THE GRASSLANDS OF THE FALKLAND ISLANDS

by

WILLIAM DAVIES, M.Sc.
Senior Grassland Investigator, Welsh Plant Breeding Station, Aberystwyth

Price 5s.

Obtainable from the Government Printer, Stanley, Falkland Islands, and from the Crown Agents for the Colonies, 4 Millbank, London, S.W.1

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PREFACE

THE report that follows is based upon observations made during the course of a comprehensive survey of the colony which was carried out between November 20, 1937, and March 11, 1938. During that period every station on the East and West Falklands respectively was visited, as well as a large number of the outlying islands. The general grassland problem has been discussed as fully as possible, not only with owners and/or managers on the stations, but with a large number of other persons representing all shades of opinion and many grades of grassland knowledge within the country.

During the four months I was in the colony I covered some 1,100 miles on horseback, well over 1,000 miles by sea in Falkland waters, and only about 40 miles by car. I greatly appreciate the readiness with which the managers of the sheep stations everywhere provided me with both horses and guides.

I have been favourably impressed by the general enthusiasm shown relative to the question of land improvement. One was everywhere well received, and in no case was any hindrance or difficulties placed in my way during the whole conduct of the work. Rather has everyone gone out of his way to assist me in my work. Private individuals have taken considerable pains to make my stay pleasant among them, while official circles gave me every possible facility and encouragement. It would be out of place to make mention of any particular names, but I would like here to thank everyone with whom I made contact for the help and the hospitality offered to me. I would wish to add that the staff of the Agricultural Department have at all times been helpful, and without their close and whole-hearted co-operation the volume of work achieved within the short time at my disposal could never have been attempted. The whole effort has been one of team work, and for this I cannot but feel highly gratified.

I am indebted to Professor Sir R. George Stapledon for the helpful interest he has taken in connection with the compilation of this report, and for the constructive criticisms I have received from him in connection with the general conduct of the survey. I must also tender my

appreciation of the valuable assistance I have received from Professor T. W. Fagan, of the Department of Agricultural Chemistry at Aberystwyth, who has been responsible for the whole of the chemical evidence presented in the Supplementary Report. I also wish to thank Professor C. Daryll Forde and the Department of Geography and Anthropology at Aberystwyth for assistance in connection with Maps I and II. Thanks are also due to the Director of the Royal Botanic Gardens, Kew, for assistance in the nomenclature of certain Falklands grasses. Acknowledgment is also made of the assistance received from the Bacteriological Department, Rothamsted Experimental Station, Harpenden, relative to preparation and despatch of cultures for inoculation trials.

WILLIAM DAVIES.

February, 1939.

ITINERARY FOLLOWED IN THE FALKLAND ISLANDS

NOVEMBER 20, 1937, TO MARCH 11, 1938.

1937.

Nov. 20.	*Arrived Stanley.*
Nov. 20-22.	*At Stanley:* interviews with Acting-Governor, Director of Agriculture, and other officials. Short tour around Stanley Common.
Nov. 22.	*Left Stanley* for Port Howard by sea (*S.S. Lafonia*).
Nov. 23.	*Arrived Port Howard.*
Nov. 23-26.	*At Port Howard.* Made first acquaintance with a Falkland Island sheep station: settlement fields and the camp. Also first acquaintance with horse-riding (Falklands style) and other modes of local transport.
Nov. 26.	*Left Port Howard* for Pebble Island (via River Island) by horseback and sea (m.v. *Gentoo*).
Nov. 26-30.	*At Pebble Island.* Tours of camp and study of settlement fields.
Nov. 30.	*Left Pebble Island* for Hill Cove by sea (m.v. *Gentoo*).
Nov. 30-Dec. 2.	*At Hill Cove.* Study of settlement fields. Climb to Mt. Donald (1,200 ft.).
Dec. 2.	*Left Hill Cove* for Roy Cove (horseback). Study of camp vegetation. Arrived Roy Cove.
Dec. 3.	*Left Roy Cove* for Chartres (horseback).
Dec. 3-6.	*At Chartres.* Tours of camp and settlement fields. Climb to Mt. Chartres (1,050 ft.).
Dec. 6.	*Left Chartres* for Fox Bay East (horseback).
Dec. 6-8.	*At Fox Bay East.* Study of camp flora in vicinity.
Dec. 8.	*Left Fox Bay East* for Fox Bay West (by motor launch), and thence to Spring Point (horseback). Study camp *en route.*
Dec. 8-10.	*At Spring Point.* Tours around settlement.
Dec. 10.	*Left Spring Point* for Port Stephens (horseback) via Double Creek and Carew Harbour.

Dec. 10-13. *At Port Stephens.* Short tours in vicinity.

Dec. 13. *Left Port Stephens* (by *S.S. Fitzroy*) for Weddell Island where spent eight hours and took opportunity to see some of the rested camps.

Left Weddell Island (by *S.S. Fitzroy*) for San Carlos (south) via Fox Bay and Port Howard.

Dec. 15. *Arrived San Carlos* (south).

Dec. 15-17. *At San Carlos* (south). Tours of camp and study of settlement fields.

Dec. 17. *Left San Carlos* (south) for Port San Carlos (horse and boat).

Dec. 17-19. *At Port San Carlos.* Tours of camp and settlement fields.

Dec. 19. *Left Port San Carlos* for Douglas (horseback).

Dec. 19-23. *At Douglas.* Short tours of the camp and settlement fields.

Dec. 23. *Left Douglas* for Stanley (by motor boat).

Dec. 23-30. *At Stanley.* Discussions With His Excellency the Governor, and with officials of the Department of Agriculture and others. Opportunities for reading botanical and agricultural literature relative to the Falkland Islands.

Dec. 30. *Left Stanley* for Johnson's Harbour (by motor launch *Georgia*).

Dec. 30-Jan. 1, 1938. *At Johnson's Harbour.* Tour of the north camp and study of settlement fields.

Jan. 1. *Left Johnson's Harbour* for Port Louis (horseback).

Jan. 1-2. *At Port Louis.* Tour to north camp and study of areas around settlement.

Jan. 2. *Left Port Louis* for Horseshoe Bay (horseback).

Jan. 2-3. *At Horseshoe Bay.* Tour of north camp and hills.

Jan. 3. *Left Horseshoe Bay* for Rincon Grande (horseback).

Jan. 3-5. *At Rincon Grande.* Tour of north coast and centre camp.

Jan. 5. *Left Rincon Grande* for Green Patch. Visited Anson (site of original Government Experimental Farm since dismantled).

Jan. 6. *Left Green Patch* for Fitzroy (horseback) via Wickham Heights. First opportunity to see and study conditions of soil and vegetation in the high mountains.

Jan. 6-8. *At Fitzroy.* Tour of camp (Mt. Pleasant and Kelp Lagoon).

Jan. 8. *Left Fitzroy* for Darwin via Swan Inlet (horseback and motor car).

Jan. 8-10. *At Darwin.* Study of camp in vicinity of Darwin and Goosegreen.

Jan. 10. *Left Darwin* for North Arm (horseback).

Jan. 10-12. *At North Arm.* Study of settlement fields. Soil inoculation experiments started in one field.

Jan. 12. *Left North Arm* for Darwin (horseback and motor car).

Jan. 13. *Left Darwin* for Port Howard (by m.v. *Black Swan*).

Jan. 13-20. *At Port Howard.* Intensive botanical study of settlement fields and of experimental blocks seeded down 1926-37. Inoculation experiments begun. Hand-crossing (artificial) of white clover. Tours of camp —Shag Cove and White Rock.

Jan. 19. *Left main settlement Port Howard* for White Rock via Manybranch and Mount Rosalie (horseback).

Jan. 20. *Left White Rock* to connect with *S.S. Fitzroy* at Tamar Pass, thence to Pebble Island.

Jan. 21. *Left Pebble Island* for Saunders Island (stayed few hours and took opportunity to see something of this island). Left *Saunders Island* for Rapid Point (per *S.S. Fitzroy*), and thence by horseback to Shallow Bay (1928-9 liming experiments) and to Hill Cove to rejoin boat.

Jan. 22. *Left Hill Cove* by *S.S. Fitzroy* for *Carcass Island* where spent few hours available touring the island (horseback), thence to *West Point Island* where spent afternoon studying the grasslands. Left for Roy Cove.

Jan. 23. *Left Roy Cove* for Chartres (*S.S. Fitzroy*).

Jan. 23-25. *At Chartres.* Ride to Green Hill and Mt. Robinson camp.

Jan. 25. *Left Chartres* for *Dunnose Head* (horseback) and Shallow Harbour. Thence to Spring Point (by motor launch).

Jan. 26. *Left Spring Point* for *New Island* (per *S.S. Fitzroy*). Full day ashore investigating grasslands, etc.

Jan. 27. *Left New Island* for Port Stephens.

Jan. 27-30. *At Port Stephens.* Ride to top of Mt. Young (1,110 ft.) and surrounding country.

Jan. 30. *Left Port Stephens* for Fox Bay and Port Howard (per *S.S. Fitzroy*).

Jan. 31. *Left Port Howard* for *Speedwell Island* (few hours ashore).

Feb. 1. *Left Speedwell Island* for *North Arm* (few hours ashore), and thence to *Sea Lion Islands* (few hours ashore).

Feb. 2. On board *S.S. Fitzroy.* Visited *Lively Island* (about an hour ashore), thence Fitzroy (few hours), thence *Bluff Cove* (two hours) and return Stanley.

Feb. 2-6. *At Stanley.* Office work: mounting of specimens of grasses and other plants collected during tours. Visits to local centres.

Feb. 6. On board *S.S. Fitzroy.* Left Stanley for Salvador Waters.

Feb. 7-8. *At San Salvador.* Tour of camp and study settlement fields.

Feb. 8. *Left San Salvador* for Douglas (horseback).

Feb. 8-10. *At Douglas.* Long tours of Douglas camp, including mountains.

Feb. 10. *Left Douglas* for Teal Inlet via Mount Simon and the valley of the Arroyomalo River (horseback).

Feb. 10-15. *At Teal Inlet.* Visits to camp, Evelyn Mountains, and Chata Hills.

Feb. 15. *Left Teal Inlet* for Stanley (horseback).

Feb. 15-Mar. 9. *At Stanley.* Visits to local centres (including Stanley Common, Navy Point, Cape Pembroke, Sparrow Cove, Mt. Low, Moody Valley): collecting and drying samples of Falkland pasture plants for chemical analysis at Aberystwyth: office work: public lecture given Stanley, March 5.

Mar. 9. *Left Stanley* for Darwin by speedboat *Georgia* to connect with *S.S. Fitzroy.*

Mar. 10. *At Darwin.* Further examination of field plots.

Mar. 11. *Left Darwin* (by m.v. *Black Swan*) to connect in Falkland Sound with *S.S. Fitzroy en route* Punta Arenas (Chile).

INTRODUCTION

THE Falkland Islands lie in the South Atlantic Ocean some 300-400 miles east of the southern extremity of the South American Continent. They are in about the same latitude (south) as that part of Wales south of Aberystwyth. Longitudinally the Falklands lie directly to the south of Labrador and Newfoundland (i.e. approximately longitude 60°W.). The group consists of two main islands (the East and West Falklands) together with a large number of adjacent islands forming a small archipelago. The aggregate area is in the vicinity of three million acres, or approximately three-fifths that of Wales.* The population is about 2,500, of whom more than one half live in the only town—Stanley.

PHYSIOGRAPHY.

The West Falkland, together with the majority of the smaller islands lying adjacent to it, is of a hilly nature. There are two main mountain ranges; one stretches in roughly a SE.-NW. direction from Mt. Maria (Port Howard) to West Point Island. The second range has its axis NE.-SW. from Mt. Maria to Mt. Moody. There are other blocks of hilly country associated with the peaks of Mt. Rosalie (Port Howard), Mt. Chartres (Fox Bay), and Mt. Young (Port Stephens). The mountains of the East Falkland are less diffuse. The Wickham Heights form an E.-W. backbone from Port Stanley to Port San Carlos. From these there are subsidiary offshoots to the north, but there is no high ground to the south. The islands off the coast of the East Falkland, together with those situated in the Falkland Sound, are all low lying. In this respect they stand in sharp contrast to the steep and mountainous islands lying off the West Falkland.

The highest peaks in the West and East Falklands respectively are Mt. Adam (3,215 ft.) and Mt. Usborne (2,245 ft.). In both cases there are large tracts of mountainous country associated with these as well as other peaks.

* Acreages in the Falklands are merely approximations, because no accurate Ordnance survey of the country has yet been made.

Geology.

The solid geology appears to be fairly simple (2). Almost the whole of the West Falkland, as well as the northern half of the East Falkland, belongs to the Devono-carboniferous series. The southern part of the East Falkland is Permo-carboniferous, while there is an agriculturally unimportant outcrop of Archaean rock at Cape Meredith. The distribution of vegetation within the Falklands does not appear to show any very close relationship to geological structure.

Climate.

Meteorological records are available only for the coast station at Cape Pembroke (near Stanley). Judged by these records the Falkland summer is considerably cooler than that of southern Britain, but the average winter temperatures are only 2°F. lower than those of London (both stations are in the same latitude), but over 6°F. lower than those of Aberystwyth.

TABLE I.

THE MONTHLY MEAN TEMPERATURES FOR JANUARY AND JULY AT CAPE PEMBROKE (STANLEY), KEW, AND ABERYSTWYTH.

Cape Pembroke (Stanley)*		Kew (40 years normal)*		Aberystwyth (1919-27 average)†	
	F.°		F.°		F.°
January (summer)	49·3	July (summer)	62·7	July (summer)	59·3
July (winter)	36·7	January (winter)	38·8	January (winter)	43·2

The average rainfall at Cape Pembroke is of the order of 25 in. and this is fairly evenly distributed throughout the year. Excessive rainfall in any one day is uncommon, and there are a large number of rainy days (probably about 250) in the year. Snow may fall on the high country in any month of the year (there was a snowfall on Mt. Usborne on January 8, 1938, which remained for a day as a white mantle on land above 1,000 ft.). Snow is, however, rare from December to March. The annual total of "snow" days averages

* After Middleton (19).
† After Martin Jones (17).

