a distance suggested that this was probably a reasonable approximation of mean height in the vicinity of the sample plot.

Under the trees there was often substantial needle litter accumulation (5 cm or more) overlying a very tough compacted peat layer in which most of the tree roots were found. Below this was a further 25 cm of dry crumbly peat, with appreciable mineral content, which in turn overlay undisturbed compact clay. There seemed to be very little root development at any depth below the superficial layer.

Many trees were coning heavily and had obviously done so in past years, judging from the cone accumulation on the ground surface. A few naturally regenerated seedlings were found on the plantation edge. The development of viable seed and natural regeneration has been noted previously by McAdam (1982).

There is no doubt that the spruce plantation forms part of the area reported (Anon, 1927) as having been planted by Reid in 1925. The absence of any Scots pine in the crop is surprising, but it seems very probable that the very wide spacing between the spruce rows has resulted from the complete disappearance of two rows of Scots pine originally planted between the spruce rows. The pine may have died out or been eaten during a period when the plantation reputedly went into check and grazing animals were allowed into the area (see Stewart, 1982). Hearsay evidence suggests that there was a marked improvement in growth of the spruce sometime after 1950, and that this coincided with the initial appearance of numerous fungal fruiting bodies in the vicinity. Dimitri (1975) suggested that the growth improvement was due either to the trees having become infected with suitable mycorrhizal fungi; or that the roots had passed through a hard layer of subsoil, thus improving their nutritional status. The first suggestion seems much the more probable of the two, and there is no doubt that the tree roots are currently mycorrhizal. Root samples examined in Britain by a Forestry Commission specialist were found to have well developed mycorrhizae involving several different fungal species.

The planting stock used at Hill Cove in 1925 was raised at Stanley using seed sent out from Kew Gardens and described as Picea Sitchensis (Sitka spruce). Doubts about the identity were first raised in 1977 (McAdam, 1982) when it was noticed that many trees showed characteristics more akin to those of Picea jezoensis. The present visit confirmed that on the basis of foliage and bud characteristics the plantation included many trees of both P. sitchensis and P. jezoensis types as well as intermediates between them. There were also occasional trees showing some affinity with other spruces such as P. smithiana. The provisional conclusion reached is that the seedlot was collected from Sitka spruce trees which had been exposed to pollen from specimens of other spruce species growing in the vicinity.

There is a second and very different wooded area worthy of note at Hill Cove, extending along a sheltered hollow below and immediately to the west of the manager's house. It is irregular in outline, occupying a total area of some 0.5 ha and contains a variety of broadleaved and coniferous species. It is of particular interest as it is almost certainly the area planted by Mr Robert Blake prior to 1898, when he left the Falklands, and therefore contains some of the oldest trees growing in the Islands. The most striking feature was the presence of several large specimens of the evergreen Nothofagus betuloides, presumably grown from some of the young trees imported from Tierra del Fuego.

They had very wide spreading, wind deformed but otherwise reasonably healthy crowns, and heights of 7-8 m. Each tree had several stems, usually in the range of 30-50 cm dbh. Some of these trees feature in the photographs illustrating the 1927 Kew Bulletin article (Anon, 1927), although identified in the captions as N. antarctica, and were obviously sizeable trees at that time. The other important broadleaved species present was White poplar (Populus alba) forming a substantial pure grove in the northern part of the area. Many of the trees had probably originated as root suckers, and sizes varied widely with heights ranging up to 7 m and dbh up to 39 cm. There were also scattered specimens of Scots pine and (probably) Corsican pine (P. nigra var maritima). Both species but particularly the Scots pine, showed declining vigour and poor foliage retention; heights were 7-8 cm and dbh ranged from 27 to 35 cm.

Roy Cove

A small but interesting plot of conifers was found at Roy Cove, some 12 miles WSW of Hill Cove and on the west coast of West Falkland. The trees occupied an area of about 0.15 ha in a small sheltered moist valley immediately to the south east of the former settlement manager's house. McAdam (1982) reported the main species as being Scots pine, but in fact the major part of the plot consisted of about 100 spruces and a few Monterey cypresses with only a scattering of dead or dying Scots pine. The general appearance of the spruces was similar to those at Hill Cove, as was the degree of variability in needle and bud characteristics. In view of the proximity of the two settlements it seems very probable that planting was done in or about 1925 using planting stock obtained from Hill Cove. Spacing between and within rows of trees was about 3 m, and it is possible that there had originally been intervening rows of another species (Scots pine?) which had died out. Height of the spruce ranged from 4 m at the exposed western side on the valley edge to 15 m in the valley bottom. Apart from the wind-damaged trees on the western edge, crowns appeared healthy and well foliaged, with frequent vigorous leaders.

Teal Inlet

At Teal Inlet, in the north of East Falkland, the main area of trees occupied an irregular area of about 0.1 ha in a shallow undulating sheltered hollow near the manager's house and adjacent to the garden area. It included several sizeable Sitka (?) spruces and substantial numbers of Monterey cypress and White poplar, with the latter suckering freely. The spruces ranged in height from 8 to 11 m

and in dbh from 37 to 56 cm; although single stemmed, their crowns showed "flagging" due to wind exposure, and foliage retention was poor due to a combination of wind and (probably) attack by the green spruce aphid Elatobium abietum. The cypresses were from 4 to 6 m in height and dbh up to 40 cm; they were bushy and multistemmed with good foliage retention despite some signs of wind pruning. Mainly growing in the shelter of the other trees, the poplar had heights of 5-6 m and diameters up to 35 cm. Planting was thought by the manager to have been done at least 40 years and possibly 50-60 years previously. It seems possible, in fact, that the spruces were planted in the mid 1920s and the poplars might date from the same period. The cypresses are unlikely to have been planted until the late 1930s at the earliest, in view of the probable timing of the initial introduction of this species at Weddell Island.

In a field to the west of the manager's house there was a further small plot of trees occupying a square area of about 0.05 ha. The species composition was similar to that in the larger area, and sizes were similar. The few spruces were completely emergent from the general canopy level, and had very thin crowns - as before probably due to past Elatobium attack as much as to exposure. Tree spacing was approximately 3 m in each direction, suggesting, as elsewhere, that there may originally have been intervening rows of trees at time of planting some 40 or more years previously.

Stanley - "Government Forest"

The so-called "Government Forest" on the hillside behind Government House in Stanley consists of two parallel strips of trees about 100 m apart and aligned on a north-south access at right angles to the contours. They were planted with Monterey cypress in 1945 and it was apparently intended to plant up the intervening area with a variety of other tree species once the cypress strips had provided shelter. The windward edge trees in both strips showed marked windpruning, but the remaining trees appeared healthy with good foliage retention. Tree size was very variable and form poor, particularly in the east strip. Heights ranged from 4 to 8 m, with the poorest growth at the upper ends of the strips where the soil became very shallow. Dbh ranged from 6 to 40 cm and there were many multistemmed trees. A trench found in the centre of the west strip showed that some sizeable tree roots had penetrated 20-30 cm vertically down cracks in the clay subsoil.

Weddell Island

On Weddell Island, lying to the west of West Falkland, planting has been done almost exclusively with Monterey cypress. The trees, which occupy a total area of about 0.15 ha, are growing mainly in a relatively sheltered hollow to the east of the manager's house. The initial planting, thought by the manager to have been done about 60 years ago, was in the form of a more or less square plot at 2-3 m spacing on a slope immediately below the house. Heights ranged from 5 m in the most exposed part beside the house to 12 m lower down the slope, and dbh ranged from 32 to 74 cm. The tops of the trees followed a very obvious windcut profile eastward from the house, and crowns were tending to become thinly foliaged. Some trees were coning heavily.

Below these older trees, there had been further planting approximately 40 years ago - mainly in the form of shelter strips around a garden area. These younger trees, often multistemmed, had heights of 6-12 m, and dbh up to 72 cm. Apart from some windpruning on their upper crowns, they appeared very healthy. Many were coning freely.

It is accepted locally that the older cypresses at Weddell represent the initial introduction of Cupressus macrocarpa to the Falklands. They apparently began to produce viable seed at an early stage and have long served as a seed source for the raising of planting stock elsewhere. It seems very probable that most if not all of the Monterey cypress (commonly referred to as "macrocarpa"), which is found extensively in garden areas throughout the Falklands, will have originated from this one introduction.

Westpoint Island

There are two small patches of trees, each 0.05-0.1 ha in area, on Westpoint Island, which lies off the north west tip of West Falkland. They are situated on a east facing slope about 800 m south of the settlement, and each consisted primarily of Monterey pine (P. radiata), with some Monterey cypress. Apparently they are the remnants of a much larger area planted mainly with Monterey pine about 1950, and which suffered very heavy losses due to desiccating winds within 6 months of planting. In general, the survivors appeared healthy, with good foliage retention, but were heavily branched and multistemmed. Heights were variable, ranging up to 5 m. Some Scots pine had been planted more recently (probably about 10 years ago) and had achieved heights up to 2 m, but many trees

had poor foliage retention.

Carcass Island

On Carcass Island, which is also adjacent to the north west tip of West Falkland, there is a relatively substantial plot of Monterey pine, planted about 1949. It occupies a more or less rectangular area 75 x 50 m (approximately 0.35 ha) in a relatively sheltered valley site 40 to 60 m above sea level on the south side of the island. Growth had generally been vigorous, giving current heights of around 9 m and dbh of 20-26 cm, but many trees were multistemmed, and branching was heavy. Foliage retention was good, except at the western corner and at the tips of some of the tallest trees where wind-damage was apparent. Planting appeared to have been at about 2 m x 2 m, but there were some irregularities suggesting limited early failures.

5. REASONS FOR TREE PLANTING SUCCESSES AND FAILURES

Assessing the specific reasons for the success or failure of many tree planting attempts in the Falklands has been 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 could seldom be obtained. Even for the outstanding Hill Cove spruce plantation there are many gaps in the available information. In this respect, the present situation differs very little from that described by Dallimore in 1919. However, from observations made on site, combined with such limited information as could be obtained from the literature and from local sources, it has been possible to deduce what have in general 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 the results achieved were due to a combination of these factors; and it was possible for favourable factors to outweigh unfavourable ones, or vice versa.

Beneficial Factors

1. Selection of a moisture receiving site with natural topographic shelter and above average nutritional status. (Usually achieved by planting in a sheltered hollow or small valley in the vicinity of 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 or creating gorse hedges.)

3. Careful protection by fencing against browsing by domestic stock or by hares (where present).

4. Planting of trees in sizeable plots or belts to obtain the benefit of mutual shelter development and canopy closure.

5. Intensive ground preparation prior to planting. (Many of the older sites used had a probable history of previous agricultural or garden cultivation; pit planting with prior preparation and loosening of soil to some depth was also 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 temperature is probably still sufficiently high to permit some root growth of conifers.)

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

Adverse Factors

1. Incorrect plant handling during transit and at the planting site. (Has included lengthy storage in unsuitable conditions or containers, and excessive exposure of roots during the planting operation.)

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

3. Use of species or provenances which did not have good resistance to wind exposure, (eg Scots pine and inland provenances of Lodgepole pine).

4. Poor choice of planting site. (Wind exposure excessive or soil moisture status inadequate.)

5. Use of excessively large planting stock with poor root/shoot ratio. (Liable to lead to heavy lossses in a windy climate with low rainfall.)

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 - failure is very probable, and at best establishment and subsequent growth will be slow).

6. PROSPECTS AND PROVISIONAL PRESCRIPTIONS FOR TREE PLANTING IN THE FALKLANDS

There is very limited direct evidence from which to assess prospects for future tree planting in the Falklands, whether for agricultural shelter or for wood production. As indicated earlier, tree planting efforts over the years have been very restricted in scope, with successful results confined almost entirely to relatively favourable sites in the vicinity of farm settlements and Stanley. Few of the locations involved have had site conditions even approximating to those typical of open "camp". Furthermore there is little to suggest directly how far the use of currently accepted forest establishment techniques might have affected results. It is therefore necessary to rely substantially on extrapolation from afforestation experience elsewhere, and particularly that relevant to upland Britain.

Any attempt to appraise tree growth potential in the Islands is inevitably dominated by consideration of the effects of the three major environmental factors wind, rainfall and soil. In relation to tree growth, the windiness of the Falklands climate imposes severe limitations, and its effects are exacerbated by the low rainfall and nature of the soil (shallow peat over clay) covering much of the land area. Together, these factors almost certainly rule out the possibility that afforestation on any substantial scale will ever be a practical proposition in the Islands (even assuming that large areas of land could be made available for the purpose). Nevertheless, there are some grounds for concluding that the use of modern establishment techniques (as pioneered by the Forestry Commission in exposed Scottish locations), combined with appropriate tree species and provenance choice, would make it possible to create effective shelterbelts, and even to produce wood on a limited scale on selected sites.

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 in site preparation, rigorous protection against browsing damage, and patience.