54, and blizzard conditions may occur during the winter. Typically snow does not lie for prolonged periods on the lowlands, and in this respect the climate must be closely similar to that in the hills of Wales. The chief characteristics of the Falkland climate may be said to be its extreme variability during any twenty-four hour period, and also the persistency of the wind. Strong winds appear to prevail for over two-thirds of the time, and the average force is about 17 miles per hour.* The spring months are said to be the most windy (19).

Weather conditions in the mountain and uplands must be a good deal more rigorous than those of Stanley and of the lowlying country in general. No records are available, but the rainfall in the uplands is greatly in excess of that of the lowlands, and it is likely that climatically and as regards rain, wind, temperature, and sunshine, they stand in much the same relationship to the country at lower elevation as do the British uplands to British lowlands. Weather conditions at sea level in the Falklands are more severe than those of lowland England and Wales, so that the climate of the mountains and uplands is correspondingly more rigorous. Judging from the summer of 1937-38 the weather in the low elevation country of the colony compares closely with that experienced on the Welsh hills above 1,000 ft., but with two differences, namely (1) the lower rainfall in the Falklands, less than 30 in. per annum, against perhaps 50 in. in our hills, and (2) the stronger and more persistent winds of the Falklands promoting frequent local storms accompanied by extremely changeable weather. It is probably true to say of the Falklands that there are many days of the summer months during any one of which weather characteristic of all four seasons of the year may be experienced.

Livestock.

Sheep are the most numerous, and these total some 600,000. Romney and Corriedale are the two most important breeds, though importations have been made of other breeds, notably Merino, Lincoln, Border Leicester, and Cheviot (20). The highest number of sheep was carried in 1898, when the total was about 807,000 (19). From 1864 when sheep farming commenced in the colony until 1898 there was a progressive increase in number of sheep carried. Subsequently there has been a more or less gradual decline to the present numbers.

* Compared with an average wind velocity of 7·6 miles per hour at Kew, and 16·6 miles per hour at Lerwick (Shetland Islands).

The following statement* shows the trends of sheep and wool production during the thirty years from 1909 to 1938:

Quinquennial period	Average number of sheep shorn per annum	Average annual export of wool (lb.)†	Average annual wool clip per sheep (lb.)
1909-1913	712,000	4,762,500	6·69
1914-1918	683,000	4,655,300	6·81
1919-1923	659,000	4,598,500	6·98
1924-1928	621,000	4,144,500	6·67
1929-1933	611,000	3,933,600	6·44
1934-1938	607,000	4,018,400	6·61

With regard to the number of sheep it will be seen that from the peak year of 1898 (when 807,000 sheep were carried) to the quinquennial period 1909-1913, the sheep population was reduced by 95,000 head, while there has been a further reduction of 105,000 sheep up to the present time. The decline in wool production is no less serious, for while the reduction in number of sheep from 1909 to 1938 represents a fall of 14·7 per cent, the wool export is down by 15·6 per cent over the same period. The fall in wool production would seem even more serious were it not for the fact that the production for 1937 was the highest for fifteen years. Omitting 1937 from the last quinquennial average (1934-38), the annual production for this period reads 3,872,000 lb. with an average clip of only 6·38 lb. per sheep. These figures when considered as a whole clearly show that gross production of wool has declined in a more or less progressive manner, and this notwithstanding that during the 1909-1938 period considerable efforts have been made to improve the stock by importation of rams from overseas.

Of other livestock, horses in 1930 numbered about 3,500 (employed mainly for riding), and in the same year there were nearly 9,500 cattle (18). The greater part of the cattle are used as foragers on the sheep stations with the aim of maintaining the pastures in better condition for sheep. The average ratio of cattle (as foragers) to sheep is only about one to seventy, while on some stations it is as high as one cattle beast to forty sheep. It is likely that with proper fencing the number of cattle could profitably be increased with general benefit to the pastures. This is specially true of soft camps.

* The statement is based upon information communicated by His Excellency The Governor (Sir H. Henniker Heaton, K.C.M.G.,) to whom I am greatly indebted.

† The amount of raw wool used internally is negligible. The figures for "wool exported" are, therefore, more or less coincident with those for "wool produced."

Dairying is in a primitive state of development. A few cows are kept for local milk supply, but imported dairy produce, including tinned milk, butter, and cheese, is commonly used throughout the colony. The number of pigs maintained is negligible, while poultry numbers about 5,000.

The sheep stations are large (commonly over 100,000 acres), and wool is the chief export, though there have been attempts to develop a meat export industry. The present sheep-carrying capacity of the Falklands is in the neighbourhood of one sheep to five acres, but the carrying capacity of many of the outlying islands is much greater than the average. On the other hand the mountain ranges either graze no sheep at all, or grazing is at its minimum and largely confined to the summer periods. Individual paddocks or fields may be very large and commonly are in excess of 10,000 acres. In the immediate vicinity of the chief settlements the enclosures may be quite small. A certain amount of oats is grown here for winter feed, while on most stations there have been attempts at laying such fields down to grass. In the main these attempts have proved costly and not altogether fruitful. Often the ley deteriorates rapidly after the first year, and the sown grasses disappear sometimes to be replaced by an open sward in which sorrel dominates. In a few cases exceptionally good pastures have been formed as a result of explicit sowings, and these successes are always attributable to the success of the wild white clover established on them.

Apart from these outstanding clover leys some of the best settlement fields are dense bent swards, often with gregarious colonies of wild white clover. Such fields are not the result of ploughing and reseeding, but of intensive grazing over a number of years. Many of these bent pastures must have a carrying capacity of appreciably more than a sheep to the acre (compared with a sheep to five acres in open camp).

THE NATURAL PASTURES

The natural climax vegetation of the Falklands is grassland of one form or another. Forming a narrow ring (typically not more than a few hundred yards wide) around many parts of the sea coast is the tussac grass (*Poa flabellata*) community. The few areas of natural tussac still remaining are relics of a once more extensive coastal fringe of this grass. Examples of its "fringe-like" distribution are still to be seen everywhere on the "tussac islands"; the smaller of these may be completely covered by the tall tussac communities, while on islands only slightly larger the tussac in pure formation forms a peripheral fringe and gives way to a shrubby or grassy vegetation towards the centre of the island.

Except for a few plantings made around certain of the main settlements, the Falklands are treeless. There are no natural woodlands of any kind, and trees are grown only with the greatest difficulty even in the most sheltered situations. There are one or two native shrubs* which grow to a maximum height of about three feet, but only exceptionally are these now sufficiently numerous to play a part either in stock nutrition or as shelter from the winds. Among other woody forms are the low-growing or prostrate shrubs which include the three ubiquitous plants, namely, diddle dee (*Empetrum rubrum*), the ecological equivalent of the British heather, Christmas bush (*Baccharis magellanica*), and mountain berry (*Pernettya pumila*). These three grow on a wide variety of situations, but are perhaps most characteristic of the dry heaths (hard ridges and rincons). Gorse (*Ulex Europaeus*) has been introduced, and some of the older plantings (now over seventy years old) form very dense and effective shelter belts.

There appears much in common between the grasslands of the Falklands and those of the high country in Britain. Many of the natural grazings are very similar in general appearance to land above 1,000 ft. in Wales. These types stretch in the Falklands from sea level to the elevated lands. The majority of the species dominant in these

* For example, Fachinal bush (*Chiliotrichium diffusum*) is well distributed throughout the colony, but nearly always stunted and in small amount. Also box (*Veronica elliptica*) limited to the West Falklands, but now rarely found.

grasslands are not indigenous to Britain. There are, however, a few species which are common to both countries. Hair grass (*Deschampsia flexuosa*) is an example. Whether such species have in fact been introduced only since the advent of European colonization cannot be known. Some other species as, for example, the usual grasses, clovers, and herbs of commerce have become established locally around the chief settlements, while still others (e.g. *Poa annua*) are almost certainly introductions, and yet have become freely established wherever they have found conditions suitable for their growth.

The most abundant indigenous species is the ubiquitous white grass*; this enters into practically every association and is the dominant element in most plant communities. White grass provides the basis for the characteristic brown, yellow, and grey colourings of the general treeless landscape. These colours in their varied shades are broken only by the dark purple of diddle-dee, and in the mountains by the greyish-white of the extensive "stone runs" or rivers of stone. Around the settlements one finds the relatively bright green closely-grazed pastures standing in sharp contrast to the colours of the general landscape; these pastures are composed almost entirely of introduced species, the chief of which are bent (*Agrostis*) and smooth-stalked meadow grass (*Poa pratensis*). In some camps bent swards have become established along frequently used tracks (the Falkland "highways"), while in others smooth-stalked meadow grass forms the chief element. In most camps there are green valleys (also conspicuous in the landscape because of their bright colour) in which the sward is often dominated by a small indigenous rush (*Juncus scheuchzerioides*), and sometimes by a mixture of this with annual grasses, or with pigvine (*Gunnera magellanica*) and cinnamon grass (*Hierochloë magellanica*). These green valleys (they are really quite narrow gully formations and frequently each will cover but an acre or two) provide some of the most valuable of the sheep grazings, and they are almost invariably heavily stocked even during the height of summer. These small valleys characteristically with steep banks on each side are usually well sheltered, and the small rush (*Juncus scheuchzerioides*) growing in them is probably one of the most valuable grazing plants indigenous to the Falklands. Around the coast, and often marking the site of old penguin rookeries, pastures composed almost entirely of *Poa annua* are to be found—this grass also colonizes the stockyards and sheep pens everywhere.

*See list at end of this Report for appropriate botanical name.

The size of any individual sheep station in the Falklands varies from about 10,000 acres to about 500,000 acres.* The size of paddock may vary from the small enclosures around the settlements to as much as perhaps 50,000 acres in the camp. The average size of open camp paddock would probably be in the neighbourhood of 10,000 acres. Boundary fences have usually been completed, but on some stations there is only a minimum of internal fences. On a few holdings new fences are being erected annually, while on others very little progress is being made towards closer subdivision of the land.

In most cases the grazing animal will have access in any one paddock to several of the various types of natural grazings, and because the grazing value of these types will vary and each group will have its own standard of relative palatability, the stock have naturally been drawn towards some more than others. Usually it is the grazings on the dry ridges and in the green valleys which have proved most palatable. The whole forms an interesting study. It is obvious that the ridges of hard camp carrying a complement of "fine grasses" (*Deschampsia flexuosa*, *Festuca ovina* var., etc.) have been overstocked, so much so that the most useful elements in the natural vegetation on them have been depleted ("eaten out"). It is also likely that indiscriminate burning has greatly accelerated the rate of this depletion.

These ridges might in the future provide some of the best grazing grounds, and they have the merit of always providing dry land on which stock can lie. At the present time they appear to carry only a minimum of herbage, while the grasses and more palatable of the herbs upon them are always closely grazed. The "swards" they carry are usually dense and compact, and often composed almost entirely of non-gramineous plants, such as Christmas bush, mountain berry, various cushion plants (*Colobanthus*, *Azorella* spp., etc.), the small fern (*Blechnum penna marina*), and sometimes half a dozen species of lichen. There is a very dense, almost impervious, mat quite three inches thick in most places, and this is usually very tough and will need to be broken up before any real improvement can be made. In the scheme of grassland improvement these hard, dry ridges might well be the first to receive attention. If wild white clover and other herbage can be successfully introduced into them they should be capable of far-reaching and permanent improvement.

* The land held by the Falkland Island Company in the East Falkland is for this purpose considered as three separate holdings (Fitzroy, Darwin, and North Arm).

With reference to the green valleys which represent another very valuable section of the natural camp, they also are being overgrazed, but partly because of the higher intrinsic fertility of the soil, and partly because the dominant plant (*Juncus scheuchzerioides*) has proved highly resistant to grazing, the sward cover on these valleys is still dense and largely "grassy." It is likely to be relatively nutritious, not only because of the leafy nature of the herbage, but also because various edible herbs (chiefly indigenous) contribute appreciably to the sward.* It is quite likely that white clover will readily find a suitable habitat on the soils of these green valleys, although clover has hitherto not spread naturally into them. Many of these little areas could be ploughed up or drastically harrowed and reseeded with every indication of success.

Diddle dee ground. This formation covers an excessive aggregate area typically in the coastal districts, although inland there are quite large areas of diddle dee. There can be little doubt that this plant has spread since early colonization, but there is reason to believe that it can be crushed out by intensive stocking. This may be seen around holding paddocks and about the settlements. On fields that have been excessively trampled by sheep diddle dee has been more or less completely displaced by "grassy" vegetation—sometimes bent, sometimes smooth-stalked meadow grass, *Poa annua*, *Aira praecox*, daisies (*Bellis perennis*) and sorrel (*Rumex Acetosella*).

White grass camp. This is the most extensive formation in the country. White grass occurs as the dominant on a variety of soil types. Where one of its chief associate plants is pigvine (*Gunnera magellanica*) the land will usually be described as hard camp. This type provides fairly valuable grazing grounds, and where the white grass forms large spaced-out clumps these provide appreciably good shelter for young lambs.

White grass also enters (in soft camp) into association with oreob (*Oreobolus obtusangulus*), swamp rush (*Rostkovia magellanica*), and with Christmas bush (*Baccharis magellanica*). This formation represents a large acreage of country both in the East and West Falklands, but does not occur to any appreciable extent on any of the outlying islands. This white grass-oreob association may be regarded as typical of average soft camp. White grass-oreob associations usually occur on

* Samples based on "pure species" have been collected of most of the characteristic grasses and herbs, and have been analysed chemically at Aberystwyth. The results are dealt with later in this report.

water-saturated peats of variable depth. They probably represent the most useful of the "soft camp" types and could be greatly improved if stocked more intensively. Yorkshire fog establishes well from surface sowings made after a burn. It is desirable to work out the details of a technique whereby fog, ribgrass, and other plants would be sown after each successive burn. The aim would be to establish new herbage in the existing sward so that stock will be drawn in increasing numbers to these areas. It is by such methods that these camps are likely to be improved in practice. Soft camps everywhere in the Falklands are at present grossly undergrazed, largely because of the unpalatable herbage growing upon them.

The chief remaining types of soft camp from the viewpoint of aggregate acreages are the peat banks (*Rostkovia* and *Astelia* in association with stunted white grass and stunted diddle dee) and the high mountain types (land tussac and mountain blue grass in association with white grass and oreob). The peat bank areas where *Rostkovia* and *Astelia* enter into the characteristic vegetation are usually formed on very deep peat, and even when situated on sloping ground hold excessive water, and are consequently very soggy and bog-like under foot. These areas are difficult to reclaim unless a process of soil formation, including the gradual decomposition of surface peat can be brought about by the introduction of new herbage. As they stand at present, these areas are unlikely to be immediately suitable habitats for the clovers, but surface sown seeds mixtures containing fog, wild white clover, and ribgrass might be tried experimentally. The effect of drainage should also be investigated for if these peat banks would drain it would then be easier to get introduced grasses established upon them.*

With regard to the mountain types of soft camp where land tussac and mountain blue grass are characteristic (although a number of lowland species also occur): these areas are on peat of variable depth (sometimes the peaty layer is quite shallow overlying rock or rubble). Quite often these grazings lie on steep slopes at high elevation (1,000-2,000 ft.), and are in many places broken by massive stone runs, or, as is very common, by small relict stone runs and boulders, which will always hamper any extensive mechanical treatment of these areas. The difficult contours, the high elevation, and the generally inaccessible nature of all this mountain land suggest that it will be the last to receive

* The Agricultural Department has successfully drained such areas on Stanley Common.

any intensive measure of improvement. However, with adequate fencing and perhaps with the help of surface sown grasses of which Yorkshire fog is seemingly the most appropriate, and with more systematic as well as more intensive grazing at certain periods of the year, very considerable improvements could be brought about on these hill pastures. There seems to be a measure of shelter in many of the mountain valleys, and they could at least provide good summer pasturage for sheep and cattle. A technique of dealing with these areas whose acreage is very considerable should be contemplated, and a scheme built up whereby stock would be rotated between mountain and lowland during the summer and winter periods respectively. Some effort has already been made in this connection at a few stations, and there is evidence that the mountain pastures have been appreciably improved as a consequence.

SEEDING AND MANURIAL TRIAL (E189) DESIGNED BY THE WELSH PLANT BREEDING STATION

In 1935 and 1936 thirty-five lots of seed, each sufficient to sow one half acre, were prepared at Aberystwyth. These, together with certain manures, were despatched to Stanley. A standard scheme of manuring was agreed upon. The forms of phosphatic manures were employed as well as a complete PKN manure. The manures were weighed and packed in England for despatch to the colony. The first lot in 1935 comprised twelve lots of seed and the appropriate manures, followed in 1936 by twenty-three lots of seed and twenty sets of manures (three centres to be "no manure"). It was suggested that the plots should be widely distributed within the colony and should be sown variously on land after

(*a*) ploughing and preparing a proper seed bed,

(*b*) surface cultivation ("scratched"),

(*c*) no pre-cultivation whatever.

The details of the seeds mixtures employed are given in Table 2. The basal mixture was similar in the two years. Five species were included at a normally adequate seed rate, together with sixteen (in 1935) and nineteen (in 1936) other lots, each sown at the rate of

4 oz. per acre. The seeds mixture was based primarily on experience gained at Aberystwyth, and was of course purely experimental. The large number of species incorporated in the mixture were to be regarded as indicator plants which might offer guidance in connection with the general seeding problem, and upon which further experiments could be based.

TABLE 2.

THE SEEDS MIXTURES (IN LB. PER ACRE) USED IN THE "ABERYSTWYTH TRIALS" (E189) STARTED 1935-36.

Species	Lb. per acre	
	1935 lots	1936 lots
Perennial rye-grass S23 Aberystwyth	15	15
Cocksfoot S 26 (1935), S142 (1936)	15	15
Crested dogstail	4	3
Rough-stalked meadow grass	2	2
Wild white clover	2	2
Other species* sown in small amount (16 lots in 1935 and 19 lots in 1936, each at 4 oz. per acre)	4	5
Total ..	42	42

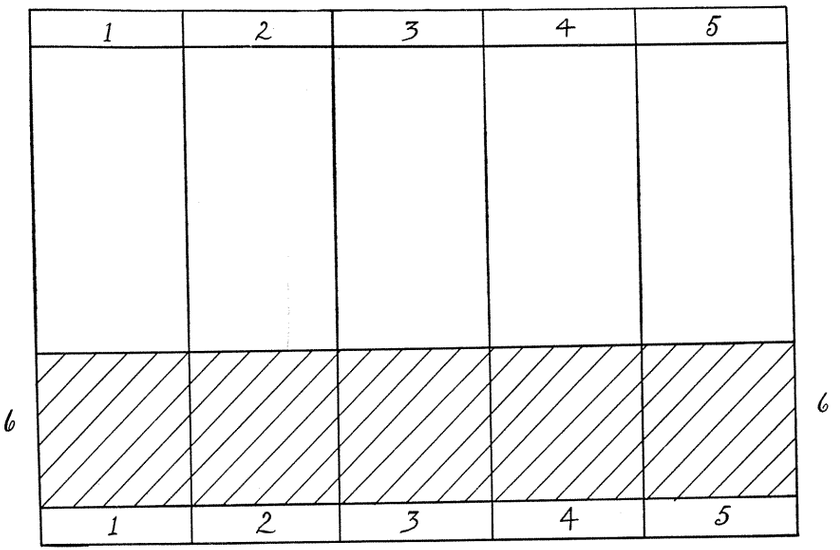
The suggested scheme of manuring was as follows:—

(1) Superphosphate (16 per cent P_2O_5) at 5 cwt. per acre,
(2) Basic slag (16 per cent P_2O_5) at 10 cwt. per acre,
(3) Control plot=no manure,
(4) Basic slag (16 per cent P_2O_5) at 5 cwt. per acre,
(5) Rock phosphate at 5 cwt. per acre,
(6) Complete artificials (C.C.F. No. 2)† at 3 cwt. per acre.

* *In both years* the following lots were sown (each at 4 oz. per acre)—timothy (S48), meadow fescue (pedigree), red fescue (S 59), meadow foxtail, smooth-stalked meadow grass (Bp 90), sweet vernal grass, Yorkshire fog, New Zealand bent, ribgrass, yarrow, burnet, chicory, red clover (late), alsike clover.

Additional to the above, timothy (S51) and tall fescue (pedigree) were added only in 1935, whereas in 1936 the following were added: Italian rye-grass, tall oat grass, buttercup, trefoil and *Lotus major*.

† Providing potash, some phosphate, and nitrogen.



PLAN OF TRIAL

The half acre block was arranged so that the differentially phosphated plots would be more or less square. One-third of the block was cross-dressed lengthwise with a "complete" PKN manure (C.C.F. No. 2) in such a way that this transected each of the phosphated plots as well as the "no manure" control plot.

Observations were made during the summer of 1937-38 on these plots sown on fifteen separate properties representing a wide range of conditions in both the East and West Falklands. The stations at which plots were laid down were as follows, the number of half acre plots seeded at each station is shown in brackets:—

Pebble Island	(4)
Hill Cove	(3)
Roy Cove and West Point ..	(2)
Chartres	(2)
Fox Bay East	(1)
Spring Point	(1)
Port Stephens	(1)
San Carlos South	(2)
San Carlos North	(4)
Douglas	(4)

(=two half acre lots subdivided)

Teal Inlet	(1)
Darwin and Goose Green.. ..	(3)
North Arm	(2)
Stanley Common	(3)

Thirty-three experiments were therefore examined.

Taken generally the standard plan was fairly well adhered to. The manurial scheme was not always according to plan in the 1935 centres, but in the second year (1936) there was strict adherence to the standard lay out at every centre. The pains that have in most instances been taken in connection with this trial are indicative of the general interest in grassland improvement which is to be found among station managers in the Falklands. In some cases the experimental areas had been fenced off in an attempt to regulate the grazing. Of the plots examined forty per cent had been laid down on ploughed land, usually on areas that had already grown crops of oats; some thirty-five per cent were sown on land which had been "scratched," often after a burn, and the remaining twenty-five per cent were surface sown without previous mechanical treatment. Altogether, therefore, the plots have been laid down under a fairly wide variety of conditions, made the wider (and therefore the more valuable) because they have been distributed among so many stations* and on many varied types of camp.

From the point of view of preparation of this report this simple experiment has provided invaluable data of an indicative kind, both with regard to the influence of phosphatic manures and the general question of seeds mixtures. It is to be hoped that further periodic observations will be made upon the plots during the next few years and that they can then be more fully reported upon. There can be no doubt of the importance of simple trials of this type replicated over a very wide range of conditions, and the results gained, even in the preliminary stages, have been of great value in indicating the possibilities of pasture improvement in the colony.

The seeds mixtures. Of the grasses sown in greatest amount in the mixtures, cocksfoot has shown the best promise. It has in most cases established itself well, and made good growth. The swards have, however, been very open and the grasses as a whole appear less robust than is usual in British grasslands. White clover seems to have germinated well in most cases, but the seedlings have not lived. The few

* These plots have been laid down at more than half of the total number of main settlements.

remaining plants of clover were usually non-nodulated ("puny"). Occasional plants which had become healthily nodulated were thriving and robust, obviously spreading rapidly during the summer of 1937-38.

Neither perennial rye-grass nor crested dogstail has shown outstanding promise, and particularly is this true in ordinary camp (as opposed to the settlement fields). In the open camp situations, and in those approaching out-camp conditions, rye-grass remains stunted, and having regard to the fact that a leafy pasture strain (S23) was used in the seeds mixture, rye-grass has a surprising tendency to go to stem and seed. Where the soil fertility is more suitable, as in some settlement fields that have been dressed with animal carcase and offal, the rye-grass has established well, and in the first harvest year has become dominant and of the characteristic deep green colour, at least on those patches where offal and carcase have been dressed very heavily. Rough-stalked meadow grass has shown itself even poorer than rye-grass. In many cases its establishment proved to be very poor, and even where reasonably well established the plants were making no leafage, and in most instances appeared to be completely starved of nitrogen, producing miserably small plants, both leaves and stems of which were purplish-red in colour. This is a characteristic reaction in a number of grasses when short of nitrogen, and has also been noted in experiments conducted on the Welsh hills. Rough-stalked meadow grass demands a high standard of soil fertility, and also does not readily tolerate an open sward or a dry habitat.

Among the species sown in small amount (see Table 2) the most promising in point of successful establishment appeared to be Yorkshire fog, red fescue, sweet vernal, and timothy. Yorkshire fog in particular has established extremely well in most situations, and in a few cases was among the most abundant components of the sown herbage, even though the seed rate was small (4 oz. per acre only). In most cases fog appeared among the sown species as second in abundance to cocksfoot (sown at 15 lb. per acre). Not only has Yorkshire fog established well, but the individual plants have grown more rapidly than those of any other of the sown species in the plots; second to fog has been sweet vernal grass, followed by cocksfoot as third in rate of growth. Taken as a whole, perennial rye-grass (represented by the pasture strain S23) has established poorly, and the plants have not grown robustly. White clover plants, where they have become nodulated, have made as much or more growth as single plants as any of the grasses, but where (as more usual) they have not nodulated, then

the growth has been negligible, and the majority of plants have died back. Timothy and red fescue have made very slow growth in the first year, but they have in most cases increased themselves by the second harvest year. The remaining species, namely, meadow fescue, tall fescue, meadow foxtail, smooth-stalked meadow grass, bent (*Agrostis*), tall oat grass, Italian rye-grass, red clover,* alsike clover,* trefoil,* *Lotus major*,* ribgrass, yarrow, burnet, chicory, and buttercups, have made no appreciable contribution to the swards from the small seed rate used. Ribgrass, *Lotus major*, yarrow, and *Agrostis*, must, however, be regarded as species of considerable promise in view of their behaviour in other areas within the Falklands. *Agrostis tenuis* forms the chief species in many of the paddocks about the various settlements, while *Lotus*, yarrow, and ribgrass have been noted in several places as flourishing introduced plants.

The results obtained from this trial, and supported by observations made throughout the colony, show that the species of greatest immediate promise for use in seeds mixtures are wild white clover, cocksfoot, timothy, Yorkshire fog, red fescue, *Agrostis tenuis* (and possibly *A. canina*), while further trial should be given to such plants as yarrow, ribgrass, dandelion, chicory, and burnet among the "weed" group, while of the legumes alsike, *Lotus*, strawberry clover, wild red clover, and suckling clover have been observed to make satisfactory growth at several stations within the colony.

The response to manures. Taken as a whole the response to the three phosphatic manures has been surprisingly small, as was also the response to the complete PKN manure. Careful observations made on all the manure plots at various centres have shown that there were slight responses to phosphates in almost every instance, but in no case could it be claimed that the response over the first and second harvest years would repay the cost of manuring, having regard to the composition and relative vigour of the manured and unmanured swards respectively. The most marked responses due to manures were at Chartres (ploughed ground), Douglas (surface scratched peat land), and at San Carlos North (uncultivated land on thin peat). The smallness of the response to phosphatic manuring which appears to be so general throughout the Falklands is the more surprising when one considers the very marked response to phosphate which takes place in many other countries, and which has been so often demonstrated

* The problem of seed inoculation arises in the case of these legumes just as with wild white clover.

on the grasslands of Britain, Australia, and New Zealand. It is to be stressed, however, that really striking response to phosphates usually occurs only where clovers and other legumes are established and grow freely. It is quite possible that if white clover can be properly established in the Falklands the response to phosphates will be much wider. Phosphates may be found indispensable to the proper growth and spread of clover. At the same time the evidence based on chemical analysis (24) shows that Falklands soils are not particularly poor in total phosphates and are at least as well supplied with available phosphoric acid as the ordinary cultivated soils of Britain. With regard to available potash, the soils of the Falklands appear to be about as rich as those growing good pasture in Britain, while the total nitrogen content of Falkland soils appears to be relatively high.

Lime. With regard to lime (CaO), chemical analysis has shown the deficiency to be very marked, thus, according to Orr (24), a soil carrying a good class of pasture in Britain may have a lime content equal to 0·800 per cent of the dry matter, whereas sixteen samples of Falkland soils analysed by him averaged only 0·126 per cent, and compared with a barren heath soil in Britain having a figure of 0·050 per cent. These data are summarized in Table 3.