In general, satisfactory results are much more likely if shelterbelts are aimed at supplementing some existing, even if limited, topographic shelter, rather than at attempting to create shelter from scratch in the most exposed and windswept grazing areas. 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. At least partial recognition of this point in the past is evidenced by the gorse hedges or even shelter fencing associated with some previous attempts at shelter planting. Although expensive, the addition of "Netlon" shelter netting or "Paraweb" screening to the windward fenceline of any new belt will almost certainly improve survival and early growth. High elevation and very dry sites should obviously be avoided, and success seems more likely where the peat layer is of greater than average depth.

The actual siting of belts within a farm must obviously depend markedly on the manager's preferences and method of stock management, as well as on local conditions. From discussion with various managers it was not possible to obtain a clear picture as to where the creation of shelter (if technically feasible) would be of greatest benefit. Three possible locations which emerged were paddocks used for lambing stud ewes, areas for holding sheep immediately after shearing, and reseeded areas. The fact that the predominant wind direction is westerly suggests strongly that a north-south orientation would normally be of most benefit. However, on some farms, the periodic occurrence of very cold south or south-easterly winds might make it necessary to consider east-west orientation.

Scottish experience indicates that on very windy sites belts should contain at least 10 rows of trees, and that 15 or 20 rows are desirable. This makes possible the development of mutual shelter within the belt, leading to improved growth and shortening of the interval until the belt begins to provide some effective shelter to leeward. The windward 2-4 rows of trees can be expected to suffer crown damage but behind them relatively normal growth is likely. The spacing between rows and between trees should be 1.5-1.8 m. Published work on shelterbelts (see Caborn, 1965) indicates that a minimum length of 200 m is desirable in order to ensure that, in the longer term, some shelter is produced over a substantial area of ground. In view of the very extensive nature of sheep management in the Falklands, it may well be necessary to consider greater lengths.

The number of tree species currently found growing in the Falklands is considerable (see Appendix 1) but only a very few of these show any real potential for use in shelterbelt planting on "camp" sites. Information from other sources suggests that there are few other temperate species with shelter planting potential which might be tried. On present evidence there are five main species which can be

considered for shelterbelt use - the conifers Cupressus macrocarpa (Monterey cypress); Picea sitchensis (Sitka spruce) of Queen Charlotte Islands (British Columbia) origin; Pinus contorta (Lodgepole pine) of North American coastal origin and Pinus radiata (Monterey pine); and the evergreen broadleaved species Nothofagus betuloides from southern South America. Three other species which might also be considered are X Cupressocyparis leylandii (Leyland cypress, which has Monterey cypress as one parent), Pinus muricata (Bishop pine) and Pinus nigra var nigra (Austrian pine). Various other trees and large shrubs known to be wind resistant have been excluded for reasons such as slow growth, unsuitability for the soil type or their being deciduous.

All other things being equal, Sitka spruce could be expected to play a major role in any shelter planting in the Falklands. It has grown well at Hill Cove, and the Queen Charlotte Islands origin has performed particularly well in very exposed Scottish plantations. Unfortunately, a cautionary note is necessary because of the apparent presence at Teal Inlet and Stanley of the green spruce aphid (Elatobium abietinum). The mild Falkland winters might favour the build up of aphid populations which could lead to serious defoliation of future spruce plantings in East Falkland at least.

The windward edge of a belt should consist of at least four rows of Lodgepole pine originating from the north coast of British Columbia from the Queen Charlotte Islands or from Alaska. Although relatively slow growing these origins are very wind resistant and remain well foliaged to ground level in exposed conditions. Subsequent rows can consist of the other species listed above, or Lodgepole pine of coastal Washington or Oregon origins; all are likely in the long term to grow taller than the north coastal and island origins of Lodgepole pine.

Prior to planting, sites should be ploughed in late summer using a modern forestry plough designed to loosen the soil to considerable depth as well as to produce turf ridges at appropriate spacing for planting. Suitable models are the trailed versions of the double throw Clark D45/T60 and single throw Clark S45/T60 ploughs (see Thompson, 1978) drawn by a low ground pressure tracked tractor of 80-100 hb (60-75 kW). The wider "platform" between furrows produced by the D45/T60 plough might lead to greater long term windfirmness. On the other hand, the greater disruption of the clay layer resulting from the much greater frequency of S45/T60 tine channels for the same number of turf ridges could increase soil moisture holding capacity and promote deeper root development. (The size of belt envisaged makes hand methods of ground preparation impractical, but for small scale use

turfs 45 cm square and 15-20 cm deep could be cut by hand, spread and inverted to provide planting positions. Small scale pit planting might also be feasible particularly if a powered large diameter post hole borer was available to assist in preparing holes which were then backfilled firmly with mixed spoil.)

Planting should be done in late autumn or early winter by notching the young trees into the sides of the large turf ridges produced, preferably on the east (leeward) side. As far as possible, tree roots should be in or near the vegetation "sandwich layer" beneath the upturned ridge. Planting stock should be healthy, sturdy transplants 20-30 cm in height with compact fibrous root systems. Exposure of the roots to desiccation by wind and sun must be avoided at all times during transport to the site and during the planting operation. As far as possible any substantial losses occurring in the first 1-2 years after planting should be replaced using similar plants. Preferably just before planting is done, phosphatic fertiliser should be broadcast over the area at a rate providing 50 kg P per ha.

Grazing animals must be completely excluded by appropriate fencing which must be maintained indefinitely if effective shelter to ground level is to be retained during the life of the belt. 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 (probably 5 years after planting). A belt must also be protected against damage by fire.

(Note: An advisory pamphlet "Tree Planting in the Falklands" was produced in the Islands by McAdam (1977). The prescriptions given above supersede those given by McAdam for shelterbelt planting, but to a large extent the underlying principles are similar.)

It is important to emphasise that shelterbelts take time to become effective and that the more difficult the basic environment for tree growth, the longer this time becomes. Even if the prescriptions given above are applied correctly, significant shelter benefits are unlikely to be obtained earlier than about 15 years from time of planting. Thereafter, if healthy growth continues, the area of effective shelter can be expected to increase substantially over the years as the height of the belt increases.

Planting for Wood Production

The prospects for wood production on any substantial scale in the Islands, whether for use as timber or fuel, must be rated as low. Even with modern forestry techniques, the environmental conditions will almost inevitably result in a prolonged establishment period and relatively slow subsequent growth. Stem form is likely to be affected adversely by climatic damage to leaders and crowns, and this in time will restrict the potential end uses of any timber produced. On present evidence, there are no suitable tree species available for the develop- of a short rotation fuelwood production system of the type used successfuly in many countries with more favourable environments.

The suggestion has been made in the past that shelterbelt planting, if sufficiently wide, might perform the dual role of creating shelter and producing wood (from thinnings). In the Falklands situation, any such approach should be avoided. It would be only too easy for a shelterbelts's effectiveness to be impaired as a consequence of injudicious thinning.

Some opportunity exists for mitigating the adverse effects of the environment by the selection of planting sites which provide topographic shelter and above average moisture status. Provided such sites can be made available, then the creation of plantations for wood production becomes a practical possibility, although only on a very modest scale because of the limited extent of potentially suitable sites (to say nothing of competition from other forms of land use). A further restriction to site availability lies in the need for reasonable proxi- mity to Stanley or to settlements. There is little point in attempting to produce wood which cannot be transported at reasonable cost to the consumer.

Potentially suitable sites lie in the lee of substantially higher ground and in valley locations providing shelter from the western quarter. They should, if possible, be water receiving ("flushed") sites or alternatively on areas of deep peat ($>$60 cm). Taking all things into consideration, the most appropriate sites appear to be in the Stanley area (to the south of the Darwin road between Sapper Hill and west end of Port Harriet; and in the upper part of the Moody Valley); near Teal Inlet and near Hill Cove. A minimum plantation size of 5 and preferably 10 ha should be used and edge effects should be minimised by making the format as square as possible.

The species and origins most likely to produce a reasonable tree crop are similar

to those suggested for shelterbelt planting. They are Lodgepole pine (coastal origins), Monterey pine, Sitka spruce (Queen Charlotte Islands origin), Monterey cypress, Leyland cypress, Nothofagus betuloides, N. pumilio and White poplar (the latter three broadleaved species primarily on more nutrient rich sites). It would in general be sensible to plant several rows of the exposure-resistant coastal British Columbia or Alaskan origins of Lodgepole pine along the western and probably southern margins of a plantation.

Methods of site preparation, planting and protection should be as indicated for shelterbelt establishment with two significant differences. Cultivation of areas with a peat depth greater than 60 cm should preferably be done using a Clark D60/- plough rather than the D45/T60 model which is appropriate for shallower peat over clay and plant spacing can be increased to 2.0 m.

The lack of reliable growth data for Falkland sites means that it is possible to give only limited general guidance on the likely yield of wood from successfully established plantations. The only existing stand of trees for which a meaningful estimate can be made is the spruce at Hill Cove, where the current stand basal area and height suggest a standing volume of approximately 500 m^3 per ha at age 58 years. Consideration of provisional yield class data for very exposed plantations in Scotland suggests that under Falklands conditions the possible yield over a 50 year rotation will be of the order of 350-450 m^3 per ha for Lodgepole pine and 450-550 m^3 per ha for Sitka spruce.

As in the case of shelterbelt planting, it is worth pointing out that it will take a substantial period of time for trees to attain a worthwhile useable size. For example, trees are unlikely to be large enough to provide fence strainer posts until 20-25 years after planting.

Amenity and Shelter Planting for Houses and Gardens

The practicability of small scale amenity and shelter planting for houses and gardens has been clearly demonstrated by the efforts of generations of Falkland Islanders, both in settlements and in Stanley. The key factors for success are:- the availability of initial shelter either in the form of shelter fences or by taking advantage of any shelter provided by existing hedges, buildings or local microtopography; intensive site preparation, involving careful pit planting after deep cultivation; and subsequent careful protection against browsing and other damage.

Monterey cypress must inevitably continue to play a major role in any such planting, in view of its well-proven wind resistance and suitability for hedging as well as specimen trees. Hebe elliptica (native box), gorse and other locally recognised hedging species are also important in the development of initial shelter. Once some degree of shelter has been created by the planting of wind resistant species or obtained by using a naturally sheltered site (eg in a hollow or small valley, it becomes feasible to grow reasonably successfully a wide range of broadleaved and coniferous species (see Appendix 1) given time, patience and persistence.

7. RECOMMENDATIONS FOR NEW TRIALS

In order to confirm the validity of the assessment and provisional prescriptions given above, it is recommended that a series of new tree planting trials should be carried out in the Falklands. Detailed recommendations are as follows:-

1. Shelterbelt Planting

The practicability of creating effective shelterbelts should be tested on sites in both East and West Falkland. For ease of supervision, maintenance and assessment, the selected sites should if possible be associated with reseeding trials being undertaken by FIARDC. Although not essential, it will be an advantage if the farm managers involved are already convinced that there are benefits to be gained from shelterbelts, and therefore have a genuine interest in the trials. Suggested locations are at Teal Inlet, the Stanley vicinity and Goose Green in East Falkland; and at Hill Cove and Fox Bay East in West Falkland. Until more information is available the driest areas of the Islands are best avoided.

Each trial belt should be established using the techniques and species described in the preceding report section. If only one plough model is used (but see below) then it should be the D45/T60. Ploughing parallel to the long axis of the belt should be done in late summer (February/March) for planting in late autumn or early winter (when soil moisture levels are likely to be more favourable than in spring). (Fortuitously, labour for fencing and other work is also likely to be more readily available in autumn than in spring.) Planting must be done by properly trained personnel, and their training would be one of the duties to be undertaken by the supervising forester.

Under the circumstances, it seems best to avoid complex experimental treatment comparisons and to examine only a very limited range of possible treatments in a very simple manner. The basic comparison must be between the various species suggested and this can best be done by planting each in successive 20-30 m lengths repeated systematically along the length of the belt. These species plots should lie to leeward of a continuous four row wide strip planted with Lodgepole pine of Queen Charlotte Islands or Alaskan origin, since no other species is likely to prove better than this for

use on the windward edge. Half of the overall belt length could be a total of 10 rows wide and half 20 rows wide in order to test the possible merit of greater than minimum width. A further useful small scale comparison easily included would be between planting into the side of the plough ridge and into the side of the furrow in view of the possibly more favourable moisture conditions as well.

The erection of "Netlon" shelter netting (or the more expensive "Paraweb" screening) along the windward edge of a belt is certain to provide some beneficial shelter during the critical early years of tree growth, and could be regarded as a standard treatment. However, it would be well worth examining the extent of the benefit on at least some sites by adding 1 m high Netlon shelter netting to only half of the windward fence length.

The nature of the basic soil type found throughout most of the Islands (25-35 cm of peat over compacted clay) is such as to discourage worthwhile tree root development below the peat layer. This leads to some doubt about the long term wind stability of shelterbelt (and other) planting. In addition, the moisture holding capacity of the peat layer might be inadequate for continued long term tree growth. Although involving extra investment in equipment, it would be well worthwhile making a simple comparison of results obtained from normal single throw S45/T60 and double throw D45/T60 ploughing, and from D45/T60 ploughing with an additional tine channel beneath each turf ridge. This latter treatment can be produced by initial use of a simple tine ripper at planting spacing, followed by passes of a D45/T60 plough aligned midway between the tine channels.