TABLE 3.

COMPOSITION OF DRY SOIL. (Percentage of dry matter).*

	Phosphoric acid (P_2O_5)		Potash (K_2O)		Lime (CaO)	Nitrogen (N)
	Total	Available	Total	Available		
Average of 16 Falkland soils	0·133	0·030	0·336	0·049	0·126	1·230
British soil (good pasture)	0·149	0·010	0·560	0·044	0·800	0·445
British soil (heather and bracken)	0·081	0·004	0·025	0·010	0·050	0·033

These figures show the relative importance of lime in Falkland and British soils. However, there is little doubt that greatly improved pastures have been established in the colony without having introduced lime. At the present time the cost of liming any considerable acreage would be prohibitive, and unless extremely cheap sources of lime can be found, liming can only be attempted on small areas around the

* After Orr (24).

settlements. Furthermore, lime applied as a top dressing to the natural vegetation in its unimproved state does not, so far as the evidence goes, have any marked response. It may, on the other hand, be found to have a very material response where applied to land ploughed up and seeded with a mixture of grasses and clovers. We know from the Aberystwyth trials that greatly improved swards can be established and maintained without explicitly liming, but at the same time the indications are that the improved swards are maintained better and more easily where lime has been applied.

In Wales mere application of lime as a top-dressing to hill land that is absolutely without trace of clover gives little or no response, but once clover is introduced the response, though it may still be delayed, ultimately becomes very appreciable.

Top-dressing with lime (ground limestone) in the Falklands. An area of approximately 200 acres around Shallow Bay (Hill Cove) was dressed with ground limestone in 1925-26 at the rate of about 20 cwt. per acre. Part of this area (Rapid Point headland) was examined in the course of the present survey. It comprised typical hard camp (dry *Empetrum* heath), diddle dee, Christmas bush, and balsam being the dominant plants. The percentage (area) composition of the vegetation (January 20, 1938) was as follows :—

Diddle dee (*Empetrum rubrum*)	25 per cent
Christmas bush (*Baccharis magellanica*) ..	26 „ „
Balsam bog (*Bolax gummifera*)	15 „ „
"Moss" (*Azorella lycopodioides*)	8 „ „
Mountain berry (*Pernettya pumila*) ..	6 „ „
Small fern (*Blechnum penna marina*) ..	5 „ „
Fine grasses (*Festuca ovina* var. et *Deschampsia flexuosa*)	3 „ „
Lavender (*Perezia recurvata*)	3 „ „
Other plants (each in small amount) ..	9 „ „
Total	100 „ „

No differences could be seen between limed and unlimed areas, while so far as one could see after an examination of the site of the old lime dump* the heavier dressings likely to have been applied there had

* The lime is understood to have been landed at Shallow Bay from boats and put into a central dump prior to distribution. The site of this lime dump was examined because it is likely to have had a dressing much in excess of one ton per acre.

promoted no change in the herbage. No one at any time admits to having noticed any difference in the grazings consequent upon liming, and this fact must carry weight, because this particular experiment had obviously created considerable local interest, both among shepherds and managers. It is quite certain that so far as the evidence from this one experiment goes, the response to liming has been negligible. It would now form a most interesting further experiment to scratch up a portion of both limed and unlimed blocks with heavy tined implements drawn behind a tractor, and to sow a mixture containing say Yorkshire fog, ribgrass, and wild white clover (appropriately inoculated seed) to see whether in fact the lime applied in 1925-26 has a residual effect. Certain of the Welsh experiments would suggest that there may be such an effect. The suggested trial should prove very valuable in providing evidence relative to the question of the rôle of lime on open camp.

A certain amount of lime was also applied (in 1925-26) to the enclosed fields around Shallow Bay House. These pastures consist largely of bent with suckling clover and white clover. They are quite typical of settlement fields, but there is here again no suggestion that the lime has had any marked response. In the absence of properly laid out plots it would be premature to draw any conclusions, yet the close similarity of these fields to others of the same kind elsewhere in the Falklands does not offer any evidence of outstanding response to lime on matted bent pastures containing clover.

Nitrogen. The dark coloured matted and peaty soils of the Falklands are fairly well supplied with nitrogen, although this is likely to be in a form not readily available to plants. The problem is how best to get these mats rotted down and to make for general biotic activity in the soil, with consequent release of nitrogen among other plant foods. A great deal of work needs to be done in relation to this whole question, one of the utmost importance in relation to grassland improvement in the Falklands where the formation of semi-decayed mat is a characteristic feature everywhere.

In the "Aberystwyth plots" (E189) the response given by the complete (PKN) manures appeared to be that typically produced by dressings of inorganic nitrogen. When applied to the natural grasslands* this dressing has increased the growth of the native grasses and tended to suppress the growth of non-gramineous plants, while when applied to ploughed land it was seldom that a single plant of any

* Where the seeds mixture was surface sown without any cultivation.

clovers was to be found on the PKN strip. This depression of clover dressings of inorganic nitrogen is fairly characteristic, especially on acid soils, and where ammonium salts are used.

Organic residues (*including animal carcase and offal*). The most striking growth responses found in the Falklands are to be associated with organic manuring. No more marked response can be seen anywhere than that due to animal carcases and offal, whether this is left on the surface of the ground or ploughed into the soil. Somewhat parallel responses may sometimes be seen after diddle dee has been burnt. At one centre there was a very marked growth response in the 1938 oat crop due to the influence of raw meat applied to the land in 1936. These responses to organic manures were of the order of parallel responses to droppings on spring and summer pastures in England. On sown pastures in the Falklands these organic residues appear to promote growth as vigorous as that on a good class of grassland in Britain, whereas alongside, and in the absence of organic manuring, growth may be negligible, the grasses showing up yellow and generally starved in appearance. Heavy organic manuring of this nature, however, does not seem to provide any increase in the clover content, although white clover on the plots tended to establish better on those manured patches than elsewhere. In view of the general bacterial inoculation problem discussed elsewhere in this report it is not to be expected that the clover will establish properly in the absence of nodulation, although temporarily no doubt white clover would live healthily on patches well supplied with available nitrogen. The whole problem is one of intense technical interest, and is again to be closely related to the general question of rotting and that of building up soil fertility.

PASTURE IMPROVEMENT ON FIELDS AROUND THE SETTLEMENTS

In the immediate vicinity of the chief settlements, as well as around many outlying shepherds' houses, there is usually an acreage of closely-grazed pastures. Typically such pastures are dominated by introduced grasses of European origin, characteristically bent and meadow grasses, while in some cases daisies and sorrel may be more abundant than the grasses; sorrel often takes charge on sown grassland which has failed to maintain itself. The clovers, and in particular wild white and suckling clovers, are frequently to be found on settlement fields, but seldom

are they present in telling quantities. It is significant to note that in most instances white clover occurs in gregarious patches and is seldom evenly distributed over any appreciable area. This fact is one to be expected in view of the whole bacterial inoculation problem on the one hand, and the lack of facilities for seed setting in white clover on the other. In the absence of any appreciable seed formation the clover has to rely wholly upon vegetative propagation, and the patchy dispersion of white clover everywhere is naturally a reflection of this. At present clover is spreading slowly from a few focal points, whereas if seed were being set in abundance (and the appropriate bacterial organisms were more widespread) then the natural rate of clover spread would obviously be speeded up enormously.

Whatever the situation or aspect, practically every settlement field (where English grasses abound) throughout the Falklands is closely grazed, and where bent is the dominant grass the herbage cover is very dense and lawn-like. In fact many of these fields are more similar to an average lawn than they are to proper grazing fields. Usually the turf itself as well as the pasture is densely matted and sod-bound (much as plants left indefinitely in pots become pot-bound and consequently unthrifty). There is not an acre of this type that would not but benefit enormously by being either ploughed up and resown or very drastically surface-cultivated and sown down. There is of course always the danger of wind erosion, but it is almost certain that these swards would respond to treatment. Where white clover and suckling clover are already fairly widespread on such fields there would be a reasonable chance of success in ploughing up and sowing directly on the upturned furrow (after levelling down with the harrow so as not to bury the seeds too deeply), bringing in the grazing animal from the very start to consolidate the surface.

The gradual improvement of these patches around the chief settlements would provide invaluable experience in the technique of cultivation and ploughing-up with immediate reseeding, as well as in the general management of young swards. This would be particularly true on stations where the plough, seeds, and manures have either never been used at all or only in the most limited amounts. If existing settlement fields can be improved to the point of clover-dominance, there will probably follow a rapid extension of the aggregate area enclosed about each settlement. If seed inoculation of white clover proves to be successful there need be no further deterrent to the general improvement of these fields. It is wholly obvious that white clover, once properly established, grows vigorously in these pastures.

Vastly added interest would be given to such ploughings, cultivations, and seedings if quite small plots of phosphates and lime were put down at the time of sowing the seeds in order to gain further evidence regarding the whole question of manuring. In view of the data based on chemical analysis of the soils and herbage (24), it is important to know how far lime in particular will affect the whole process of pasture improvement, and especially with regard to the maintenance of white clover.

SEEDS MIXTURES FOR SETTLEMENT FIELDS

Having regard to all the evidence derived both from the experimental plots and from trials privately conducted by station managers it would seem that the following type of seeds mixture should fulfil requirements in the paddocks around the settlements :—

Timothy	5-15 lb. per acre
Creeping red fescue	1- 3 „ „ „
Cocksfoot	4- 8 „ „ „
Wild white clover	1- 3 „ „ „
Perennial rye-grass	8-14 „ „ „
Ribgrass	4-10 „ „ „

The essential basis of all the seeds mixtures laid down must be an attempt to get a flourishing take of wild white clover, and while the question of clover establishment remains still unsolved then the mixtures must of necessity be largely experimental in nature. At the present time perennial rye-grass appears to have only a limited use largely as a temporary grass included to cover the first year or so, while the slower growing species (red fescue and white clover in particular) are establishing themselves. Ordinary commercial perennial rye-grass could be used for this purpose, much as Italian rye-grass is utilized in Britain. Chief reliance is to be placed on creeping red fescue and wild white clover, while timothy and cocksfoot are the most promising top grasses. Emphasis must here be laid upon the use of proper pasture strains. Wild white clover is of recognized value and is unlikely to be immediately improved upon for conditions in the Falklands. The ordinary white clovers of commerce emanating from northern and central Europe should be carefully avoided, and until further evidence is forthcoming reliance should be placed upon British strains of wild white clover.

With regard to the grasses, emphasis must be placed upon pasture strains. The difficulty with these is that seed supplies are very limited, particularly those which are products of the Welsh Plant Breeding Station. There can be little doubt, however, that the pasture strains will be found better suited to conditions in the Falklands than the ordinary strains of commerce, and it is suggested that a good deal of seed of the pedigree strains could be specially grown on the stations. This is true of cocksfoot and red fescue, whereas timothy (and in particular pasture strains) may flower too late in the season to produce a reliable seed crop. White clover, along with the other cross-fertile clovers, of course provides a special problem. These clovers do not normally set seed unless pollinated by bees, so that clover seed production cannot be attempted until such time as bees are introduced and established in the colony.

The whole question of proper seeds mixture is one for further experiment. A great deal of useful experience could be gained if whenever a field was being laid down to grass it was laid down in plots say of an acre each. There would be no necessity to fence the plots as such, but only to modify the seeds mixture sown on each, so that some one or more points are being tested. The mixture quoted above might be used as a basis, and the following suggested mixtures might be tried out. It is obvious that the modifications, additions, and subtractions are innumerable, and the few suggestions made hereunder are to be regarded merely as guides. The species and strains enumerated are those which have so far shown greatest promise under Falkland conditions.

TABLE 4.

SEEDS MIXTURES FOR SETTLEMENT FIELDS: SOME SUGGESTED EXPERIMENTAL MIXTURES.

Species	1	2	3	4	5	6	7	8	9	10
Timothy (pasture strain, e.g. S48 or S50)	4	8	4	4	8	8	8	8	20	4
Creeping red fescue (e.g. S 59) ..	1	3	1	1	1	1	1	1	1	10
Cocksfoot (pasture strain, e.g. S 26 or S143 or Akaroa)	—	—	—	8	—	—	—	—	—	—
Wild white clover (Kentish) ..	1	3	3	1	1	1	1	1	1	3
Perennial rye-grass (commercial or N.Z. certified)	14	8	8	8	14	14	10	14	8	14
Perennial rye-grass (pasture strain, e.g. S23)	—	—	8	—	—	—	—	—	—	—
Wild red clover	—	—	—	—	4	—	—	—	—	—
Lotus major	—	—	—	—	—	4	—	—	—	—
Ribgrass	—	—	—	—	—	—	20	—	—	—
Yarrow	—	—	—	—	—	—	—	1	—	—

It is to be emphasized that clover seed will need to be inoculated, and it is important to note that the strain of bacteria infecting white and red clovers is not effective on *Lotus major*, so that the special *Lotus* strain of bacterial culture should be used wherever this species is included in the seeds mixture. The alternative to seed inoculation is of course dressing the newly sown land with already inoculated soil from existing clovery areas.* The rate of application of inoculated soil used as a top-dressing immediately after sowing the seeds need not be more than 5 to 10 cwt. per acre, so long as care is taken that it is collected from areas of well-nodulated clover.†

SEEDS MIXTURES FOR THE OPEN CAMP

(*a*) *Surface sowing without previous mechanical cultivation.* There are extensive areas of camp in the Falklands, and in particular of soft camp, which would be greatly improved if an increased number of stock could be drawn to them. Yorkshire fog sown on the surface without prior cultivation has been shown to establish itself readily on these situations, and when established seems to be greatly relished by stock; it is definitely more palatable than the native herbage. There are indications which suggest that if fog is introduced and the amount of grazing thereby increased the ground tends to consolidate, and the animal through its droppings and its urine increases the rate of decomposition and in this way influences the general biotic activity of soil and herbage. Once this process of biological activity is started and the peaty soils begin to decompose the surface mat is progressively rotted down. All the time the surface is hardening up and becoming drier as the capacity of the spongy surface to hold water becomes lessened. It is to be stressed that the surface sowing of Yorkshire fog is regarded only in the light of a pre-treatment, the ultimate ideal for which to aim is a clover-rich sward, and this can only come about after the introduction of wild white clover, and possibly only at a later stage after the process of consolidation of the peat has proceeded for some little time.