At each location the minimum aim should be to create a shelterbelt at least 250 m long with a north-south orientation. If topography and other factors allow, the addition of a further belt more or less at right angles, to give a T or L-shaped configuration, would be very valuable for further examination of the benefits to stock provided by shelter from different wind directions.

In order to compare "exposure" levels at the various trial locations it is desirable to use the tatter flag technique widely used in British upland forestry and introduced to the Falklands some years ago by McAdam (1980). At a later stage, the availability of tatter flag data could be very useful in interpreting the tree growth performance obtained, as well as assisting

in the selection of potential locations for further shelterbelt planting.

2. Planting for Wood Production

To verify the predicted (limited) potential for wood production, a small number of trial plantations should be established on carefully selected sites in the vicinity of Stanley and some farm settlements. From the logistical viewpoint, the latter could most conveniently be those involved in shelterbelt trials. At each location a block size of 10 ha will probably be sufficient for the creation of realistic "forest" conditions, provided that a long narrow format is avoided, although the area could usefully be increased to 20 ha if circumstances allow.

The general locations recommended in the first instance are (for the Stanley vicinity) to the south of the Darwin road between Sapper Hill and the west end of Port Harriet, and in the upper part of the Moody Valley; at Teal Inlet; and at Hill Cove. The locations in the Stanley vicinity have the important advantage of ready access by road to potential wood consumers, as well as providing deep peat soils on which soil moisture availability is unlikely to be a problem.

The establishment methods to use are those detailed earlier (and are essentially the same as for shelterbelt trials). For the deep peat areas to be used in the Stanley area, the non-tine D60 plough will produce a more desirable form of ploughing than the D45/T60 model required for shallower peats. As in the case of shelter planting, a four row strip of Queen Charlotte Islands or Alaskan origins of Lodgepole pine should be planted along windward block edges to improve internal growing conditions. Within each plantation the various species recommended earlier should be planted in units of not less than 0.5 ha.

As in the case of shelterbelt trials, it is desirable to use the tatter flag technique to provide an objective measure of "exposure" for inter-site comparions at a later stage.

3. Creation of an Arboretum

Serious consideration should be given to the development of an arboretum or forest garden on a site close to Stanley. If established and developed

properly, this could have a valuable educational and amenity function as well as providing on a single site a comparison of a wide range of tree and shrub species which can be grown in the Falklands.

Similar suggestions have been made on several past occasions (see eg McAdam, 1982), usually involving a location in or beside the gardens of Government House. The two strips of Monterey cypress forming the "Government Forest" were apparently planted for the purpose of creating a sheltered area for subsequent planting of other species. In fact, there does not appear to be scope there for the development of a worthwhile arboretum area because of the relatively shallow soil and exposed nature of the slope rising behind Government House.

A more suitable site exists slightly to the west of Stanley, beyond the butchery, in the vicinity of the former satellite tracking station. It is therefore recommended that a minimum area of 5 ha should be acquired there for arboretum development. An essential first stage of such development will be the creation of a shelterbelt system to protect the west, south and east edges of the selected area, and it may also be desirable to subdivide it internally by means of a further north-south belt to provide additional shelter internally. These shelterbelts could be established at the same time as the recommended shelterbelt trials, and be similar in design. (From the amenity viewpoint it would however be desirable to avoid completely straight belt alignment and to have some parts of each belt substantially wider than others.) Thereafter plots of other species could gradually be planted up within the protected area. Continuous protection will be required against growsing animals and fire.

4. Organisation, Control and Supervision of the Trials

Overall responsibility for the recommended trials should rest with FIARDC, who can provide the infrastructure, local knowledge and administrative back-up required for successful organisation and longer term management. However, to ensure that techniques are properly applied and that the results obtained are as reliable as possible, it is essential that adequate skilled technical forestry supervision is available during the organising and planting of these trials and that comprehensive accurate records are maintained. The supervisory forester, who could be obtained on secondment from the Forestry Commission, should have substantial first-hand practical experience

of the problems and practices involved in the afforestation of difficult exposed sites in Scotland. He should also be familiar with forest research techniques. If the recommended trials programme is undertaken, then he would be required for an initial period of 6 months (probably January to June) in order to participate in site selection, ground preparation, fencing and planting. In autumn of the following year he would be required for a further 2 month period, and for one month in each of the succeeding 4 years in order to ensure appropriate maintenance and early assessment of the trials.

Since cultivation with appropriate modern forest ploughs is considered essential for success, it will be necessary to obtain a suitably experienced plough operator from Britain. A period of 2 months in late summer (February-March) is likely to be required for the work, provided that appropriate arrangements can be made in advance for prompt movements of the ploughing outfit between locations.

5. Provision of Planting Stock for Trials

In order to obtain suitable planting stock of appropriate species, it will be necessary to arrange for importation from established forest nurseries outwith the Falklands. There would be theoretical advantages from production of the required trees within the Islands, including the avoidance of potential phytosanitary problems, minimising of transit damage risks and exact matching of growing seasons. However, the quantities required for the trials (which in forestry terms are very modest) go far beyond what have been produced in the Falklands on a "hobby" basis in recent years. It is considered that the advantages of internal production are outweighed by the problems involved in trying to establish a proper nursery of sufficient size and with appropriate skilled supervision; together with the probable minimum lead time of 4 years required to produce the required transplant quantities, and the need to ensure that plant roots develop appropriate mycorrhizae. Importation of plants appears much more logical and cost-effective provided that suitable plant health safeguards are defined and applied. Given thorough inspection at the despatching nurseries by the relevant plant health authority, and pesticide treatment if necessary, phytosanitary risks should be at an acceptably low level.

All other things being equal, forest nurseries in the southern parts of Chile and Argentina would be a logical choice because of their proximity and environmental similarity. Regrettably, the present political situation appears to rule out this option, and the remaining alternative sources of supply are nurseries in Britain and New Zealand.

As and when any supply arrangements are made, it is essential that the methods of packaging and transport ensure that young trees arrive in the Falklands in the best possible condition. This would best be achieved by using refrigerated containers. Some initial losses in the trials are inevitable and it will be necessary to have plants available to make good failures. This could best be done by including an allowance of say 20% for beating up purposes in the quantities obtained for initial planting; and lining out the excess numbers in garden or other cultivated areas near planting sites.

If it is ever considered necessary to develop a small forest nursery in the Islands, then the most suitable sites are likely to be found in the vicinity of Stanley Dairy, Mullet Creek, Government House or the recommended arboretum location.

8. ESTIMATED COSTS OF ESTABLISHMENT AND INITIAL MAINTENANCE OF TRIALS

The following are the approximate costs involved if the recommended shelterbelt and wood production trials are undertaken:-

		£	£
1.	Cost of supervisory forester		
	Salary, etc, for total of 12 months	10500	
	Travel (6 return visits to Falklands)	9000	
	Accommodation	5000	
	Total	24500	
2.	Cost of ploughing operations		
	Operator's wages (3 months), travel and accommodation	5000	
	Hire of tractor, plough carriage, and assorted plough heads from UK for 4 months (including transit period)	5000	
	Shipping to and from Falklands	4000	
	Operating costs including fuel, repairs and transport between sites	9000	
	Total		23000
3.	Cost of fencing materials and erection		
	Shelterbelts (including "Netlon" on windward edges)	30000	
	Plantations	32000	
	Total		62000
4.	Cost of planting stock and planting		
	270000 plants (including beating-up allowance)	29000	
	Shipping to Falklands	9000	
	Planting operation	4000	
	Total		42000

5. Cost of fertiliser treatment
(Phosphatic fertiliser and application)

Total	13500

6. Cost of beating up and other maintenance
(initial 5 year period)

Total	4000
Grand Total	£169000

(Note: If it were desired to purchase rather than hire ploughing equipment, the estimated cost of doing so would be as follows:-

Low ground pressure tractor (Fiat 80 or similar)	33500	
Clark (Parkgate) universal plough carriage	5000	
Clark D45/T60, D60/- and S45/T60 plough heads and separate tine ripper head	4500	
Shipping to the Falklands	2000	
Total		£45000

This compares with the estimated hire charge (including return shipping costs) of £9000. However, on completion of the trials cultivation programme, the purchased outfit would have a residual value of, say £35000. Purchase might be considered if other (agricultural) uses for the tractor were foreseen within the Islands).

9. ACKNOWLDGEMENTS

My grateful thanks for assistance and hospitality must go to Dr John Ferguson and Mr Austin Davies of FIARDC, both of whom went to considerable lengths to ensure that my stay in the Falklands would be an interesting and enjoyable one. Mr Davies was responsible for my travel arrangements within the Islands, coping cheerfully and effectively with numerous last-minute programme changes necessitated by factors outwith his control.

I was impressed by the friendly and helpful nature of my reception wherever I went. Particular mention must be made of the managers and others who provided hospitality and valuable information on past planting efforts at the various settlements visited. Thanks are also due to the King family at the Upland Goose Hotel, who accepted with equanimity my somewhat erratic comings and goings; and to the staff at FIGAS who went out of their way to fit my air travel requirements into their busy schedules.

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APPENDIX 1

TREE AND TALL SHRUB SPECIES FOUND IN FALKLAND ISLANDS

The following table lists tree and tall shrub species found growing within the Falkland Islands in September 1983 together with notes on location, frequency and performance. The list cannot be regarded as exhaustive because a very few locations known to have tree growth could not be visited in the time available, nor was it possible to undertake a comprehensive inspection of all garden areas seen. However, it almost certainly includes all species of any real significance.

Botanical (and common) name	Notes
1. BROADLEAVED SPECIES	
Acer pseudoplatanus (sycamore)	Rare - 1 tree (height 5 m, dbh 15 cm) found at Hill cove in moist sheltered hollow. May also be in Stanley - see McAdam (1982).
Betula pubescens (birch)	Rare - bushy multistemmed trees at Teal Inlet (2) and Weddel Island (the latter with height 4 m) in garden areas.
Berberis buxifolia (calafate)	Relatively common in gardens - height to 2 m.
Chiliotrichum diffusum (fachine)	Native shrub growing to 2 m - locally common on moist sheltered sites.
Cordyline australis (cabbage palm)	Rare, but growing well in mild climate of Carcass Island - several specimen to 4 m; 1 small specimen at Chartres.
Crataegus monogyna (?) (hawthorn)	Occasional as shrubs and hedges to 3 m in gardens eg at Hill Cove, Roy Cove, Stanley. Some may be C. oxycantha?
Embothrium coccineum (Chilean fire bush)	Very rare - 1 specimen in a Stanley garden reported by McAdam (1982), but not confirmed.
Escallonia macrantha	Infrequent in garden areas, as at Hill Cove; height to 2 m.
Eucalyptus spp.	Rare - garden specimens found at Hill Cove, Roy Cove, Teal Inlet and Stanley; generally healthy and vigorous, with heights up to 5 m and dbh 18 cm (Hill Cove); position species identification not possible but E. gunnii and E. coccifera almost certainly present.
Fuchsia magellanica	Occasional - sheltered gardens in milder areas - height up to 3 m.

Hebe elliptica (native box)	Native shrub growing to 3 m in the wild, locally common on coastal sites in W. Falkland; widely and successfully used for shelter hedging around gardens.
Hebe speciosa (veronica)	Relatively common in gardens as shrub or hedging - height up to 3 m.
Ilex aquifolium (holly)	Rare; 1 specimen found in sheltered garden at Hill Cove, height 3 m.
Laburnum anagyroides (laburnum)	Rare; in sheltered gardens as at Roy Cove.
Nothofagus antarctica (nirre)	Seen only at Hill Cove - scattered, bushy, wind-swept, multistemmed tree on exposed site with heights to 5 m, probably planted in 1920s. Apparently grew well in Mt Usborne trial planted in 1977 by McAdam (1982) - up to 2 m in 4 years - but probably destroyed in 1982.
N. betuloides (coigue)	Seen only at Hill Cove - several large bushy trees of height 7-8 m, with massive multiple stems, and dating from 1890s growing in sheltered moist hollow; also some scattered bushy multi-stemmed specimens up to 5 m in height on nearby exposed site dating from 1920s. At Keppel Island (not visited) there are apparently sizeable specimens which may well have been planted prior to 1820 (Whitley - personal communication).
N. obliqua (roble)	McAdam (1982) reported 7-8 m specimen at Teal Inlet but this could not be found and cannot be confirmed.
Phormium tenax (New Zealand flax)	Rare, but growing vigorously to 1.5 m in Carcass Island garden sites; one good specimen seen in Hill Cove garden.
Populus alba (white poplar)	Common in garden and plantation areas - oldest trees probably date from late 19th century, generally healthy and vigorous, with suckering frequent; tree sizes up to 7 m x 39 cm dbh.
Ribes spp (flowering currant)	Relatively common in gardens with height to 3 m if some shelter available; mainly R. sanguineum but S. American R. valdivianum also present.
Salix spp	Relatively common in sheltered garden areas and in lee of larger trees; heights to 3-4 m; positive species identification difficult in absence of leaves, but S. viminalis, S. fragilis, S. alba and S. triandra probably present.
Sambucus nigra (elder)	Relatively common in gardens; generally windpruned if exposed; height to 2-3 m.