* In the case of *Lotus major* the appropriately inoculated soil would come from areas now in *Lotus*.

† In a soil inoculation experiment conducted at Port Howard in January, 1938, on a three months old ley pronounced nodulation took effect within four days. The rate of dressing in this case was 1 ton of soil per acre.

In most cases the only requisite pre-treatment before sowing of Yorkshire fog is to burn off all coarse herbage. The rate of seeding of fog for such surface sowings need not be more than 4 to 8 lb. per acre. The points in choice of fog in preference to other species for this initial phase of pasture improvement are :—

(i) the readiness with which it establishes in these habitats,
(ii) its highly palatable nature relative to the natural species,
(iii) the relative cheapness of seed supplies.

For the purpose of sowing out on wet camp unhusked seed holds some advantage over highly cleaned seed in so much as it can be distributed more easily at lower seed rates and also because samples of unhusked fog will often contain other seeds of value, including suckling and white clovers as well as other grasses.

The surface sowing of Yorkshire fog seed without prior cultivation is likely to find its greatest usefulness in connection with the soft camps, including white grass flats, white grass with oreob, marshy valleys of brown swamp grass (*Rostkovia*) and the tops as well as the sides of peat banks. Sowings of Yorkshire fog are also likely to assist in the improvement of mountain grazings. The procedure therefore suggested for all types of soft and wet camp is to broadcast unhusked fog at the rate of at least 4 lb. per acre after the area to be sown has first been burnt over. There is no necessity to fence off the sown area. The whole scheme will at first be experimental and the technique modified as occasion demands. It may be found, for example, an advantage to sow fog seed every time an area of white grass camp is burnt over, whereas in other cases a proper seeds mixture, including wild white clover, may be employed at the second reseeding.

With regard to the regrassing of hard camp, all the evidence indicates that pre-cultivation is necessary before any seed is sown. This is particularly true on diddle dee areas and on allied types of closely matted swards where lichens, Christmas bush, and mountain berry contribute appreciably to the vegetation. On such areas the mat is so dense and thick that unless this is disturbed mechanically seed cannot make contact with the soil. Some sort of tilth, therefore, must be obtained before reseeding takes place. All the experimental plots laid down on hard ridges show that even moderate establishment of seed is not obtained without first scratching the surface. Where diddle dee ground was burnt fairly good takes were obtained. This procedure, however, seems to be a very dangerous one, for if the soil is at all dry

the hot fire made by the highly resinous diddle dee burns into the ground, often with serious consequences, and which may involve complete wind erosion of the surface soil, leaving only bare "clay" or subsoil. Hard camp should never be burnt over. The evils attendant upon the use of the fire-stick on hard camp are to be seen everywhere in the colony.

(*b*) *Surface seeding after drastic "scratching" with tined implements.* Surface cultivation with tractor-drawn tined implements offers considerable scope in the regrassing of various grades of hard camp in the Falklands. Over large areas such "scratching" of the surface would provide some sort of a seed bed, thus overcoming some of the difficulties and the risks of soil erosion attendant upon the use of the plough. Grassland cultivation of this kind is tractor work, and cannot be done properly by horse labour, and in particular by the light horse of the Falklands. It is essential to pierce the mat and to get sufficient bare soily material to ensure that the seeds become established. Having regard to all the conditions it is suggested that from twenty to forty per cent of the surface be bared prior to sowing the seeds. Twice-over with the appropriate implement should be sufficient in all cases, whereas in many instances once-over would be enough. Care must obviously be taken (particularly where the proportion of coarse sand is high) not to promote soil (wind) erosion, and the amount of bared surface will therefore depend largely upon local conditions. The best way to combat soil erosion is to get the land regrassed as quickly as possible.

The seeds mixture for the purpose should contain a proportion of seeds which will establish quickly. For this reason Yorkshire fog must find a place in such mixtures. Further trials should be started in order to test the value of red fescue, cocksfoot, timothy, rye-grass, and bent on these habitats, while among the miscellaneous herbs ribgrass and yarrow might prove valuable. Properly inoculated seed of wild white clover and suckling clover should be used in all experimental mixtures. For the seeding out of surface cultivated land the following should be regarded as the minimum rates of seeding for the individual species. The maximum rate need not be in excess of three to four times these amounts:—

Yorkshire fog	5 lb. per acre
Creeping red fescue	2 „ „ „
Cocksfoot	5 „ „ „
Perennial rye-grass	5 „ „ „

Timothy	5 lb. per acre.
Wild white clover	1 „ „ „
Suckling clover	1 „ „ „
Ribgrass	5 „ „ „
Yarrow	½ „ „ „

(*c*) *Ploughing and sowing on the upturned furrow.* There are a number of difficulties in the way of ploughing in the Falklands, not the least of which is the exceedingly uneven and tussocky nature of many areas that might otherwise plough up quite well. There is little doubt that with modern grassland ploughs (tractor drawn) a good deal of land could be successfully ploughed up. There are, however, other difficulties of a more serious nature, and these include:—

(i) The fact that the densely matted turf, often of great thickness, does not rot down and decompose readily after being ploughed up. Typically the ploughed up turf will remain dry and may even promote a condition approaching complete desiccation on the surface. This mat when ploughed up seems to lose the capacity to hold water; neither does it allow water to filter through in either an upward or downward direction. This produces conditions unfavourable either for rapid rotting or for vigorous growth of any seed that may have been sown.

(ii) Where a fine tilth has been obtained the powdery soil on the surface may be completely removed by wind. This is often to be observed on settlement fields which have been ploughed up for a number of years. Wind erosion becomes a very serious danger in areas where the soil is sandy or contains a fair proportion of sandy material. Until further evidence based on experimental ploughing is forthcoming the plough should not be employed extensively in areas carrying sandy soils.

Where the plough is to be used on land hitherto never ploughed, the technique should be to plough the furrow as flat as possible and to sow Yorkshire fog and ribgrass directly on the upturned sod. A deep fine tilth is not necessary for grass seeds, while a loose friable tilth is definitely harmful unless it can be properly consolidated before the seed is sown. The aim should be to get a grass cover as quickly as possible (hence the value of fog) so that animals will be drawn to these areas to feed, to excrete, and to consolidate. In effect the whole aim must be to do everything possible to influence the rotting down of the old turf. If the current trials with seed inoculation of the clovers are successful, then white and suckling clovers (and perhaps cheap seed of

broad red clover) may be used in these sowings. The paramount importance of Yorkshire fog in this initial phase immediately after ploughing lies in its proved ability to grow quickly from seed, and its highly palatable nature relative to the native herbage.

With regard to the whole question of Yorkshire fog sowings in relation to improved carrying capacity, it is interesting to record the following data from Grave Cove Point (Roy Cove Station).* Seed of Yorkshire fog was sown on this area about 1915-18, and the plant has now spread itself over some 400 acres which have been fenced off. The stock carried records for the season 1936-37 on this block of 400 acres, are given as follows:—

2,600 sheep for two months, equivalent, to say, 156,000 sheep days,

12 horses for twelve months
12 bullocks for twelve months } equivalent, to say, 44,000 sheep days (calculating 1 horse or bullock to 5 sheep).

A total of 200,000 sheep days on 400 acres, or 500 sheep days per acre for the whole year. This would be equivalent to about 1·4 sheep per acre per annum as compared with the average for the whole station of about 1 sheep to 4 acres, an increased production of the order of five- or six-fold. These figures are based on the grazing records of a single year, but they provide a general indication of the order of increased stocking which will follow upon the introduction of new grasses. The increase is likely to be even greater on the more favourable situations, and particularly where white clover becomes firmly established in these swards.

The evidence from West Point Island too emphasizes the value of Yorkshire fog. West Point shows the heaviest carrying capacity of any station and appears to be one of the few on which the number of sheep carried has not been materially reduced since 1895. It is highly significant, therefore, to record that there is a far greater acreage of Yorkshire fog on West Point than on any other station in the colony. This grass probably contributes appreciably in excess of twenty-five per cent to the total herbage on West Point Island as a whole. That is not to say that fog is the ideal basis for the sward on such habitats. Much preferable, and probably of still higher carrying capacity, would be a sward composed of cocksfoot, red fescue, and wild white clover. Fog, however, being a perennial must be an improvement upon the annual grasses, especially during periods of dry weather in the summer

* The figures are based on data kindly provided by Mr. S. Miller of Roy Cove.

months. Annual hair grass (*Aira praecox*) and ratstail fescue (*Festuca Myuros*), together with other annual grasses, provide the basis of the pastures on many of these islands. During wet seasons these plants provide excellent grazings on which sheep fatten readily. In years of even short duration summer drought, however, these annual grasses by their very nature will dry up completely, while perennial grasses remain green and flourishing. The relative abundance of the small annual grasses is probably the chief reason why these islands feel so keenly the effect of spring and summer droughts.

ROTATIONAL GRAZING—IN THEORY AND IN PRACTICE

Proper pasture control with intermittent resting of paddocks is of fundamental importance in maintaining any type of grassland. With regard to the present natural pastures and the ranch system of grazing as conducted in the Falklands, a considered system of spelling areas in rotation would have the effect of assisting the finer grasses, for it is these that are bearing the brunt of the grazing at the present time. In effect, and on many areas, these more palatable elements of the natural herbage seldom get any rest at all. If new and still more palatable species are to be introduced, and particularly if the highly palatable clovers are to be maintained in vigorous condition, periodic resting of the paddocks will be found more than ever necessary.

The whole question of controlled grazing is closely linked with that of fencing, and the subdivision of existing paddocks. In a general way the efficiency of grazing control will always be in inverse proportion to the size of paddock. The number of paddocks available as individually fenced units will generally determine the length and frequency of the rest periods that can be given to any particular paddock. The salient point is that on any given area of grassland there is a mixture of plants which differ in palatability, in vigour of growth and in general utility as grazing plants. Under a system of continuous stocking it is the most palatable and always the most useful of these that will be eaten out. The greater the difference in relative palatability between the different species, the more rapid are the highly palatable ones likely to be exterminated. Not only does the grazing animal itself tend to

deplete them by continued defoliation, but the less palatable elements in the sward by virtue of not being appreciably grazed off are allowed to become by so much the more aggressive.

The Falkland white grass meadows provide a fairly good example of this. Native fog appears to be relatively palatable, whereas white grass and oreob are both relatively unpalatable. Native fog has almost certainly been greatly reduced in amount, although it is still found in a wide variety of grassland types. Skottsberg (26) records this species as being less abundant (in 1908) than formerly, and there is no evidence to suggest it has since increased. The case for a proper system of controlled grazing of the natural swards is that the elements that receive most attention from the animal are given a period of rest. With improved swards it is still more important that the pastures be given periodic rest, and in particular will this be true on areas where the clovers have been introduced into native herbage after surface seeding.

FENCING AND SUBDIVISION OF PADDOCKS

The need for a policy of subdividing existing paddocks and the creation of new fences is of primary importance taken as part of a larger scheme of land improvement. At present the grazing units are too large and are so few in number on many holdings that even the simplest system of rotational grazing is impossible. For conditions in typical open camp in the Falklands paddocks of the order of 600 to 1,000 acres apiece would seem to be a first ideal for which to work, whereas with regard to fields around settlements, about 10 acres would appear to be the optimum size. The value of closer subdivision lies in its effect upon the control of grazing, and the better utilization of grass. The tendency throughout the Falklands is for the grazing animal to concentrate upon the dry ground (hard camp), while the damper ground (soft camp) receives only a minimum amount of grazing and trampling from the animals. Sheep and cattle where left to their own devices will choose to graze upon the green valleys (which always seem to be grazed to excess) and upon the ridges of hard camp, while of the soft camp lying adjacent it is almost true to say that no hoof ever traverses it.

The whole essence of the thesis for subdivision is to aim first at better utilization of the pastures, which includes the less severe grazing of hard camp and green valleys, and *a much more severe grazing of the*

soft camp. Evidence collected on soils examined from a number of fields around Stanley shows that intensity of trampling by grazing animals has exerted a tremendous influence upon the character of these peaty soils. Very limited stocking and lenient grazing has practically no effect upon the peat, whereas excessively heavy stocking causes a complete soil change. On heavily stocked areas the superficial layers of the peat decompose and break down to form a soily mat typically about 3 in. thick. This overlies a well humified soily peat some 6 to 9 in. in depth, and which shows a gradual change below to the usual type of soft camp peat.

Associated with this soil change is a complete transformation of the herbage growing on the surface; the unchanged peat soil carries an inferior herbage in which white grass and oreob are dominant, whereas after a process of consolidation a dense matted sward of bent is carried. These changes in soil and grassland types are evidential and indicate how important a part the biotic factor plays in the development of grassland in the Falklands. The matted bent or brown top type of sward is a big improvement upon the original rough grazings of the white grass-oreob type, but if white clover could be introduced a still greater degree of improvement would be brought about.

Examples of this process of making soil from immature peat under the influence of the biotic factor are to be seen around every settlement in the colony. The fields about the settlement even where there has never been any cultivation show gradations from bent pastures where there is heavy treading and grazing to the natural white grass and other soft camp types where the influence of the animal is less marked. Similarly the areas along the coast where the Gentoo penguin has nested show the same transition, although in these cases the destruction of the native vegetation is usually so rapid and so complete, and also the inbrought fertility (by penguin excreta) is so great that *Poa annua* has usually taken charge to the exclusion of almost every other species.