Sarothamnus scoparius (broom)	Rare in gardens, height to 2 m in shelter.
Sorbus aria/intermedia (whitebeam)	Infrequent in garden areas, usually in lee of larger trees; bushy form with height to 3-4 m if some shelter.
S. aucuparia (rowan)	As for S. aria/intermedia.
Ulex europaeus (gorse or whin)	Widely found in paddock hedges throughout islands: more or less naturalised; height up to 2-3 m.
2. CONIFEROUS SPECIES	
Araucaria araucana (monkey puzzle)	Very rare - one specimen in a Stanley garden, height 5 m.
Cupressocyparis leylandii (Leyland cypress)	Infrequent garden specimens - one with height of 4-5 m at Chartres.
Cupressus macrocarpa (Monterey cypress)	Very common - by far the commonest tree in the Islands - used widely for shelter planting and hedging around houses and gardens; very wind resistant, generally healthy and vigorous; heights to 8 m on exposed sites and 12 m with some shelter, dbh up to 70 cm; often multistemmed and bushy.
Picea glauca (white spruce)	Rare - two poor specimens about 2 m high seen on Weddell Island and another at Hill Cove.
Picea sitchensis (sitka spruce)	The second most common conifer in the Islands; forms outstanding plantation at Hill Cove and good healthy plot at Roy Cove; large trees at Stanley and Teal Inlet, but suffering from Elatobium; tallest tree 17 m (Hill Cove) at 58 years, heights in excess of 12 m are common and dbh up to 70 cm. Some doubts about identity - may have hybrid elements.
Pinus contorta (lodgepole pine)	Relatively common, mainly in shelter plantings over past 2-5 years, but also in gardens to some extent; health and vigour depends largely on provenance, with interior provenances obviously unsuitable; on exposed site at Hill Cove, Washington coast provenance has performed well - height 3 m in about 18 years.
P. mugo/uncinata (mountain pine)	Rare - found in a young shelterbelt at Hill Cove; healthy, good foliage retention, height to 2.5 m in about 18 years.
P. nigra var nigra) (Austrian pine) P. nigra var maritima) (Corsican pine)	Relatively common, both in older plantations and in gardens; often not easy to differentiate between the two species because of exposure effects; Austrian pine more common and with better foliage retention. Height up to 8 m and dbh to 40 cm; one large bushy healthy

	specimen at Government House thought to be about 90 years old.
P. radiata (Monterey pine)	Relatively common both in plantations and garden areas; more recent planting mainly in west of Islands eg at Carcass and Westpoint Islands, and Hill Cove; usually healthy, vigorous and well foliaged; good plot on Carcass Island site, with height of 9 m in about 24 years; two trees in the Hill Cove spruce plantation had heights of 8 m and dbh 60 cm, and two similar large bushy trees grow at Government House.
P. sylvestris (Scots pine)	Relatively common, both in plantations and garden areas; foliage retention often poor, older trees multistemmed and windswept unless sheltered; heights to 7-8 m and dbh to 35 cm.

AGR/3/1/1

38

DSR 11C

Mr King

A copy of Dr Low's report must be given to all members of Executive and Legislative Councils. You know to whom you gave copies on 15 December. Please ensure that those who did not receive a copy have one sent to them.

16 XII

Copies sent to all Councillors who did not get one at Exco, today. I have filed the copies which were attached to this minute.

21/12/83

(40)

REFERENCE AGR/31/3

CHIEF EXECUTIVE

V R WALDRON (FORESTRY)

Dr Low's report on his visit in September is on file.

As directed in his TORs he made "recommendations" for trial plantings for shelter belts and timber production (at a cost of $214,000 over the first five years).

However in discussion with me it was clear that he recognised and accepted that with lead times of 15 years to prove viability of shelter belts and 20-25 years for timber these proposals were most unlikely to be accorded any priority by FIG.

J Reid
DEVELOPMENT OFFICER

4 January 1984

AGR/31/3

(41)

10 January 84

V R Waldron Esq
Weather Vane
Wadenhoe
Peterborough PE8 5SX

Dear Mr Waldron

I was naturally very interested to read your letter of 28 December; unfortunately I have not had an opportunity of reading the article in the "Daily Telegraph" to which you refer.

At present the Falkland Islands Government is considering the most recent report on tree planting by Dr A J Low of the Forestry Commission and no decisions will be taken for a while yet.

As far as a development grant for afforestation is concerned, we have yet to formulate the rules for giving financial assistance out of the Development Corporation and that too will take some time to decide.

I hope that this does not all sound too cautious but my own feeling is that we have to decide our development priorities very carefully and slowly and get things right to avoid some of the mistakes of the past.

Yours sincerely

David Taylor
Chief Executive

eem

See letter from J McAdam at (4)

To save sheep and lambs from death by freezing winds, and aid Tourism (2)

AGR/3113.

Mr. [redacted] V. R. WALDRON
WEATHER VANE
WADENHOE
PETERBOROUGH PE8 5SX
TELEPHONE: CLOPTON 327

Mr David Taylor
Chief Executive Officer
Falkland Islands Development Fund
Port Stanley

December 28th 1983

Re: Planting Tree windbreaks / Forestry Research Nursery

Dear Sir

In answer to your provocative article by your Daily Telegraph correspondent Alan Copps of yesterday, my enthusiasm for helping the increased prosperity of the Falkland Islands is by no means fading, in fact it is bubbling over with words which must of necessity be transformed into works.

I believe that a "Forestry Research Nursery" should be established, to raise suitable trees for windbreak planting.

That the report of McAdam of Belfast University be implemented plus the modifications, if any, due to his present visit to the Islands.

That the Directors of J.L. Waldron Ltd of Port Howard West Falkland be asked to consider offering a site and the present manager there suggesting one easily workable establishment and economical maintenance, after survey of a site is completed.

Although I have not yet visited the Islands or Port Howard nor asked the Directors; I suggest a site near the Port Howard Racecourse might be surveyed in the first instance.

I have ample evidence to offer you of my sincerity, ancestry, likely cooperation from the farmers, and experience with Tree planting.

In the spirit of My great uncle James Fovergue Waldron, founder of Port Howard in 1867 and of my late cousin Maurice Cheyne Waldron a great friend of Falkland Islanders and chairman of Falkland Island Co, I ask for a grant from your Development Fund over five years.

Yours, as Consultant advisor,

Sincerely
Victor. R. Waldron

TREE PLANTING IN THE FALKLAND ISLANDS

by

Alan J Low

(Forestry Commission, Northern Research Station, Roslin, Midlothian.)

SUMMARY

The Falkland Islands experience a cool, windy and relatively dry climate. The soil is typically shallow peat over clay, although deeper peat is locally present, and the natural vegetation is grass - heath with no native trees or large shrubs. Climatic and soil conditions, lack of knowledge and inadequate protection have hampered past attempts to establish a wide variety of tree species. Successful results have been largely confined to favourable sites near houses and gardens. A very few sizeable tree plots exist, notably at Hill Cove, Roy Cove, Weddell Island and Carcass Island. Future tree planting prospects were appraised during a visit in 1983. The creation of effective shelterbelts appeared feasible, using modern establishment techniques developed in upland Britain, correct species choice, careful site selection, adequate belt width, protection against damage, good technical supervision and patience. The most promising species are Cupressus macrocarpa, Picea sitchensis (Queen Charlotte Islands origin), Pinus contorta (coastal origins only), Pinus radiata and Nothofagus betuloides. Using the same species, limited planting for wood production may also be possible on a very few sheltered, moist accessible sites. Small scale amenity and shelter planting for houses and gardens is clearly practicable. Imported planting stock will be necessary due to the impracticality of raising sizeable quantities in the Islands.

1. INTRODUCTION

The Falkland Islands lie in the south Atlantic ocean, just to the east of the southern tip of South America. They have an essentially cool, windy climate and basic soil fertility is low. There is a small permanent population of around 1800, with just over half living in the capital, Stanley (the only urban community) and the remainder distributed between farm settlements scattered around the coast. For many years the Island economy has been based on low-input sheep farming for wool production. Much of the land area is owned by farming companies; it is divided into some 50 farm units varying in size from 2000 to 160 000 ha and with an average stocking density of one sheep per ha. Most of the islanders' basic requirements have to be imported with the inevitable high freight charges adding substantially to costs.

Tree and large shrub species are absent from the natural vegetation and attempts in the past to establish tree growth have for various reasons met with very limited success. However, there has recently been considerable interest in the possibility of initiating a tree planting programme in the Islands aimed at creating agricultural shelter, producing wood and improving the amenity of settlement areas (see eg Shackleton, 1982; Stewart, 1982; and McAdam, 1982). In a report on the possible development of the Falklands (Shackleton, 1982) it was recommended that expert advice on tree planting should be obtained from the Forestry Commission. Partly as a result of this, the author spent three weeks on the Falkland Islands during September 1983 examining the results of the limited tree planting done in the past; considering the impact of climatic and other site limitations on tree growth; and trying to assess how far these limitations could be overcome by using modern forestry techniques developed for difficult, exposed upland sites in northern Britain. Thanks to the assistance of staff at the Falkland Islands Agricultural Research and Development Centre (FIARDC), and the availability of the government-operated internal air service it proved possible to inspect almost every location known to have significant tree growth. Visits were paid to many farm settlements both on the two main islands and on several of the smaller ones. In addition two lengthy overland journeys by Land-Rover provided valuable experience of the terrain at close quarters.

2. THE FALKLAND ISLANDS ENVIRONMENT

Environmental conditions in the Falkland Islands have been described previously in some detail by Skottsberg (1945), Pepper (1954), Moore (1968) and McAdam (1980a). The present brief review will concentrate primarily on environmental factors of relevance to tree growth and tree planting in the Islands.

Location

The Falkland Islands lie in the south Atlantic Ocean, between latitude 51° 00' and 52° 30' S, and longitude 57° 40' and 61° 30' W, some 500 km east of the entrance to the Magellan Straits. The archipelago consists of two large islands - East Falkland and West Falkland - and over 200 smaller islands of varying sizes, with a total land area of about 12,000 km^2 (see Figure 1).

Topography

Much of the land area is hilly, particularly in West Falkland and in the northern half of East Falkland. The principal mountain areas extend across the northern parts of the islands, rising to 705 m in East Falkland (Mt Usborne) and 701 m in West Falkland (Mt Adam). The southern part of East Falkland consists of the low-lying undulating plain of Lafonia. Most of the coastline is deeply indented with many long inlets and sounds. Small rivers, streams and shallow ponds are common.

Climate

The only location for which reliable long term climatic data exist is the town of Stanley near the eastern extremity of East Falkland. Limited information is available for a few of the farm settlements.

Because of their situation, the Islands generally experience a cool temperate oceanic climate characterised by a narrow mean temperature range, relatively low rainfall and high average windspeed. The winters are mild and the summers cool, with mean monthly temperatures in Stanley of 2.2°C and 8.8°C for July and January respectively. Air temperature rarely rises above 20°C or falls below -6°C, and ground frost can occur in any month. There is some evidence that both summer and winter temperatures are appreciably higher in the western part of the island group.

Annual rainfall is far from uniform throughout the islands and at sea level is thought to range from about 300 mm to over 650 mm. For Stanley, which lies in one of the wetter areas, the mean annual rainfall is 640 mm. The drier locations generally lie in the southern parts of the archipelago while those with higer rainfall are usually situated to the north and east of higher ground. Monthly figures are lower in the spring months of September, October and November, and at Stanley a soil water deficit may occur from October to March. During the winter months, snowfall is seldom heavy and normally does not lie for long.

The most notable feature of the climate is its windiness. There is a high frequency of strong winds, although the proportion of gales is low. At Stanley, the average wind speed is 8.5 m s^{-1} or 17 knots, and about 50 per cent of the winds are between south west and north west. Although seasonal variation is not great, wind speeds tend to be higher in October and November (spring), at a time when air humidity is below average, leading to increased desiccating potential.

McAdam (1980) investigated the use of tatter flags as a means of assessing "exposure" in the Falklands. For sites at Stanley, Goose Green and Salvador (all in East Falkland) the average tatter rate was 9.8 cm^2 day^{-1}; and tatter was more rapid in summer than in winter. Similar (and in some cases even higher) tatter rates have been recorded for experimental plantation areas on very exposed sites near the north and west coasts of Scotland, and on islands in Shetland, Orkney and the Hebrides (Forestry Commission data). However, McAdam rightly advises caution in making direct comparison because of apparent differences in the climatic factors contributing to flag tatter in the Falklands and in the British Isles.

Soil

Throughout much of the island area, and particularly at lower elevations, the soil consists of a relatively shallow layer (25-35 cm) of dark brown fibrous peat overlying a compacted clay subsoil. The transition from peat to clay is often abrupt and there may be some iron deposition between the two. The clay may be sandy or silty, depending on the underlying geology, and may include a shallow (5-10 cm) upper zone containing some incorporated organic matter or with ochreous staining. There is usually dense root development throughout the peat layer, but rooting seldom penetrates more than a few centimetres

into the compacted clay. In the north and north east of East Falkland (and particularly in the Stanley vicinity) there are sizeable areas where the peat layer is much deeper than elsewhere, with depths of 1 m or more.

Not surprisingly the soils are acid, with pH typically 4.0 to 5.0. From an agricultural viewpoint they are regarded as being of low fertility. Phosphorus (P) levels are generally very low, although potassium (K) and magnesium (Mg) levels are considered adequate (Ferguson, 1980). Unexpectedly, only limited growth response has followed application of P fertiliser in recent FIARDC grass reseeding trials.

Vegetation

The natural vegetation communities have been described by Skottsberg (1945), Moore (1968), Davies et al (1971) and McAdam (1980b).

Most of the land area is covered by communities classed as "oceanic heath". By far the most extensive communities are those dominated by Cortaderia pilosa (d'Urv.) Hack. (whitegrass) and covering very large areas of the more gentle slopes and of undulating or level ground (such as Lafonia). Empetrum rubrum Vahl ex Willd. (diddle-dee) is normally the dominant species in the dwarf shrub association which is the only other really extensive community, and which occurs on drier slopes and shallower peat than the whitegrass.

The treeless nature of the Falkland Islands vegetation has been emphasised in most scientific reports over the years (eg Dallimore 1919, Skottsberg 1945, Moore 1968 and McAdam 1982). The only native woody species capable of growing to a height of 1 m or more are the shrubs Chiliotrichum diffusum (Forst. f.) Dusen or (fachine) and Hebe elliptica (Forst. f.) Pennell or (native box) (see Moore 1968). The former is a relatively insignificant bush found in sheltered moist valley locations; the latter is restricted in the wild to coastal locations in West Falkland but is widely used as a garden hedging plant throughout the Islands. In addition to these two native species, the European shrub Ulex europaeus L. (gorse) has become more or less naturalised in various locations having been widely planted in the form of hedges round paddocks adjacent to settlements. It is considered to have been introduced to the Islands in 1848 (Dallimore, 1919).

3. BRIEF HISTORY OF ATTEMPTS TO INTRODUCE TREES

From the early days of settlement, the absence of indigenous trees and a desire to create shelter resulted in various attempts to introduce a wide range of tree species either from South America or from Europe. Dallimore (1919) describes these attempts and their outcome in the following words:-

> "From the time when the earliest emigrants entered the country the absence of trees appears to have made the greatest impression upon newcomers, and from the middle of last century successive Governors and a few of the more progessive settlers have considered the possibility of establishing trees either for ornament or profit. Planting schemes, usually of a half-hearted character, have been suggested from time to time, but whether from apathy, lack of general sympathy or the disinclination to risk money on a project that could only be considered in the light of an experiment, they have not materialised and the introduction of young trees or tree seeds has not gone beyond the individual efforts of a few settlers and a few attempts by government officials to procure trees and shrubs for the garden at Government House. Unfortunately in the few efforts that have been made the persons interested have not possessed sufficient technical knowledge to enable them to give the young trees the special attention necessary to enable them to overcome the unfavourable conditions which prevail, neither have they made proper reports upon the behaviour of the various species tried ..."

The remarkable extent to which Dallimore's words sum up the present situation will become apparent later in this paper.

Probably in the early 1890s, Mr Robert Blake began what Dallimore (writing in 1919) regarded as "the most determined attempt that has yet been undertaken to establish a plantation of trees" at Hill Cove in West Falkland. This included some Nothofagus plants (probably N. betuloides Mirb. imported from Tierra del Fuego), Austrian pine (Pinus nigra var. nigra Harrison) imported from Britain, Austrian pine and Scots pine (P. silvestris L.) raised locally from seed and a poplar (probably Populus alba L.) raised from cuttings obtained from a tree in Government House gardens. Mr Blake appears to have been well aware of the need for sensible site selection, good ground preparation, provision of early shelter (by using gorse hedges) and protection from browsing mammals. What is almost certainly the result of his efforts remains today as an

irregularly-shaped mixed woodland area in a hollow beside the Hill Cove settlement manager's house. Very useful photographs of this area, probably taken in 1925, appear in the 1927 Kew Bulletin (Anon, 1927).

In 1919, staff at Kew Gardens were asked to provide advice on tree planting in the Falklands, and this request resulted in Dallimore's 1919 paper. He gave detailed guidance on how best to establish trial plantations and many of his far-sighted prescriptions remain valid today. An important result of Dallimore's recommendations was the appointment of Mr James Reid, who had trained in forestry at the Royal Botanic Garden in Edinburgh, to the post of Forest Officer in the Falkland Islands (see Dallimore, 1920) - a post which he held from 1920 to 1925.

In 1920, Reid took with him from Britain seedlings and transplants of various temperate coniferous and broadleaved tree species, including pines, spruces, alders, birch, sycamore and elm, as well as cuttings of numerous poplar and willow species (Dallimore, 1920). Seedlots of many coniferous and broadleaved species were also sent out in 1919-21. A description of Reid's activities and early results obtained is given in the 1927 Kew Bulletin (Anon, 1927). He established a small nursery in the gardens of Government House in Stanley and succeeded in raising substantial numbers of trees from seed (particularly Scots pine and Sitka spruce (Picea sitchensis (Bong.) Carr.). In general, the planting stock brought out from Britain did not do well. His initial planting trials were made on the south side of Mt Low, near Sparrow Cove in East Falkland. The results obtained were so poor that further attempts at afforestation there were abandoned. Reid then concentrated his activities at Hill Cove where a 10 acre paddock near the settlement had been made available by Mr Blake for trial work. It is reported that "... in the autumn of 1925 ground was prepared for planting. Ditches were cut at 15 yard intervals and led into a natural stream which flows through the middle of the paddock. Holes were prepared 3 feet apart, turf being removed and the soil and clay broken up to a depth of 14 inches. In several cases the moor pan was found to be only some four inches below the ground surface and this necessitated breaking up with crowbars and pickaxes. Six acres so prepared have already been planted out with 30,000 conifers of which the Scots pine and Sitka spruce give promising results. All the trees planted were raised at Port Stanley except 1,000 Scots pine which were raised at Hill Cove, West Falklands. The nursery at Government House, Port Stanley, has been stocked with 40,000 seedlings, part of which it is proposed to plant out at Hill Cove next spring and the remainder in the following year". Also

of interest is the fact that in 1923, Reid apparently obtained plants of Nothofagus antarctica (Forst.) Oerst and N. obliqua (Mirb.) Blume from Punta Arenas in Chile. There is unfortunately no indication of where these were planted, but the likelihood is that some at least went to Hill Cove.

After 1925, intermittent tree planting attempts continued but it is difficult to obtain a clear picture of what occurred because of lack of records covering the next 30 years or so. It is likely that the first introduction of Monterey cypress (Cupressus macrocarpa Gord.) to the Islands occurred in the late 1920s at Weddell Island. It is unfortunate that the source of plants used cannot be identified because most if not all of the Monterey cypress trees and hedges established throughout the Islands seem to have originated as seeds or cuttings taken from the initial plot beside the Weddell manager's house. There is also no clear indication of when Monterey pine (Pinus radiata D. Don) was first planted. A plot on Carcass Island dates from the late 1940s, but two large specimen trees at Government House in Stanley were thought by the present gardener to have been planted in the 1920s.

In 1957-58 the Falkland Islands Company (FIC) imported from Britain several thousand transplants of various coniferous species which were used to create small plantations at Fitzroy and Goose Green. Planting was done in fenced enclosures on spaced-furrow Cuthbertson ploughing. Mishandling of the plants during transit and particularly at time of planting led to failure at Fitzroy (see Clement, 1967). At Goose Green results were only marginally better due to failure to maintain exclusion of stock from the plots.

Finally, McAdam (1982) records three further recent attempts to extend tree planting. He raised from seed a wide range of temperate tree and shrub species and in 1977 distributed the young plants to various settlements. He also produced an advisory leaflet on tree planting in the Islands (McAdam, 1977). In the same year, he imported Nothofagus antarctica transplants from Esquel in Argentina and planted them at four sites on the southern slopes of Mt Usborne. Initial growth of the Nothofagus was encouraging, but the trees are thought to have been destroyed by browsing in 1982. Also in 1977, the Sheep Owners' Association purchased a quantity of Lodgepole pine (Pinus contorta Douglas ex Loud.) seed from the Forestry Commission. This seed, of Washington coast origin, was distributed to interested association members, some of whom have since raised and planted out young trees (eg at Teal Inlet).

4. PRESENT LOCATION AND NATURE OF TREE GROWTH

From the preceding review it will be apparent that efforts over the years to establish trees in the Falklands have been limited in scope and that failures have been common. Successful planting has been confined very largely to the vicinity of farm settlement areas and to the town of Stanley. There have been very few attempts to establish trees on sites in the "camp" (ie land outwith the vicinity of settlements), and even fewer successes. In consequence, the present day landscape remains essentially treeless throughout the Islands, except in the vicinity of habitation.

A list of the tree and major shrub species found growing in the Falklands at present is given in Appendix 1, which also provides brief notes on frequency of occurrence and performance. This list cannot be regarded as exhaustive, because time did not permit a detailed examination of all garden areas, but it almost certainly includes all species of any real significance.

Stanley

In Stanley, sizeable trees, shrubs and hedges are conspicuous features of gardens throughout the town area. Most gardens have substantial evergreen hedges reinforcing the shelter effect of slatted wooden perimeter fencing and there are numerous individual trees and shrubs. By far the most common tree species present is Monterey cypress (Cupressus macrocarpa), both as individual specimens and as hedging. Lodgepole and Austrian pines are also fairly common; many other tree and shrub species are present in small numbers, including Sitka spruce, Pinus radiata, various willows (Salix spp), elder (Sambucus nigra L.), Berberis spp, Ribes spp and Hebe spp. The native Hebe elliptica is frequently used as hedging. Tree heights up to 6 m are common, tending to be taller in the lee of buildings. Crowns frequently show conspicuous signs of wind pruning on their west sides, but for most part are well-foliaged and appear healthy.

Farm Settlements

Very few farm settlements do not posses at least some trees or shrubs (albeit often very windswept if few in number) in the vicinity of houses and gardens (Plate 1). Usually the manager's house at least will have some adjacent tree growth and evergreen hedges to improve garden shelter. Frequently very sheltered

garden areas have been created by the establishment of large hedges or shelter strips of trees several metres in height. Wooden shelter fences or gorse hedges have often been used in the past to help establish tree growth for shelter purposes. As in Stanley, Monterey cypress is by far the most common tree species found, but various pines, Sitka spruce and White poplar have also been used to some extent for shelter planting. Where some degree of shelter (whether artificial or natural) has been available a wide range of other, and particularly broadleaved, tree and shrub species may be found, with willows, Sorbus spp and Ribes spp the most common. A high concentration of birdlife was a very noticeable feature associated with the presence of tree and shrub growth.

Most settlement planting over the years has been intended to provide shelter and amenity for gardens and houses, and in consequence has usually been very limited in extent. Only at a very few locations has tree planting been on a sufficient scale, and survival and growth been sufficiently good, to have led to the development of anything approaching woodland conditions. These important "woodland" sites are at Hill Cove (Plate 2) and Roy Cove (Plate 1a) in West Falkland, Teal Inlet and Stanley in East Falkland, and on Weddell (Plate 1b), Westpoint and Carcass Islands. Evidence from these locations is of particular value in assessing the potential for future tree planting in the Islands and each is described separately below. Particularly during the past 30 years, there have been some attempts to establish belts or blocks of trees aimed at providing shelter in stockholding paddocks near settlements eg at Fitzroy, Goose Green and Hill Cove. Most have failed, and at best the results have been less than satisfactory, for reasons such as faulty plant handling prior to planting, incorrect species choice and inadequate protection against browsing damage.

Hill Cove

At Hill Cove, on the north coast of West Falkland, the main plantation (Plate 2) lies 200 m north west of the settlement manager's house. It is easily the most impressive area of trees growing in the Falklands today, and is of particular importance in providing the only example of anything approaching large-scale forestry planting in the Islands. Fortunately it is also one of the very few locations for which the early history is reasonably well documented (see Anon, 1927) although information on later stages of growth is sketchy.

The total area involved is just over 1 ha and takes the form of a narrow elongated

triangle some 260 m in length, with its long axis aligned slightly west of north. The maximum width from east to west is about 75 m. The site lies 8-20 m above sea level and is exposed to the west and north although sheltered from the south by substantially higher ground.