In both uncultivated settlement fields and penguin grounds the transformation in the herbage is accompanied by the destruction of the raw surface peat and the production of a soily, as opposed to a peaty, surface layer. Perhaps the major distinction between the two-soil conditions is in their water-holding capacity—the original peat will normally be sponge-like and highly retentive of moisture, whereas the surface mat of soil residual upon the action of frequent grazing, treading, and manuring by the animal may be quite dry, even after heavy

rain. This latter "soil" bears a close resemblance to the "mat" on British heaths and moorland, but it seems to be even less pervious to water than its British counterpart. It was observed in the Falklands that after a heavy shower the rainwater lay in the surface depressions forming small pools 3 to 4 in. in diameter, while the mat lying below was not even damped. This condition is very commonly met with around the settlements on the matted bent pastures, and it is very significant to note that pool formation of the type described did not take place where white clover was abundant. The formation of mat under the patches of white clover is always less pronounced than below a purely grassy sward of bent and the like. It is also much more pervious to water. In dry weather the *Agrostis* mat is characteristically "bone dry," while at the same time there is an appreciable degree of dampness in the clovery turf. An exactly parallel case is to be found on the Welsh hills when clovery and non-clovery patches are compared on uncultivated ground.

THE PLACE OF "BURNING" IN CAMP IMPROVEMENT

Periodic burning of the wet and soft types of camp designed to clean off the dead, coarse, and unpalatable herbage can only do good, but burning should always be followed systematically by a sowing of seeds. Yorkshire fog, which establishes readily on this type of land, should be sown after every burn. Trials could also be made with inoculated white clover surface sown and where possible trodden into the ground by sheep. There is much soft and semi-soft camp in the Falklands which would greatly improve if white clover and suckling clover could be introduced successfully into the natural swards.

The ideal when burning camp is to singe off the dead vegetation and to leave unharmed all green and growing leafage. In no case should the fire burn into the roots. On wet camp where white grass is dominant such singeing is possible on a large number of days in the year. Damp weather should be chosen for these burns, while in general little or no burning should be done during long dry spells. The vegetation at ground surface level is never very dense on wet white grass camp, so that in preparation for a seed bed nothing more is needed than to remove the coarse dead leafage residual from former years.

As a generalization hard camp in the Falklands should never be burnt, and this is particularly true of diddle dee ridges. Diddle dee is highly inflammable when wet or dry, and gives off terrific heat. The process of singeing is in most cases not possible on hard camp, because of the ease with which fire will enter the soil, while regeneration of vegetation of any kind is extremely slow after such fires. Areas of hard camp burnt in past years tell their own tale. The grasses and the more valuable herbs are burnt to the roots and any seed of these lying in the surface is destroyed. This is an important point, for there is a very considerable annual regeneration from seed taking place on hard camp in the Falklands. After the rainy spell in January, 1938, large numbers of fresh seedlings of native grasses and herbs were to be found everywhere.

There can be little doubt that the dry ridges have suffered considerably in the past from indiscriminate burning. The prevalence of mountain berry—a practically worthless plant for grazing but one that can withstand fire and can recover fairly rapidly because of its extensive and highly resistant root system—on many of these ridges shows well the adverse effect of burning. The course of action with regard to improvement of hard camp, therefore, seems to be to cultivate the surface and to sow seeds rather than to introduce a burn. On soft camp the process is to singe and sow seeds. The aim in both cases is the ultimate establishment of wild white clover.

LEGUMINOUS CROPS IN BUILDING UP SOIL FERTILITY

The value of clovers and other legumes (members of the pea family) in improving the texture and fertility of soil in which they are grown is too well known to need further comment. The role of herbaceous legumes in pasture lands, however, still needs further to be stressed. Under conditions in the Falkland Islands wild white clover is likely to be the legume of outstanding merit and applicability, though sight must not be lost of the possibilities of other legumes for special purposes—suckling clover in the initial phases and for very poor situations, red clover for hay production in the settlements, *Lotus major* for certain swampy areas to name but three of the potentially valuable species.

The clover plant is not only of high food value compared with most plants, but is usually very palatable, and also tends to improve the general palatability of other plants growing in association with it. The mere drawing of stock to graze upon areas where there is clover helps to improve those areas, the animals dung, urinate, and consolidate, all of which assist in the building up of fertility and in an increased rate of biological activity in the soil. In the words of the practical man "clover eats the mat," and there is no factor destined to be of greater importance with regard to pasture improvement in the Falklands than that associated with the "eating of mat." General improvement of pasture lands cannot take place unless the mat of only semi-decomposed plant residues is in some way rotted down, and the plant foods locked up in it brought into circulation once again.

The greatest single factor in the pursuit of land improvement in the Falklands is the spread of wild white clover. Every effort should be made to experiment in order to test ways and means of getting clover into all types of pastures. It is almost certain that most types of hard camp will grow clover, given free nodulation by appropriate bacterial cultures.* Whether or not white clover, or any other suitable legume, can be grown upon the wet camps generally and including the deeper peat soils, is a matter for further investigation. The indications point towards success.

By virtue of its capacity to collect nitrogen from the air the clover plant enriches the soil and builds up fertility in general. This enrichment of the soil increases soil activity in general and promotes the rotting of otherwise undecomposed herbage. This process results in a freer and more rapid circulation of plant foods, particularly on properly controlled grazings in which the animal is not only eating relatively rich herbage, but is excreting correspondingly rich manure.

The surface rooting clovers, such as wild white clover, appear to be able to build up surface fertility at a more rapid pace than deep-rooted legumes, although no doubt the latter have an added value in so much as they have a greater ability to draw fresh nutrients to the surface from the deeper soil layers.

With regard to bacterial inoculation the trials now in progress should show whether the appropriate practical way is to dress the

* Certain strains of *Bacillus radicicola* (the clover bacteria) have been found to be parasitic (32), and useless as agents for nitrogen fixation. These forms appear, however, o be quite exceptional.

seed with bacterial culture, or simply to dress all newly sown areas with bacterially infected soil (=white clover soil). In trials conducted at Aberystwyth (23), both white clover soil and bacterial cultures gave satisfactory results on hill lands which in their unimproved state are more or less devoid of legumes, much as is the case in the Falklands.

Relative to the whole question of inoculation it is to be remembered that all legumes are in practice dependent upon their symbiotic bacteria, but the appropriate strain of bacteria may differ from one legume to the other. The clovers (i.e. species of *Trifolium*) can be cross-inoculated —that is, the bacteria on white clover will also infect other members of the genus, but will not usually affect nodulation in other genera, e.g. *Lotus*, *Ulex* (gorse), *Medicago* (lucerne).

This raises another point of practical importance in the Falklands, namely, that connected with the establishment of gorse for hedges and shelter breaks. Normally considerable difficulty is now being experienced in establishing seedling gorse, and there is reason to think that part of the difficulty is due to lack of efficient nodulation. It would in any case always seem a wise precaution when making new plantings of gorse to dress with inoculated soil from underneath existing gorse bushes, so as to ensure that the appropriate bacteria are available for the new seedlings. The easiest way to do this would be to have a supply of "gorse-inoculated soil," and to throw a small handful of this around the newly planted seedlings. Where a new gorse hedge is being established from seed, then mix the seed with inoculated soil before sowing.

Adequate inoculation with the appropriate bacteria is of course applicable to all legumes. Once the Falkland soils have been well impregnated with bacteria, and once these several legumes (and pointedly of course the clovers) really get spread widely throughout the colony, the need for inoculating new sowings may never arise because the bacteria will spread just as quickly as the clover. It is quite conceivable therefore that the settlement fields will only require to be inoculated during the first quite few years following the systematic introduction of nodule organisms. The spread of the organism may be even more rapid than is indicated here. The important point is to make the soil conditions suitable for the development and rapid multiplication of the organisms, and it is here that the importance of lime, and perhaps of phosphatic manures, may be felt in due course.

INOCULATION EXPERIMENTS WITH WHITE CLOVER

SOME FALKLAND RESULTS

The study of white clover in the Falklands reveals two important facts. First that white clover once established grows luxuriantly and spreads in gregarious patches, particularly around the settlements and dwelling houses. In some cases it has entered the native vegetation and locally suppresses that vegetation. The second fact is that when sowings of wild white clover seed are made only occasionally have full stands been obtained. The general experience from sowings has been that the clover seed germinates well, but the seedlings die off after a few months. These deaths have usually been attributed to adverse weather conditions, but a close study of the problem suggests very strongly that the phenomenon is due wholly or in very large part to the lack of nodulation. The majority of clover seedlings studied in the year of sowing showed no nodulation, even though the number of seedlings per unit area was large and the general establishment of clover satisfactory.* In some cases the seedlings appeared to have fully green leafage, while in others the young seedlings were yellow and obviously sick ("puny").

On year old sowings the position had changed appreciably. The total population of white clover seedlings had been reduced to quite small numbers, and almost every plantlet still alive was a "puny" (i.e. not nodulated and with yellow leafage). Sometimes scattered plants would show up bright green and vigorous: wherever these were examined they were fully nodulated and obviously healthy. The general indications from observations made in the field, therefore, would suggest that given appropriate bacterial inoculation, normal nodulation and spread of white clover plants would take place.

In order to test whether nodulation could be induced artificially a number of simple experiments were set up at several stations. These experiments were of two types, namely (1) potting "puny" seedlings and year-old plants with and without a dressing of "white clover soil," and (2) applying a dressing of "white clover soil" to plots in the field (seeding year and one year old swards).

* Accurate seedling counts made on the white clover at Port Howard showed that the initial percentage establishment may be very high in white clover. In this instance the field had been seeded in October, 1937, previous to the analysis, and there were on the average forty-two white clover seedlings per square foot (this represents an establishment of about seventy per cent from a 3 lb. per acre sowing).

In the pot experiments the technique was to use soil from the natural grazings where contamination by clover bacteria (*B. radicicola*) was at most only a remote possibility. A number of "puny" seedlings were lifted from sown fields and planted in two pots. One pot received a sprinkling of "white clover soil" and the other pot was used as control. The two pots were labelled and placed at a distance apart from one another, either in the conservatories at the several centres or in the house garden. In each case they were kept under observation and watered when necessary. It is of course to be emphasized that under the circumstances nothing but the most simple of experiments could be set up. I must, however, acknowledge the readiness with which everyone offered facilities in regard to setting up these small tests and the interest displayed in them generally.

Pot experiments were set up at five different stations, and the results are detailed in the following statement.

Location	Date started	Date examined	Result
	1937	1938	
Chartres	Dec. 4	Jan. 23	Good nodulation, large nodules.
Port Stephens ..	Dec. 11	Jan. 27	Nodules numerous but relatively small in size.
Port Howard (1) ..	Dec. 14	Jan. 14 Jan. 30	Well nodulated, but nodules small. (Control partially nodulated.)
	1938		
Port Howard (2) ..	Jan. 14	Jan. 30	Nodulated, small nodules.
	1937		
Douglas	Dec. 21	Feb. 8	Good nodulation, large nodules.
	1938		
Darwin	Jan. 9	Mar. 9	Good nodulation, large and small nodules.

Successful nodulation was obtained, therefore, in every case, although in many instances the nodules appeared to be smaller than typical. At one centre the control pot had also become weakly nodulated. This may have been due to faulty technique as well as to a variety of other causes. The point is unimportant in the present instance where the main issue was to test whether or not inoculation could be brought about by an application of appropriate soil. Nodulated plants were healthier in appearance than those non-nodulated, and in most cases had also made appreciably more growth than the control plants.

Field plots were laid down at three different stations, and details of these are given below:—

TABLE 5.

DETAILS OF SOIL INOCULATION (FIELD EXPERIMENTS)

Location	Harvest year of pasture at start of trial	State of development of clover at start of trial	Size of plot	Approx. rate of soil application per acre	Date started	Date examined	Results
Chartres ..	First ..	"Puny"	1 sq. yd.	1 ton	1937 Dec. 4	1938 Jan. 23	Good nodulation; plants had become healthy green. Growth definitely renewed.
North Arm ..	”	”	4 sq. yds.	5 cwt. ..	1938 Jan. 11	Feb. 1	negative result on nodulation and growth.
” ..	”	”	”	1 ton ..	”	”	”
” ..	”	”	”	2 tons ..	”	”	”
” ..	”	”	”	4 tons ..	”	”	”
” ..	Seeding ..	Clover seedlings normal but non-nodulated	80 ”	5 cwt. ..	”	”	”
Port Howard	” ..	”	400 ”	1 ton ..	Jan. 14	Jan. 18	80 per cent had become nodulated on January 18, 1938. (i.e. four days after soil application).
					Re-examined	Jan. 31	Complete nodulation in sixteen days and with occasional nodulated plants away from the plot.

The field trials at Chartres and Port Howard were successful, and therefore corroborative of the evidence from all the pot experiments. At North Arm, however, no nodulation was found on any of the treated plots. There is no apparent reason why the North Arm trial should have given negative results, particularly when white clover is spreading and making healthy growth in numerous gregarious patches about the settlement generally. This experiment needs to be repeated, using both inoculated soil and resowing with inoculated seed.

The plot at Port Howard proved most interesting in that the seedlings already well established showed nodulation within four days of having been dressed with soil. The following data collected from this experiment are of interest:—

Nodulation of white clover seedlings.

Soil applied January 14, 1938, examined January 18, 1938 (after four days).

	Well nodulated	*Not nodulated*	*Indeterminate*
Ten seedlings from plot receiving inoculated soil	8	1	1
Ten seedlings from control plot (no soil) ..	Nil	9	1

The nodulation "take" was in this case not only very successful but surprisingly rapid. These plots were re-examined on January 31, 1938, and the results confirmed the previous readings, namely, that free nodulation had taken place on the plot receiving inoculated soil.*

These trials have no pretension to finality, but they go to show quite decisively that bacterial inoculation with subsequent nodular development can be induced as a result of dressing with inoculated soil. All the observations go to show that seed or soil inoculation is essential before white clover can be expected to become properly established from sowing. The simplest way to inoculate is to dress the seed with bacterial culture, and trials to test the efficacy of seed inoculation under Falkland conditions are now in progress.†

* I am indebted to Mr. Weir and to Mr. Douglas Pole-Evans for making the January 31 examination.

† Appropriate cultures have been prepared by the Bacteriological Department, Rothamsted, and despatched to the Department of Agriculture, Stanley, for dissemination and general trial.