The tree crop consists of pure spruce (nominally Sitka spruce (Picea sitchensis) but see below) growing at approximately 1 m spacing in rows 3.0-3.5 m apart. The general vigour and health of the trees was very impressive, with most having prominent erect leaders and excellent foliage retention. On the exposed western edge the crowns of the outer row of trees had been damaged by wind above the level of a 2 m high gorse hedge. However, growth and foliage retention appeared to be relatively normal 2-3 rows inside the plantation. Apart from the outer 1-2 rows, the trees had been completely brashed, revealing very uniform stocking, more or less complete canopy closure and no sign of dead or windblow trees or of trees removed. Growth appeared to have been consistently more vigorous in a 40 m wide strip at the southern end of the plantation, and a 0.03 ha temporary sample plot (20 m x 15 m) was laid out within this area. Measurement of all trees in the plot indicated a mean diameter at breast height (dbh) of 21 cm, a basal area of 109 m^2/ha and a stocking density of 3100 trees/ha. The largest tree in the plot had a dbh of 37 cm, but on the plantation edges tree diameters in excess of 60 cm were found. Hypsometer measurement of tree heights proved possible only at the plantation edges and even there problems were created by the long branches extending to ground level. The tallest tree found, which had a height of 17 m, was on the eastern edge in a slight hollow (NB: McAdam (1982) reported a maximum height of 18.9 m in August 1982 (ie 1 year earlier, but this was almost certainly an over-estimate). More typical trees on the south-east edge outwith the hollow had an average height of 15.5 m, and visual examination from a distance suggested that this was probably a reasonable approximation of mean height in the vicinity of the sample plot.

Under the trees there was often substantial needle litter accumulation (5 cm or more) overlying a very tough compacted peat layer in which most of the tree roots were found. Below this was a further 25 cm of dry crumbly peat, with appreciable mineral content, which in turn overlay undisturbed compact clay. There seemed to be very little root development at any depth below the superficial layer.

Many trees were coning heavily and had obviously done so in past years, judging from the cone accumulation on the ground surface. A few naturally regenerated

seedlings were found on the plantation edge. The production of viable seed and natural regeneration has been noted previously by McAdam (1982).

There is no doubt that the spruce plantation forms part of the area reported (Anon, 1927) as having been planted by Reid in 1925. The absence of any Scots pine in the crop is surprising, but it seems very probable that the very wide spacing between the spruce rows has resulted from the complete disappearance of two rows of Scots pine originally planted between successive spruce rows. The pine may have died out or been eaten during a period when the plantation reputedly went into check and grazing animals were allowed into the area (see Stewart, 1982). Hearsay evidence suggests that there was a marked improvement in growth of the spruce sometime after 1950, and that this coincided with the initial appearance of numerous fungal fruiting bodies in the vicinity. Dimitri (1975) suggested that the growth improvement was due either to the trees having become infected with suitable mycorrhizal fungi; or that the roots had passed through a hard layer or subsoil, thus improving their nutritional status. The first suggestion seems much the more probable of the two, and there is no doubt that the tree roots are currently mycorrhizal. Root samples examined in Britain by a Forestry Commission specialist were found to have well developed mycorrhizae involving several different fungal species.

The planting stock used at Hill Cove in 1925 was raised at Stanley using seed sent out from Kew Gardens and described as Picea sitchensis (Sitka spruce). Doubts about the identity were first raised in 1977 (McAdam, 1982) when it was noticed that many trees showed characteristics more akin to those of Picea jezoensis (Sieb. & Zucc.) Carr. The present visit confirmed that on the basis of foliage and bud characteristics the plantation included many trees of both P. sitchensis and P. jezoensis types as well as intermediates between them. There were also occasional trees showing some affinity with other spruces such as P. smithiana. A possible explanation is that the seedlot was collected from Sitka spruce trees which had been exposed to pollen from specimens of other spruce species growing in the vicinity. Unfortunately, Kew Gardens staff have been unable to locate any information on the origin of the seed.

There is a second and very different wooded area worthy of note at Hill Cove, extending along a sheltered hollow below and immediately to the west of the manager's house (see Plate 2b). It is irregular in outline, occupying a total area of some 0.5 ha and contains a variety of broadleaved and coniferous species. It is of particular interest as it is almost certainly the area planted by

Mr Robert Blake prior to 1898, when he left the Falklands, and therefore contains some of the oldest trees growing in the Islands. The most striking feature was the presence of several large specimens of the evergreen Nothofagus betuloides; presumably grown from some of the young trees imported from Tierra del Fuego. They had very wide-spreading, wind-deformed but otherwise reasonably healthy crowns, and heights of 7-8 m. Each tree had several stems, usually in the range of 30-50 cm dbh. Some of these trees feature in the photographs illustrating the 1927 Kew Bulletin article (Anon, 1927), although identified in the captions as N. antarctica, and were obviously sizeable trees at that time. The other important broadleaved species present was White poplar (Populus alba), forming a substantial pure grove in the northern part of the area. Many of the trees had probably originated as root suckers, and sizes varied widely with heights ranging up to 7 m and dbh up to 39 cm. There were also scattered specimens of Scots pine and (probably) Corsican pine (P. nigra var maritima (Ait.) Melville). Both species, but particularly the Scots pine, showed declining vigour and poor foliage retention; heights were 7-8 cm and dbh ranged from 27 to 35 cm.

Roy Cove

A small but interesting plot of conifers was found at Roy Cove, some 12 miles west south west of Hill Cove and on the west coast of West Falkland. The trees occupy an area of about 0.15 ha in a small sheltered moist valley immediately to the south east of the former settlement manager's house (Plate 1a). McAdam (1982) reported the main species as being Scots pine, but in fact the major part of the plot consisted of about 100 spruces and a few Monterey cypresses with only a scattering of dead or dying Scots pine. The general appearance of the spruces was similar to those at Hill Cove, as was the degree of variability in needle and bud characteristics. In view of the proximity of the two settlements it seems very probable that planting was done in or about 1925 using planting stock obtained from Hill Cove. Spacing between and within rows of trees was about 3 m, and it is possible that there had originally been intervening rows of another species (Scots pine?) which had died out. Height of the spruce ranged from 4 m at the exposed western side on the valley edge to 15 m in the valley bottom. Apart from the wind-damaged trees on the western edge, crowns appeared healthy and well foliaged, with frequent vigorous leaders.

Teal Inlet

At Teal Inlet, in the north of East Falkland, the main area of trees occupies

an irregular area of about 0.1 ha in a shallow undulating sheltered hollow near the manager's house and adjacent to the garden area. It included several sizeable Sitka (?) spruces and substantial numbers of Monterey cypress and White poplar, with the latter suckering freely. The spruces ranged in height from 8 to 11 m and in dbh from 37 to 56 cm; although single stemmed, their crowns showed "flagging" due to wind exposure, and foliage retention was poor due to a combination of wind and (probably) attack by the green spruce aphid Elatobium abietum Walker. The cypresses were from 4 to 6 m in height and dbh up to 40 cm; they were bushy and multi-stemmed with good foliage retention despite some signs of wind pruning. Mainly growing in the shelter of the other trees, the poplar had heights of 5-6 m and diameters up to 35 cm. Planting was thought by the manager to have been done at least 40 years and possibly 50-60 years previously. It seems possible, in fact, that the spruces were planted in the mid 1920s and the poplars might date from the same period. The cypresses are unlikely to have been planted until the late 1930s at the earliest, in view of the probable timing of the initial introduction of this species at Weddell Island.

In a field to the west of the manager's house there was a further small plot of trees occupying a square area of about 0.05 ha. The species composition was similar to that in the larger area, and sizes were similar. The few spruces were completely emergent from the general canopy level, and had very thin crowns - again probably due as much to past Elatobium attack as to exposure. Tree spacing was approximately 3 m in each direction, suggesting, as elsewhere, that there may originally have been intervening rows of trees at time of planting some 40 or more years previously.

Stanley - "Government Forest"

The so-called "Government Forest" on the hillside behind Government House in Stanley consists of two parallel strips of trees (approximately 40 m x 10 m and 60 m x 20 m respectively) about 100 m apart and aligned on a north-south access at right angles to the contours. They were planted with Monterey cypress in 1945, and it was apparently intended to plant up the intervening area with a variety of other tree species once the cypress strips had provided shelter. The windward edge trees in both strips showed marked wind pruning, but the remaining trees appeared healthy with good foliage retention. Tree size was very variable and form poor, particularly in the east strip. Heights ranged from 4 to 8 m, with the poorest growth at the upper ends of the strips where

the soil became very shallow. Dbh ranged from 6 to 40 cm and there were many multi-stemmed trees. A trench found in the centre of the west strip showed that some sizeable tree roots had penetrated 20-30 cm vertically down cracks in the clay subsoil.

Weddell Island

On Weddell Island, lying to the west of West Falkland, planting has been done almost exclusively with Monterey cypress. The trees, which occupy a total area of about 0.15 ha, grow mainly in a relatively sheltered hollow to the east of the manager's house. The initial planting, thought to have been done about 55 years ago, was in the form of a more or less square plot at 2-3 m spacing on a slope immediately below the house (Plate 1b). Heights ranged from 5 m in the most exposed part beside the house to 12 m lower down the slope, and dbh ranged from 32 to 74 cm. The tops of the trees followed a very obvious wind-cut profile eastward from the house, and crowns were tending to become thinly foliaged. Some trees were coning heavily.

Below these older trees, there had been further planting approximately 40 years ago - mainly in the form of shelter strips around a garden area. These younger trees, often multi-stemmed, had heights of 6-12 m, and dbh up to 72 cm. Apart from some wind pruning on their upper crowns, they appeared very healthy. Many were coning freely.

It is accepted locally that the older cypresses at Weddell represent the initial introduction of Cupressus macrocarpa to the Falklands. They apparently began to produce viable seed at an early stage and have long served as a seed source for the raising of planting stock elsewhere. It seems very probable that most if not all of the Monterey cypress (commonly referred to as "macrocarpa"), which is found extensively in garden areas throughout the Falklands, will have originated from this one introduction.

Westpoint Island

There are two small patches of trees, each 0.05-0.1 ha in area, on Westpoint Island, which lies off the north west tip of West Falkland. They are situated on a east facing slope about 800 m south of the settlement, and each consisted primarily of Monterey pine (P. radiata), with some Monterey cypress. Apparently they are the remnants of a much larger area planted mainly with Monterey pine

about 1950, and which suffered very heavy losses due to desiccating winds within 6 months of planting. In general, the survivors appeared healthy, with good foliage retention, but were heavily branched and multi-stemmed. Heights were variable, ranging up to 5 m. Some Scots pine had been planted more recently (probably about 10 years ago) and had achieved heights up to 2 m, but many trees had poor foliage retention.

Carcass Island

On Carcass Island, which is also adjacent to the north west tip of West Falkland, there is a relatively substantial plot of Monterey pine, planted about 1949. It occupies a more or less rectangular area 75 x 50 m (approximately 0.35 ha) in a relatively sheltered valley site 40 to 60 m above sea level on the south side of the island. Growth had generally been vigorous, giving current heights of around 9 m and dbh of 20-26 cm, but many trees were multi-stemmed, and branching was heavy. Foliage retention was good, except at the western corner and at the tips of some of the tallest trees where wind-damage was apparent. Planting appeared to have been at about 2 m x 2 m, but there were some irregularities suggesting limited early failures.

5. REASONS FOR TREE PLANTING SUCCESSES AND FAILURES

Assessing the specific reasons for the success or failure of many tree planting attempts in the Falklands is 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 could seldom be obtained. Even for the outstanding Hill Cove spruce plantation there are many gaps in the available information. In this respect, the present situation differs very little from that described by Dallimore in 1919. However, from observations made on site, combined with such limited information as could be obtained from the literature and from local sources, it has been possible to deduce what have in general 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 the results achieved were due to a combination of these factors; and it was possible for favourable factors to outweigh unfavourable ones, or vice versa.

Beneficial Factors

1. Selection of a moisture-receiving site with natural topographic shelter and above-average nutritional status. (Usually achieved by planting in a sheltered hollow or small valley in the vicinity of 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 or creating gorse hedges.)

3. Careful protection by fencing against browsing by domestic stock or by hares (where present).

4. Planting of trees in sizeable plots or belts to obtain the benefit of mutual shelter development and canopy closure.

5. Intensive ground preparation prior to planting. (Many of the older sites used had a probable history of previous agricultural or garden cultivation; pit planting with prior preparation and loosening of soil to some depth was also 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 temperature is probably still sufficiently high to permit some root growth of conifers.)

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

Adverse Factors

1. Incorrect plant handling during transit and at the planting site. (Has included lengthy storage in unsuitable conditions or containers, and excessive exposure of roots during the planting operation.)

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

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

4. Poor choice of planting site. (Wind exposure excessive or soil moisture status inadequate.)

5. Use of excessively large planting stock with poor root/shoot ratio. (Liable to lead to heavy lossses in a windy climate with low rainfall.)

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 - failure is very probable, and at best establishment and subsequent growth will be slow).

6. PROSPECTS AND PROVISIONAL PRESCRIPTIONS FOR TREE PLANTING IN THE FALKLANDS

There is very limited direct evidence from which to assess prospects for future tree planting in the Falklands, whether for agricultural shelter or for wood production. As indicated earlier, tree planting efforts over the years have been very restricted in scope, with successful results confined almost entirely to relatively favourable sites in the vicinity of farm settlements and Stanley. Few of the locations involved have had site conditions even approximating to those typical of open "camp". Furthermore there is little to suggest directly how far the use of currently accepted forest establishment techniques might have affected results. It is therefore necessary to rely substantially on extrapolation from afforestation experience elsewhere, and particularly in upland Britain.