THE AGRONOMIC BEHAVIOUR OF LEGUMES OTHER THAN WHITE CLOVER

In the course of the survey opportunity arose to study the behaviour of leguminous plants other than white clover. These usually occur as scattered plants sometimes resulting from definite sowings, but more often they have made sporadic appearance about the settlements and the wharves. Usually the seed will have been introduced in imported packing material and in hays that have been imported. Such importations have been made in the past from Britain, New Zealand, South America, and elsewhere.

Considering the evidence generally, and relative to the question of palatability, all these introduced legumes stand high in the scale of palatability. Emphatically the clovers (including of course white clover) are among the most palatable herbage plants in the colony. This high standard of palatability of say white clover confirms results elsewhere in temperate climates. An endorsement with regard to this point seems necessary here only because it is frequently asserted in the Falklands that white clover (in particular) is not palatable, and is only infrequently eaten by stock. My own observations during the summer of 1937-38 show that white clover is of outstanding palatability, and this is true generally of other clovers.

Red Clover. Once properly established, red clover grows well and comes to normal maturity. When seed is sown the usual lack of nodulation is noted, and only occasional plants pass the seedling stage. Forms of wild red clover show particular promise as pasture plants in the Falklands, because of their apparent persistency. Wild red sown at Port Howard in 1930 is still a good stand (more than one plant per square yard of ground, and the plants dense and robust).

Alsike clover. Occasional plants are to be found around some of the main settlements. Judged by the woody nature of the rootstock some of these plants must be of considerable age. In most cases there is little or no lateral spread, and of course seed is not set. Alsike seed has been frequently used in seeds mixtures for settlement fields and given appropriate inoculation might prove a very valuable species. "Puny" plants were established in some of the experimental plots (E189).

Strawberry clover. A few plants have become established here and there. The only plot examined that had been sown with this clover

was at Port Howard. Here a few robust plants each covering about a square foot of ground still survive from a 1930 sowing.

Lotus major. This species had not established itself to any appreciable extent in the experimental plots (E189). Several small experimental sowings have been made at Port Howard, both near the settlement and in open camp. *Lotus major* is also established at Bombilla House (Douglas Station), where established mature plants are vigorous and in healthy condition. This species warrants further trial, especially for wet and soft camp. In any trial sowings of the seed care should be taken that the appropriate *Lotus* bacterial strain is used, either by special culture or by using soil from existing stands of *Lotus major.*

Lucerne. Only two plants were seen throughout the Falklands, and both of these grew healthily and were presumably nodulated, although the deeper roots could not be examined without the risk of destroying the plants which in both instances were looked upon as valuable "museum specimens."

Sainfoin. Sainfoin grows (January, 1938) in the settlement garden at Saunders Island. New sowings made in small plots in the open camp at Saunders were dying off as advanced seedlings. Of the seedlings whose roots were examined, none showed a trace of nodulation, and the leafage had the typical "puny" colouration. It would appear that sainfoin could be established (given appropriate bacterial culture) on limited areas for use as a fodder crop.

Lupins. Garden lupins planted for floral display grow well in gardens throughout the Falklands, and wherever examined their roots were found to be abundantly nodulated and the nodules of very large size. Flowering is very profuse in the sheltered gardens, but only an occasional pod produces seeds—again emphasizing the lack of appropriate pollinating agents in the colony.

The Annual Clovers.

Suckling clover. This is fairly well established around many settlements, and is about as abundant as white clover. It is only occasionally to be found in the open camp, and then only following explicit sowings. Around the settlements the plant appears to be fully nodulated, but in camp only occasionally so. Non-nodulated plants do not make vigorous leaf production, and are at best very stunted. If seed of suckling clover can be procured at cheap rates it is a species

well worthy of further trial throughout the Falklands,* for given its appropriate bacteria it will establish readily under adverse conditions, and may be useful as a forerunner of white clover. An additional advantage is that being self-fertile suckling clover can produce seed in the absence of external pollinating agents.

Subterranean clover. At Hill Cove a sowing made about 1929 is still producing plants in gregarious patches and these were flowering freely during the summer of 1937-38. It is of considerable significance to have it on record that subterranean clover is able to withstand a series of Falkland winters. Also that this plant has been able to re-establish itself annually in a very dense matted turf such as is characteristically found in settlement fields. This clover is of outstanding value in Australia where the surface soil is relatively loose and the winter climate is normally mild and wet. Subterranean clover is self-fertile. Being an annual it has to re-establish itself annually. It is interesting, therefore, to note that this clover has also been able to ripen its seed annually over an eight-year period in the Falklands. Hill Cove stands in a favourably sheltered position, but even so the behaviour of this stand of subterranean clover is instructive.

Other Annuals.

Sweet peas grow well in conservatories and are well nodulated. Similarly the ordinary culinary pea flourishes in the shelter of kitchen gardens. Among the trefoils a few plants of spotted trefoil (*Medicago maculata*) were examined in Stanley gardens. These were healthy in appearance and nodulated.

THE VALUE OF CERTAIN "WEEDS" IN LAND IMPROVEMENT

Many of our so-called British "weeds" have a special value where the improvement of poor grassland is concerned. Ribgrass, yarrow, catsear, burnet, chicory, and dandelion, are among the more valuable species, but probably it is ribgrass upon which immediate attention

* Suckling clover is often an impurity in unhusked samples of Yorkshire fog. Where that is so it might repay to clean out some of the clover from these seed bulks, so as to inoculate the seed. Alternatively, inoculated soil might be sown with the seed where the sample is known to contain appreciable quantities of the clover.

should be focused because of the ease with which it grows on a variety of situations, also because the supplies of commercial seed are reasonably cheap. The leafage of ribgrass is particularly rich in lime, phosphoric acid, and potash (10). It provides a heavy crop of feed, and has a fairly long grazing season. The leafage is palatable and the plant makes reasonably good recovery after being grazed off. It is fairly resistant to heavy grazing by stock. Ribgrass will establish on poor soils, and on the whole appears to be of considerable promise in the Falklands. It did not make a good showing in the experimental plots, but the few plants to be found around many settlements indicate that the species is worthy of further trial.

The greatest interest from the viewpoint of problems in the Falklands in connection with many of these "weeds" is that they are minerally rich and will therefore help to provide a more balanced ration than now appears to be available. Many of the natural grazings have been shown by Orr (24) to be very deficient in minerals, so that any plant which has a high mineral content may prove to be a valuable introduction into the grasslands. In so far as the special conditions of the Falklands are concerned, it would seem that any plant that will grow and is palatable is to be welcomed, particularly on the soft camps, for the greatest immediate need of these is for a plant which will draw stock to consolidate, to dung, to urinate, and so to accelerate biological activity in the soil.

SEED PRODUCTION IN THE FALKLANDS

Having regard to the fundamental importance of introducing new species, many of which will be of British origin, into the pastures of the Falkland Islands, a review of the possibilities of seed production in the colony appears to warrant some consideration.

(*a*) *The grasses.* Stock seed of these could be obtained from Britain, and elsewhere, but stress is to be laid upon getting proper pasture strains in the first instance, especially as regards timothy, cocksfoot, and creeping red fescue—these are among the grasses likely to be of greatest relative value in the Falklands. Having regard to local conditions, and in the light of seed production experience at Aberystwyth, it would probably be best to grow home-grown seed in rows which could be harvested, tied into sheaves like corn, and stooked to complete the ripening and drying processes in the spacious woo

sheds, much as is now done with the oat crops. Seed production work at Aberystwyth has shown that in many species the best yields of seed are obtained when grown in drills, and where the manuring with phosphatic and nitrogenous manures has been liberal.

The majority of ordinary British grasses flower and set seed abundantly in the Falklands. Whether or not seed can be grown and harvested as paying crops on the stations themselves remains a matter of trial. It is obvious that the colony could make itself appreciably self-supporting after a few years, but with regard to many species it may be found ultimately cheaper to import seed supplies. Yorkshire fog seeds abundantly in the colony, but while seed can be bought cheaply on the British market it would seem less costly to import seed of this species.

The growing-on of supplies of approved pasture strains of those grasses whose supply is limited on the English market, and which are shown to have a particular value in the Falklands, might prove remunerative, and would in any case provide the stations with the necessary supplies of seed. This is a point of some considerable importance when the difficulties of transport, freights, and general geographical isolation of the colony are taken into account. It is all a matter of experiment and of trial. Some of the late-flowering pasture strains in timothy, for example, may flower too late in the season for proper setting and harvesting of the seed. Cocksfoot, rye-grass, sweet vernal grass, and the fescues should flower early enough to provide good seed harvests in most years. Whether they can be successfully harvested under normal and prevailing weather conditions is another matter.

There are a number of indigenous grasses too which have proved themselves valuable, and some attempt should be made to grow them for seed. Among the grasses native fog (*Trisetum spicatum*), *Aira* (*Deschampsia flexuosa*), and sheep's fescue (*Festuca ovina* var. *magellanica*) are three species of obvious usefulness in the natural pastures. The technique of seed production, and the collection of stock seed, should be the concern of the Agricultural Department in the colony.

(*b*) *The clovers.* Most clovers once properly established seem to flower in great profusion in the Falklands.* The perennial clovers

* This profuse flowering is a marked feature in a number of European species grown in the Falklands. Gorse (*Ulex europaeus*) for example, blooms so freely that at the peak of flowering in November and December the bushes are literally one solid mass of dazzling yellow, and not a trace of green shoot tips is to be seen.

are nearly all obligatory cross-fertile, fertilization being normally done by bees and associated insects. Because of the absence of bees, therefore, in the Falklands these legumes seldom set any seed. Examination of some 10,000 florets of white clover made in Stanley and elsewhere during February, 1938, showed that only about one flower in every 2,500 produces seed. This order of seed setting (0·04 per cent) is to be accounted for by natural self-fertilization (36).

In order to see whether or not white clover would in fact set and ripen seed in greater abundance under Falkland conditions if pollinating agents were available, a number of heads of clover were hand-pollinated, using the technique normally used at Aberystwyth (36). Some dozen or so heads were thus dealt with at Stanley during the last week of December, 1937, and a number was similarly treated at Port Howard on January 18, 1938. Seed was freely set at both centres, and a number of ripe seeds have been harvested at Port Howard,* from the heads so pollinated. These successful pollinations therefore leave no doubt that white clover is capable of producing seed in the Falklands if bees were available to effect pollination. Further experience would be required to know whether clover could be grown as a seed crop and whether the seed would ripen sufficiently well before the onset of adverse weather conditions in the autumn.

Allied to this whole problem is the general question of the introduction of bees. There seems to be no valid reason why bees should not prosper in the colony once they were successfully established. Bees are found on the Patagonian coast and in the Chilean Andes in the neighbourhood of Natales. In the latter case these bees were observed working on white clover, and both here and around Punta Arenas white clover sets and ripens seed freely. These observations are recorded because it is often claimed in the Falklands that bees would not stand up to the wind and weather in general. The prevalence of pollinating bees in southern Patagonia with its high persistent winds and more rigorous winter climate would seem to imply that bees could be established in the Falklands. There is room here for co-ordinated experiments based on expert advice from somebody qualified in bee culture. The problem of the introduction of the appropriate bee should be relatively simple. From the viewpoint of land improvement it is a matter of fundamental importance that the clovers should be spread about as rapidly and as widely as possible. For obvious reasons seed

* Information privately communicated by Mr. Pole-Evans.

setting is important, apart altogether from the question of producing seed crops as such in the clovers.

The annual clovers in the main are self-fertile, and it is a matter of interest only to note that both suckling clover and subterranean clover set seed quite freely in the Falklands. The former of these is widespread about dwelling places, while the latter has been established from sowings at one or two stations.

SOIL FERTILITY AND PASTURE PROBLEMS : THE EVIDENCE OF THE PENGUIN GROUNDS

All the evidence collected during the present survey of the Falklands suggests that one of the chief difficulties is the extent of mat formation and the general lack of decomposition, together with the slow rate of biological activity in the soils. In this respect the evidence afforded by the penguin grounds is most illuminating, particularly in relation to the Gentoo penguin (*Pygoscelis papua*). This penguin lives gregariously, and the colony moves its nesting place ("rookery") each year. It may form a new "rookery" on any of the plant associations offering to it on the coast, as, for example, diddle dee heath, white grass slopes, and areas of dense mountain berry. "Rookeries" have been made in *Bolax* (balsam bog) heaths, and even in the thickets of tall fern. Wherever the new rookery is made, the whole of the natural vegetation is completely destroyed by the trampling of the birds, and before the end of the nesting season the mat of vegetation has largely decomposed, leaving the surface completely bare of vegetation. The residual soil is obviously extremely rich in plant foods. This process is repeated annually. The result is that after a period of years the vegetation on whole areas, representing in the aggregate hundreds of acres, is completely transformed. In such a manner are the "penguin points" produced.

The recolonization of the penguin rookeries by new vegetation is most instructive. European annuals are usually the first colonizers; groundsel (*Senecio vulgaris*) is often the first of the new-comers, and this may temporarily form a dense cover for a year, or two years. After this phase of temporary colonization by these annuals the penguin rookeries usually become completely grassed over, resulting in a very dense, closely grazed sward. The chief component (and sometimes

almost the only one) is the annual meadow grass (*Poa annua*) which is kept closely grazed by sheep and appears to remain as a stable community for an indefinite period. It is most significant that on all the "penguin points," so-called, there seems to be no tendency to revert to the original type of native vegetation, and there is never the same tendency to form "mat."

The evidence from the penguin rookeries is highly instructive and shows that where excessive quantities of nitrogen-rich residues (penguin excreta) are applied to the surface soil, the mat rapidly breaks up, and a soil of higher fertility is produced. Peaty soils, such as those found in the Falklands, are rich in total nitrogen, but often poor in available nitrogen. In peats of this nature the amount of carbonaceous material is very high, and the ratio of carbon to nitrogen is too wide to support active growth, and the soils, therefore, remain dead and inactive. When the carbon : nitrogen ratio is narrower than about 15 : 1 there is usually enough nitrogen in the soil for general activity to take place. "Mat" is therefore decomposed (34).

In practice nitrogen may be added in a variety of ways, such, for example, as applying manures rich in easily available nitrogen, or alternatively, of introducing new plants on which stock will feed and return nitrogen-rich excreta to the soil.