Any attempt to appraise tree growth potential in the Islands is inevitably dominated by consideration of the effects of the three major environmental factors wind, rainfall and soil. In relation to tree growth, the windiness of the Falklands climate imposes severe limitations, and its effects are exacerbated by the low rainfall and nature of the soil (shallow peat over clay) covering much of the land area. Together, these factors almost certainly rule out the possibility that afforestation on any substantial scale will ever be a practical proposition in the Islands (even assuming that large areas of land could be made available for the purpose). Nevertheless, there are some grounds for concluding that the use of modern establishment techniques (as pioneered by the Forestry Commission in exposed Scottish locations), combined with selection of appropriate tree species and origins, would make it possible to create effective shelterbelts, and even to produce wood on a limited scale on selected sites.

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 in site preparation, rigorous protection against browsing damage, and patience.

In general, satisfactory results are much more likely if shelterbelts are aimed at supplementing some existing, even if limited, topographic shelter, rather than at attempting to create shelter from scratch in the most exposed and wind-

swept grazing areas. 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. At least partial recognition of this point in the past is evidenced by the gorse hedges or shelter fencing associated with some previous attempts at shelter planting. Although expensive, the addition of "Netlon" shelter netting or "Paraweb" screening to the windward fenceline of any new belt would almost certainly improve survival and early growth. High elevation and very dry sites should obviously be avoided, and success seems more likely where the peat layer is of greater than average depth.

The actual siting of belts within a farm must obviously depend markedly on the manager's preferences and method of stock management, as well as on local conditions. From discussion with various managers it was not possible to obtain a clear picture as to where the creation of shelter (if technically feasible) would be of greatest benefit. Three possible locations which emerged were paddocks used for lambing stud ewes, areas for holding sheep immediately after shearing, and reseeded areas. The fact that the predominant wind direction is westerly suggests strongly that a north-south orientation would normally be of most benefit. However, on some farms, the periodic occurrence of very cold south or south-easterly winds at time of shearing or lambing might make it necessary to consider east-west orientation.

Scottish experience indicates that on very windy sites belts should contain at least 10 rows of trees, and that 15 or 20 rows are desirable. This makes possible the development of mutual shelter within the belt, leading to improved growth and shortening of the interval until the belt begins to provide some effective shelter to leeward. The windward 2-4 rows of trees can be expected to suffer crown damage but behind them relatively normal growth is likely. The spacing between rows and between trees should be 1.5-1.8 m. Published work on shelterbelts (see Caborn, 1965) indicates that a minimum length of 200 m is desirable in order to ensure that, in the longer term, some shelter is produced over a substantial area of ground. In view of the very extensive nature of sheep management in the Falklands, it may well be necessary to consider greater lengths.

The number of tree species currently found growing in the Falklands is considerable (see Appendix 1) but only a very few of these show any real potential for use in shelterbelt planting on "camp" sites. Examination of the literature suggests

that there are few other temperate species with shelter planting potential which might be tried. On present evidence there are five main species which can be considered for shelterbelt use - the conifers Cupressus macrocarpa (Monterey cypress); Picea sitchensis (Sitka spruce) of Queen Charlotte Islands (British Columbia) origin; Pinus contorta (Lodgepole pine) of North American coastal origin and Pinus radiata (Monterey pine); and the evergreen broadleaved species Nothofagus betuloides from southern South America. Three other species which might also be tried are X Cupressocyparis leylandii (Leyland cypress, which has Monterey cypress as one parent), Pinus muricata D. Don (Bishop pine) and Pinus nigra var nigra (Austrian pine). Various other trees and large shrubs known to be wind resistant have been excluded for reasons such as slow growth, unsuitability for the soil type or their being deciduous.

All other things being equal, Sitka spruce could be expected to play a major role in any shelter planting in the Falklands. It has grown well at Hill Cove, and the Queen Charlotte Islands origin has performed particularly well in very exposed Scottish plantations. Unfortunately, a cautionary note is necessary because of the apparent presence at Teal Inlet and Stanley of the green spruce aphid (Elatobium abietinum). The mild Falkland winters might favour the build up of aphid populations (see Carter, 1972) which could lead to serious defoliation of future spruce plantings in East Falkland at least.

The windward edge of a belt should consist of at least four rows of Lodgepole pine originating from the north coast of British Columbia, from the Queen Charlotte Islands or from Alaska. Although relatively slow-growing, these origins are very wind-resistant and remain well foliaged to ground level in exposed conditions. Subsequent rows can consist of the other species listed above, or Lodgepole pine of coastal Washington or Oregon origins; all are likely in the long term to grow taller than the north coastal and island origins of Lodgepole pine.

Prior to planting, sites should be ploughed in late summer (February/March) parallel to the long axis of the belt, using a modern forestry plough designed to loosen the soil to considerable depth as well as to produce turf ridges at appropriate spacing for planting. Suitable models are the trailed versions of the double throw Clark D45/T60 and single throw Clark S45/T60 ploughs (see Thompson, 1978) drawn by a low ground pressure tracked tractor of 80-100 hp (60-75 kW). The wider "platform" between furrows produced by the D45/T60 plough might lead to greater long term windfirmness. On the other hand, the greater disruption of the clay layer resulting from the much greater frequency of S45/T60

tine channels for the same number of turf ridges could increase soil moisture--holding capacity and promote deeper root development. (The size of belt envisaged makes hand methods of ground preparation impractical, but for small-scale use turfs 45 cm square and 15–20 cm deep could be cut by hand, spread and inverted to provide planting positions. Small scale pit planting might also be feasible particularly if a powered large-diameter post hold borer was available to assist in preparing holes which were then backfilled firmly with mixed spoil.)

Planting should be done in late autumn or early winter (when soil moisture levels are likely to be more favourable than in spring), notching the young trees into the sides of the turf ridges, preferably on the east (leeward) side. As far as possible, tree roots should be in or near the vegetation "sandwich layer" beneath the upturned ridge. Planting stock should be healthy, sturdy transplants 20-30 cm in height with compact fibrous root systems. Exposure of the roots to desiccation by wind and sun must be avoided at all times during transport to the site and during the planting operation. As far as possible any substantial losses occurring in the first 1-2 years after planting should be replaced using similar plants. Preferably just before planting is done, phosphatic fertiliser should be broadcast over the area at a rate providing 50 kg P per ha.

Grazing animals must be completely excluded by appropriate fencing which must be maintained indefinitely if effective shelter to ground level is to be retained during the life of the belt. 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 (probably 5 years after planting). A belt must also be protected against damage by fire.

It is important to emphasise that shelterbelts take time to become effective and that the more difficult the basic environment for tree growth, the longer this time becomes. Even if the prescriptions given are applied correctly, significant shelter benefits are unlikely to be obtained earlier than about 15 years from time of planting. Thereafter, if healthy growth continues, the area of effective shelter can be expected to increase substantially over the years as the height of the belt increases.

Planting for Wood Production

The prospects for wood production on any substantial scale in the Islands, whether for use as timber or fuel, must be rated as low. Even with modern forestry

techniques, the environmental conditions will almost inevitably result in a prolonged establishment period and relatively slow subsequent growth. Stem form is likely to be affected adversely by climatic damage to leaders and crowns, and this in time will restrict the potential end uses of any timber produced. On present evidence, there are no suitable tree species available for the development of a short-rotation fuelwood production system of the type used successfuly in many countries with more favourable environments.

The suggestion has been made in the past that shelterbelt planting, if sufficiently wide, might perform the dual role of creating shelter and producing wood (from thinnings). In the Falklands situation, any such approach should be avoided. It would be only too easy for a shelterbelts's effectiveness to be impaired as a consequence of injudicious thinning.

Some opportunity exists for mitigating the adverse effects of the environment by the selection of planting sites which provide topographic shelter and above-average moisture status. Provided such sites can be made available, then the creation of plantations for wood production becomes a practical possibility, although only on a very modest scale because of the limited extent of potentially suitable sites (to say nothing of competition from other forms of land use). A further restriction to site availability lies in the need for reasonable proximity to Stanley or to settlements. There is little point in attempting to produce wood which cannot be transported at reasonable cost to the consumer.

Potentially suitable sites lie in the lee of substantially higher ground and in valley locations providing shelter from the western quarter. They should, if possible, be water-receiving ("flushed") sites or alternatively on areas of deep peat ($>$60 cm). Taking all things into consideration, the most appropriate sites appear to be in the Stanley area (to the south of the Darwin road between Sapper Hill and the west end of Port Harriet; and in the upper part of the Moody Valley); near Teal Inlet and near Hill Cove. A plantation size of at least 5 and preferably 10 ha is desirable and edge effects should be minimised by making the format as square as possible.

The species and origins most likely to produce a reasonable tree crop are similar to those suggested for shelterbelt planting. They are Lodgepole pine (coastal origins), Monterey pine, Sitka spruce (Queen Charlotte Islands origin), Monterey cypress, Leyland cypress, Nothofagus betuloides, N. pumilio and White poplar (the latter three broadleaved species primarily on more nutrient-rich sites).

It would in general be sensible to plant several rows of the exposure-resistant coastal British Columbian or Alaskan origins of Lodgepole pine along the western and probably southern margins of any plantation.

Methods of site preparation, planting and protection should be as indicated for shelterbelt establishment with two significant differences. Cultivation of areas with a peat depth greater than 60 cm should preferably be done using a Clark D60/- plough rather than the D45/T60 model which is appropriate for shallower peat over clay, and plant spacing can be increased to 2.0 m.

The lack of reliable growth data for Falkland sites means that it is possible to give only limited general guidance on the likely yield of wood from successfully established plantations. The only existing stand of trees for which a meaningful estimate can be made is the spruce plantation at Hill Cove, where the current standing volume is of the order of 500 m^3 per ha at age 58 years. Growth data for very exposed plantations in Scotland suggest that under Falklands conditions the possible yield over a 50 year rotation will be of the order of 350-450 m^3 per ha for Lodgepole pine and 450-550 m^3 per ha for Sitka spruce.

As in the case of shelterbelt planting, it is worth pointing out that it will take a substantial period of time for trees to attain a worthwhile useable size. For example, trees are unlikely to be large enough to provide fence strainer posts until 20-25 years after planting.

Amenity and Shelter Planting for Houses and Gardens

The practicability of small scale amenity and shelter planting for houses and gardens has been clearly demonstrated by the efforts of generations of Falkland Islanders, both in settlements and in Stanley. The key factors for success are:- the availability of initial shelter either in the form of shelter fences or by taking advantage of any shelter provided by existing hedges, buildings or local microtopography; intensive site preparation, involving careful pit planting after deep cultivation; and subsequent careful protection against browsing and other damage.

Monterey cypress must inevitably continue to play a major role in any such planting, in view of its well-proven wind resistance and suitability for hedging as well as specimen trees. Hebe elliptica (native box), gorse and other locally recognised hedging species are also important in the development of initial

shelter. Once some degree of shelter has been created by the planting of wind resistant species or obtained by using a naturally sheltered site (eg in a hollow or small valley, it becomes feasible to grow reasonably successfully a wide range of broadleaved and coniferous species (see Appendix 1) given time, patience and persistence.

Provision of Planting Stock

In order to obtain suitable planting stock of appropriate species, it will be necessary to arrange for importation from established forest nurseries outwith the Falklands. There would be theoretical advantages from production of the required trees within the Islands, including the avoidance of potential phytosanitary problems, minimising of transit damage risks and exact matching of growing seasons. However, the quantities required for the trials (which in forestry terms are very modest) go far beyond what have been produced in the Falklands on a "hobby" basis in recent years. The advantages of internal production are outweighed by the problems involved in trying to establish a proper nursery of sufficient size and with appropriate skilled supervision; together with the probable minimum lead time of four years required to produce the required transplant quantities, and the need to ensure that plant roots develop appropriate mycorrhizae. Importation of plants appears much more logical and cost-effective provided that suitable plant health safeguards are defined and applied. Given thorough inspection at the despatching nurseries by the relevant plant health authority, and pesticide treatment if necessary, phytosanitary risks should be at an acceptably low level.

All other things being equal, forest nurseries in the southern parts of Chile and Argentina would be a logical choice because of their proximity and environmental similarity. Regrettably, the present political situation appears to rule out this option, and the remaining alternative sources of supply are nurseries in Britain and New Zealand.

As and when any supply arrangements are made, it is essential that the methods of packaging and transport ensure that young trees arrive in the Falklands in the best possible condition. This would best be achieved by using refrigerated containers. Some initial losses are inevitable and it will be necessary to have plants available to make good failures, preferably by including an allowance of say 20% for beating up purposes in the quantities obtained for initial planting; and lining out the excess numbers in garden or other cultivated areas near planting sites.

If it is ever considered necessary to develop a small forest nursery in the Islands, then the most suitable sites are likely to be found in the vicinity of Stanley Dairy, Mullet Creek, Government House or the recommended arboretum location.

7. RECOMMENDATIONS FOR NEW TRIALS

To confirm the validity of the conclusions drawn and provisional prescriptions given, it is suggested that new tree planting trials should be carried out in the Falklands as follows:-

Shelterbelt Planting

The practicability of creating effective shelterbelts should be tested in both East and West Falkland and for ease of supervision, maintenance and assessment, the selected sites should if possible be adjacent to reseeding trials being undertaken by FIARDC. It would also be an advantage if the farm managers involved were already convinced that there were benefits to be gained from shelterbelts, and therefore had a genuine interest in the trials. Suggested locations are at Teal Inlet, the Stanley vicinity and Goose Green in East Falkland; and at Hill Cove and Fox Bay East in West Falkland. Until more information is available the driest areas of the Islands are best avoided.

At each location the minimum aim should be to create a shelterbelt at least 250 m long with a north-south orientation. If topography and other factors allow, the addition of a further belt more or less at right angles, to give a T or L-shaped configuration, would be very valuable for further examination of the benefits to stock provided by shelter from different wind directions. Under the circumstances, it seems best to avoid complex experimental treatment comparisons and to examine only a very limited range of possible treatments in a very simple manner. The basic comparison should be between the various species suggested and this can best be done by planting each in successive 20-30 m lengths repeated systematically along the length of the belt. These species plots should lie to leeward of a continuous four row wide strip planted with Lodgepole pine of Queen Charlotte Islands or Alaskan origin, since no other species is likely to prove better than this for use on the windward edge. Half of the overall belt length could be a total of 10 rows wide and half 20 rows wide in order to test the possible merit of greater than minimum width. A further useful small scale comparison easily included would be between planting into the side of the plough ridge and into the side of the furrow in view of the possibly more favourable moisture conditions as well as greater shelter in the latter position.

The erection of "Netlon" or "Paraweb" shelter screening along the windward edge

of a belt is certain to provide some beneficial shelter during the critical early years of tree growth, and could be regarded as a standard treatment. However, it would be well worth examining the extent of the benefit on at least some sites by attaching 1 m high "Netlon" shelter netting to only half of the windward fence length.

The nature of the basic soil type found throughout most of the Islands (25-35 cm of peat over compacted clay) is such as to discourage worthwhile tree root development below the peat layer. This leads to some doubt about the long term wind stability of shelterbelt (and other) planting. In addition, the moisture holding capacity of the peat layer might be inadequate for continued long term tree growth. Although involving extra investment in equipment, it would be well worthwhile making a simple comparison of results obtained from normal simple throw S45/T60 and double throw D45/T60 ploughing, and from D45/T60 ploughing with an additional tine channel beneath each turf ridge. This latter treatment can be produced by initial use of a single tine ripper at planting spacing, followed by passes of a D45/T60 plough aligned midway between the tine channels.

Assessment of "exposure" levels at the various trial locations should be done using the tatter flag technique widely used in British upland forestry and introduced to the Falklands some years ago by McAdam (1980). At a later stage, the availability of tatter flag data could be very useful in interpreting growth results and assisting in the selection of sites for further shelterbelt planting.

Planting for Wood Production

The potential for wood production, could be tested using a small number of trial plantations established on carefully selected sites in the vicinity of Stanley and some farm settlements as indicated earlier. At each location a block size of 10 ha will probably be sufficient for the creation of realistic "forest" conditions, provided that a long narrow format is avoided, although the area could usefully be increased to 20 ha if circumstances allow. The locations in the Stanley vicinity have the important advantage of ready access by road to potential wood consumers, as well as providing deep peat soils on which soil moisture availability is unlikely to be a problem. The establishment methods to use have already been described, and within each plantation the various species recommended earlier should be planted in units of not less than 0.5 ha.

As in the case of shelterbelt trials, use of the tatter flag technique would provide an objective measure of "exposure" for inter-site comparions at a later stage.

Creation of an Arboretum

Serious consideration should be given to the development of an arboretum or forest garden on a site close to Stanley. This could have a valuable educational and amenity function as well as providing on a single site a comparison of a wide range of tree and shrub species which can be grown in the Falklands. Similar suggestions have been made in the past (see eg McAdam, 1982), usually involving a location in or beside the gardens of Government House. The two strips of Monterey cypress forming the "Government Forest" were apparently planted for the purpose of creating a sheltered area for subsequent planting of other species. In fact, there does not appear to be scope there for the development of a worthwhile arboretum area because of the relatively shallow soil and exposed nature of the sloping sites.

A more suitable site exists slightly to the west of Stanley, in the vicinity of the former satellite tracking station, and would provide the minimum area of 5 ha desirable for arboretum development. An essential first stage would be the creation of a shelterbelt system to protect the west, south and east edges of the selected area. Thereafter plots of other species could gradually be planted up within the protected area. Continuous protection will be required against browsing animals and fire.

Organisation, Control and Supervision of Trials

Overall responsibility for any trials should preferably rest with FIARDC, who could provide the infrastructure, local knowledge and administrative back-up required for successful organisation and longer term management. However, to ensure that techniques are properly applied and that the results obtained are as reliable as possible, skilled technical supervision will be required during the establishment of trials and accurate records must be maintained. The supervisory forester should if possible have substantial first-hand practical experience of the problems and practices involved in the afforestation of difficult exposed sites in Scotland, and be familiar with forest research techniques.

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APPENDIX 1

TREE AND TALL SHRUB SPECIES FOUND IN THE FALKLAND ISLANDS

The following table lists tree and tall shrub species found growing within the Falkland Islands in September 1983, together with notes on location, frequency and performance. The list cannot be regarded as exhaustive because a very few locations known to have tree growth could not be visited in the time available, nor was it possible to inspect fully all garden areas seen. However, it almost certainly includes all species of any real significance.

Botanical (and common) name	Notes
1. BROADLEAVED SPECIES	
Acer pseudoplatanus (sycamore)	Rare - 1 tree (height 5 m, dbh 15 cm) found at Hill cove in moist sheltered hollow. May also be in Stanley - see McAdam (1982).
Betula pubescens (birch)	Rare - bushy multistemmed trees at Teal Inlet (2) and Weddell Island (the latter with height 4 m) in garden areas.
Berberis buxifolia (calafate)	Relatively common in gardens - height to 2 m.
Chiliotrichum diffusum (fachine)	Native shrub growing to 2 m - locally common on moist sheltered sites.
Cordyline australis (cabbage palm)	Rare, but growing well in mild climate of Carcass Island - several specimen to 4 m; 1 small specimen at Chartres.
Crataegus monogyna (?) (hawthorn)	Occasional as shrubs and hedges to 3 m in gardens eg at Hill Cove, Roy Cove, Stanley. Some may be C. oxycantha?
Embothrium coccineum (Chilean fire bush)	Very rare - 1 specimen in a Stanley garden reported by McAdam (1982), but not confirmed.
Escallonia macrantha	Infrequent in garden areas, as at Hill Cove; height to 2 m.
Eucalyptus spp.	Rare - garden specimens found at Hill Cove, Roy Cove, Teal Inlet and Stanley; generally healthy and vigorous, with heights up to 5 m and dbh 18 cm (Hill Cove); positive species identification not possible but E. gunnii and E. coccifera almost certainly present.
Fuchsia magellanica	Occasional - sheltered gardens in milder areas - height up to 3 m.

Hebe elliptica (native box)	Native shrub growing to 3 m in the wild, locally common on coastal sites in W. Falkland; widely and successfully used for shelter hedging around gardens.
Hebe speciosa (veronica)	Relatively common in gardens as shrub or hedging - height up to 3 m.
Ilex aquifolium (holly)	Rare; 1 specimen found in sheltered garden at Hill Cove, height 3 m.
Laburnum anagyroides (laburnum)	Rare; in sheltered gardens as at Roy Cove.
Nothofagus antarctica (nirre)	Seen only at Hill Cove - scattered, bushy, wind-swept, multistemmed trees on exposed site with heights to 5 m, probably planted in 1920s. Apparently grew well in Mt Usborne trial planted in 1977 by McAdam (1982) - up to 2 m in 4 years - but probably destroyed in 1982.
N. betuloides (coigue)	Seen only at Hill Cove - several large bushy trees of height 7-8 m, with massive multiple stems, and dating from 1890s growing in sheltered moist hollow; also some scattered bushy multi-stemmed specimens up to 5 m in height on nearby exposed site dating from 1920s. Sizeable specimens reported on Keppel Island (not visited) may have been planted prior to 1820 (Whitley - personal communication).
N. obliqua (roble)	McAdam (1982) reported 7-8 m specimen at Teal Inlet but this could not be found and cannot be confirmed.
Phormium tenax (New Zealand flax)	Rare, but growing vigorously to 1.5 m in Carcass Island garden sites; one good specimen seen in Hill Cove garden.
Populus alba (white poplar)	Common in garden and plantation areas - oldest trees probably date from late 19th century, generally healthy and vigorous, with suckering frequent; tree sizes up to 7 m x 39 cm dbh.
Ribes spp (flowering currant)	Relatively common in gardens with height to 3 m if some shelter available; mainly R. sanguineum but S. American R. valdivianum also present.
Salix spp	Relatively common in sheltered garden areas and in lee of larger trees; heights to 3-4 m; positive species identification difficult in absence of leaves, but S. viminalis, S. fragilis, S. alba and S. triandra probably present.
Sambucus nigra (elder)	Relatively common in gardens; generally windpruned if exposed; height to 2-3 m.

Cytisus scoparius (broom)	Rare in gardens, height to 2 m in shelter.
Sorbus aria/intermedia (whitebeam)	Infrequent in garden areas, usually in lee of larger trees; bushy form with height to 3-4 m if some shelter.
S. aucuparia (rowan)	As for S. aria/intermedia.
Ulex europaeus (gorse or whin)	Widely found in paddock hedges throughout islands: more or less naturalised; height up to 2-3 m.
2. CONIFEROUS SPECIES	
Araucaria araucana (monkey puzzle)	Very rare - one specimen in a Stanley garden, height 5 m.
X Cupressocyparis leylandii (Leyland cypress)	Infrequent garden specimens - one with height of 4-5 m at Chartres.
Cupressus macrocarpa (Monterey cypress)	Very common - by far the commonest tree in the Islands - used widely for shelter planting and hedging around houses and gardens; very wind resistant, generally healthy and vigorous; heights to 8 m on exposed sites and 12 m with some shelter, dbh up to 70 cm; often multistemmed and bushy.
Picea glauca (white spruce)	Rare - two poor specimens about 2 m high seen on Weddell Island and another at Hill Cove.
Picea sitchensis (sitka spruce)	The second most common conifer in the Islands; forms outstanding plantation at Hill Cove and good healthy plot at Roy Cove; large trees at Stanley and Teal Inlet, but suffering from Elatobium attack; tallest tree 17 m (Hill Cove) at 58 years, heights in excess of 12 m are common and dbh up to 70 cm. Some doubts about identity - may have hybrid elements.
Pinus contorta (lodgepole pine)	Relatively common, mainly in shelter plantings over past 2-5 years, but also in gardens to some extent; health and vigour depends largely on provenance, with interior provenances obviously unsuitable; on exposed site at Hill Cove, Washington coast provenance has performed well - height 3 m in about 18 years.
P. mugo/uncinata (mountain pine)	Rare - found in a young shelterbelt at Hill Cove; healthy, good foliage retention, height to 2.5 m in about 18 years.
P. nigra var nigra) (Austrian pine)) P. nigra var maritima) (Corsican pine)	Relatively common, both in older plantations and in gardens; often not easy to differentiate between the two species because of exposure effects; Austrian pine more common and with better foliage retention. Height up to 8 m and dbh to 40 cm; one large bushy healthy

	specimen at Government House thought to be about 90 years old.
P. radiata (Monterey pine)	Relatively common both in plantations and garden areas; more recent planting mainly in west of Islands eg at Carcass and Westpoint Islands, and Hill Cove; usually healthy, vigorous and well foliaged; good plot on Carcass Island site, with height of 9 m in about 24 years; two trees in the Hill Cove spruce plantation had heights of 8 m and dbh 60 cm, and two similar large bushy trees grow at Government House.
P. sylvestris (Scots pine)	Relatively common, both in plantations and garden areas; foliage retention often poor, older trees multistemmed and windswept unless sheltered; heights to 7-8 m and dbh to 35 cm.

A J LOW TREE PLANTING IN THE FALKLAND ISLANDS

CAPTIONS FOR ILLUSTRATIONS

Figure 1. Map of the Falkland Islands group showing locations relevant to tree planting.

Plate 1. a. View of typical farm settlement at Roy Cove in West Falkland, showing plot of conifers to the east of the manager's house and paddocks surrounded by gorse hedges planted on turf banks.

b. Plot of Cupressus macrocarpa about 55 years old on slope immediately east of manager's house on Weddell Island. Note the very obvious wind-cut profile extending eastwards from the house.

Plate 2. a. View of main Hill Cove spruce plantation viewed from the south. Note proximity to the sea and lack of significant shelter on the west (left) side.

b. Aerial view of Hill Cove plantations from the north. Note the generally uniform dense canopy of the spruce crop (planted in 1925), and the narrowness of the wind-pruned zone adjacent to the Ulex hedge on the windward edge. The older (pre-1898) mixed broadleaved and conifer plantation lies in the hollow between the 1925 spruce area and the manager's house.