The first of these methods will have only a limited immediate application in the Falklands because of the prohibitive price of nitrogenous fertilizers, as well as the difficulties of storage of many of the more suitable compounds. It would, however, be of technical interest to see on an experimental scale how far rapid rotting could be induced by excessively heavy applications of say calcium cyanamide or nitrochalk, followed by the sowing of grass and clover seeds on the surface.

Of more immediate practical significance in the colony perhaps is the possible introduction of new plants into the existing vegetation; plants that are themselves rich in nitrogen and will promote the return of animal urine and dung that is correspondingly rich. The most valuable of these plants are the clovers, because not only are they themselves rich in nitrogen, but also they enrich the soil by the process of fixation of nitrogen direct from the air. Thus white clover has been said to "eat the mat." The problem of grassland improvement in the Falklands resolves itself, therefore, to a very appreciable extent into a matter of how best to establish and promote the growth of white clover and other legumes.

Further to the general question of regrassing the penguin grounds: at present the penguin rookeries are allowed to revegetate themselves. Instead they should be properly seeded out, using a mixture of wild white clover and grasses. The existing penguin points where the predominant swards are of *Poa annua* could also be greatly improved by hard scratching with tined implements followed by the sowing of a similar clover-grass seeds mixture. All penguin points might be fenced off from the rest of the camp, and the grazing controlled upon them. Here are potential areas of valuable winter feed if properly fenced and controlled. At present the penguin points are being far too severely grazed. This treatment is neither good for the pasture whose output is at a low limit, nor for the animal, which never gets a belly full, even though what it gets may be chemically of very high nutritive value.

TUSSAC (*POA FLABELLATA*) AS A CULTIVATED CROP

Tussac appears to have all the valuable characters of a specialized crop plant grown for winter fodder. Tussac is indigenous to the coastal fringe of the Falklands under conditions where there is no doubt excess of sea spray, but probably much more important, an abundance of sea life (seal and sea birds) whose excreta have enriched the soil over generations of time. The natural home of this tussac is, therefore, one of high soil fertility. Under natural conditions too seal and other wild animals make pathways between the plants, and in effect inter-cultivate them. This inter-cultivation must itself have had an important influence, and would help to prevent other plants from establishing themselves. This, and the constant supply of animal and bird manure, has undoubtedly to a very large extent been instrumental in building up the rich soils of the tussac lands.

Tussac is a most interesting plant in so much as it makes an abundance of leafy growth during the summer, and this remains wholly winter green. It appears to be able to withstand complete defoliation (cutting rather than grazing) in winter, but is apparently not able to resist continued defoliation throughout the summer months. It is said that horses and cattle do not harm the plant, and it can make normal recovery after being grazed by these animals. Uncontrolled grazing with sheep, however, will rapidly deplete areas of tussac. This

is probably due to the more selective grazing of sheep, and to the fact that the crown of the tussac plant is well above ground, and therefore easily accessible. Added to this the young basal shoots are extraordinarily palatable, having a decided nutty flavour,* and it is likely that these will be selected by sheep in preference to older leafage. These shoots are produced in the autumn, so that if they are eaten out by sheep during winter the plant is unable to recover properly, and ultimately dies.

Although the coastal lands are the native habitat of tussac, the plant has been established inland on many classes of soil. It grows successfully in enclosed chicken yards around settlements, and dwelling houses throughout the colony. Close observations made upon areas purposely planted show that to be successful tussac requires two conditions, namely (i) high fertility, especially in terms of freely available nitrogen, and (ii) freedom from the competition of other plants. Plantings of tussac made away from its native soils often show the typical yellow colour of the leaves, denoting nitrogen starvation. Under such conditions the plant does not flourish, and it is quickly overcome by other vegetation, commonly sorrel and smooth-stalked meadow grass. In the chicken runs, on the other hand, the plant receives a plentiful supply of manures, and the ground between the plants is kept more or less free from other vegetation by the fowls. The normal and healthy growth of tussac plants in chicken runs provides an important piece of evidence, and indicates the lines along which to develop a technique of tussac growing on a wider scale.

There is need here for considerable experiment, aiming to find a practical method of growing tussac on a variety of soils, for no plant is likely to be more useful to the sheep industry of the Falklands, particularly from the viewpoint of providing winter feed. It is important to find the proper method of growing tussac as a winter forage plant. A few acres of tussac planted in every paddock in the colony would be an invaluable asset. Such areas effectively fenced off from the rest of the paddock would be used primarily for winter feed, and treated as cultivated crops, to be tilled and kept scarified at least while the crop was being established. It is almost certain that they would have to be heavily manured with nitrogen-rich fertilizers.† Fish meals,

* The young shoots have a delicious nutty flavour when eaten raw, strongly suggestive of the flavour of coconut.

† Trials are now being instituted at Aberystwyth, designed to test the agronomic response of tussac to differential manuring and management.

whale guano, kelp, and other organic residues would seem most appropriate, but they might have to be supplemented by non-acid inorganic nitrogenous manures, such as calcium cyanamide, nitro-chalk, calcium nitrate, etc. The appropriate manuring is a matter for field experiment.

The suggestion is that in tussac the colony has a potentially valuable winter fodder crop among its native plants, and every endeavour should be made to make the fullest possible use of that crop. Such a special purpose crop could stand a good deal of extra expense in terms of inbrought fertilizers, because it would provide stock with green fodder at a time of year when feed is scarce. This scarcity of nutritious food in winter is at present probably the basal cause of most of the annual loss in sheep experienced in the colony.

THE RECLAMATION OF SAND DRIFTS AND OTHER DENUDED AREAS

Sand drifts are of fairly frequent occurrence on many parts of the coast, and have been especially severe on some of the islands. In one or two instances these drifts have started from large inland ponds, and the sand has been blown over extensive tracts of camp, leaving a denuded area behind it. Such sand drifts may become a serious menace, and unless the sand is stabilized and dunes are formed the area of denuded land becomes increasingly large. The consequences of such erosion have been most serious on the smaller islands, and on hard camp on the mainland because the denuded areas fail to regenerate quickly, often they have remained bare of all vegetation.

The most successful method of combating drifting sand in the Falklands has been through the planting of marram grass (*Ammophila arenaria*). This grass has proved itself to be better than sand oat grass (*Elymus arenarius*), considerable plantings of which have formerly been made. The instance of Cape Pembroke Peninsula quoted by Hubbard (15) is typical. Plantings were started there in 1925, on part of a 2,000 acre block which had been completely denuded by off-shore sand. Both marram grass and lyme grass (sand oat) were used, but only marram has maintained itself during the subsequent thirteen year period. The major part of this peninsula was still bare of vegetation in 1938. The

Department of Agriculture is now making further plantings, using marram grass on sandy areas and tussac on the peats. In order to establish the new plantings this peninsula has been kept free from stock during 1937-38, and it is of interest to record that the (1925) marram is reseeding itself extensively among the dunes which have formed as a result of the earlier plantings.

Experience with marram grass generally would suggest that new plantings should be fenced and kept more or less free from grazing animals during the period of establishment and early dune formation. This is the more important in the Falklands because the leaves of marram seem to be very palatable. Once the grass is properly established, and fair-sized dunes have been formed, stock do no harm, and the dunes provide excellent shelter for ewes and lambs. The hollows in among older dunes become "grassed" over (the native small rush being a notable colonizer), but the regrassing process could be greatly accelerated by the sowing of seeds. At Fox Bay West red fescue has established successfully from seed sown among stabilized sand dunes.

Among other denuded areas are the extensive tracts of coastal tussac lands, many of which are now either completely bare or carry only a sparse vegetation. It is probably fairly generally realized that tussac can be re-established on these areas if planted. The problem is largely one of cost, because to be successful such plantings have to be fenced off. Considerable areas have been replanted in tussac, in the main with good result. Sometimes fencing of these old tussac grounds is impracticable, and here trial sowings of seeds might be made. There seems to be no valid reason why these areas should be left in their present non-vegetated state. It would at least be worth while making experimental sowings of white clover (inoculated seed) and the grasses. Yorkshire fog would be better than nothing at all. Alternatively and on a small scale, turfs containing white clover from around the settlements might be planted in the first instance.

A third type of denuded area observed in the Falklands is the so-called "clay ridges." These occur as relatively small areas, both in the vicinity of many settlements and in open camp. These have resulted from wind erosion which may have followed excessive grazing and unwise burning, or both. In any case the original vegetation has been destroyed, and the soil removed completely, in some instances up to several feet (see Plate 18), leaving a subsoil of yellow "clay." These areas are usually completely devoid of vegetation, and erosion by wind is still proceeding. The surface is hard and clay-like, and seems

difficult to regrass. Gorse when established appears to grow well on these bared patches, and if more extensively used would at least prevent the continued expansion of these areas.

ADMINISTRATIVE RECOMMENDATIONS

On the basis of data collected during the course of the survey it has been found possible to make certain practical recommendations in relation to the improvement of grasslands within the colony. Any general reconnaissance of this kind, however, must of necessity leave many gaps. Emphasis must be laid upon the fact that no agronomic investigational work has ever been carried out on Falkland grasslands. The evidence collected during this survey has been based very largely on a few simple but very valuable trials which have been initiated by managers of sheep stations. In addition the seeds mixture and manurial trials started in 1935, and in which the Welsh Plant Breeding Station collaborated, have provided invaluable data, while the recent activities of the Department of Agriculture in Stanley in dissemination of grass seeds (largely Yorkshire fog) for trial have not only helped to create a renewed grassland interest among managers, but have also provided further evidence much of which has been freely drawn upon in the present report.

There can be no doubt whatever that grassland improvement is possible over a very large part of the Falklands. The working out of a proper technique of land improvement must remain largely a matter for the colony itself. It is obvious that were the improvement of grasslands to become generally practised the whole outlook of the country and its people would be changed. Grass is the chief and almost only agricultural crop, and it is wholly likely that grassland will always remain the mainstay of agriculture in the country. Because of this, and because of the potential development of better pastures in the colony, the whole grassland problem requires closer investigation than is possible in a rapid survey. There is every reason to suppose that such investigations would bring about results of value in pointing the way to improve the stock-carrying capacity of the grasslands.

Expansion of the Present Department of Agriculture

With the possible exception of certain investigations which would demand well-equipped laboratory facilities, the greater part of the grassland investigational work must of necessity be conducted within

the Falkland Islands themselves. It is recommended, therefore, that the present Department of Agriculture should be strengthened, both in personnel and in equipment. Relative to personnel it is suggested that two new appointments should be made.

In the first place there would be required a really sound grassland man trained in the methods and technique of grassland research. This man needs to be carefully chosen, both from the view of his training and of his personality. The position offers difficulties connected with the geographical isolation of the colony, and the lack of technical contacts which must follow from this were the man to remain in the colony for an indefinite period. Because of these difficulties it is suggested that a Colonial Agricultural Scholar specially trained in grassland research should be appointed to the staff of the Department after post-graduate training for a period of, say, two tours (six years in all) and that at the end of that period he be replaced by an officer similarly trained under the Colonial Office Scheme for Agricultural Scholarships. After the end of the period of service in the Falklands some guarantee of future employment in some associate service must be given.

This, it is understood, should be possible, as the officer if trained under the Colonial Agricultural Scholarship Scheme would be eligible for absorption into the Colonial Agricultural Service. The virgin field of work and the general experience likely to be gained in the Falklands would probably provide an inducement for the right type of man to accept, if only for the valuable training he would receive. It is my view that no inducement be given to prolong the stay for longer than two tours, were the research officer willing, or even anxious, to stay. From the viewpoint of the investigational work, and especially with a view to bringing in fresh ideas, a change of officer fairly frequently is desirable. Continuity in the investigations would be guaranteed if the grassland man were to be joined by his successor for a period of, say, two or three months before the end of each six year period. There would be a further guarantee of continuity if the head of department (i.e. the Director of Agriculture) were made a permanent appointment.

The second appointment should be a livestock man with a sound training in general pastoral farming. He would act as direct stock assistant to the present head of department, who is himself a highly qualified livestock man. This new appointment would need to be on a permanent basis with periodic overseas leave, part of which should be spent in appropriate institutional work, either in Great Britain or

elsewhere. It is, I think, essential that technicians of this type should be given facilities for refreshing their knowledge, and for bringing themselves up to date in technical matters.

The duties of the livestock assistant would be to place himself in constant touch with the camp and its problems. He would act in an advisory capacity, both upon livestock and upon grassland matters. He would also keep himself in close touch with his "grassland" colleague, who would thus be left so much the more free to conduct his investigational duties. It would be a mistake to hamper the "grassland" man unduly by asking him to carry out more than a minimum of advisory work, although he must acquaint himself thoroughly with the camp throughout the colony.

In connection with the proposed expansion of the Department of Agriculture it is to be hoped that the services of the present head of the department will be retained for at least a second period of secondment from New Zealand. Men with the requisite foresight, personality, sound technical knowledge and administrative ability are not always to be found. It is essential that this first phase in the development of the new department shall be in capable hands, and that there should be continuity of policy in the administration of the colony. Unless such continuity can be guaranteed with reasonable certainty it would seem far better not to expend any further monies upon development, but rather to allow the pastoral industry of the colony to develop purely along its own lines.

Relative to equipment and facilities in general the Department of Agriculture should have land at its disposal, and that land for many reasons should lie in close proximity to Stanley. It is understood that the Government hold such a site (Block 57), and I have examined this area in some detail. In some ways it provides an admirable site. In situation it is almost as good as could ever be expected ; its acquisition by the Department of Agriculture would, however, entail the constant use of a boat for the purpose of transporting men and material to and from Stanley. The block referred to contains chiefly soft camp, and the site would have added attraction if parts of the adjacent Block 4 could be procured. (It is possible that this might be done on an exchange basis *quid pro quo* with the present owners of Block 4.) The easterly peninsulas in Block 4 carry a good deal of hard camp, and one feels sure that within Blocks 4 and 57 an area could be chosen which would very appropriately be representative of almost every grassland type within the colony.

PHOTOGRAPHS RELATING TO THE REPORT

(Photographs by author and dated November, 1937, to March, 1938)

Plate 1.

Chartres Settlement—a typical setting. Mt. Chartres with stone run in valley at back.

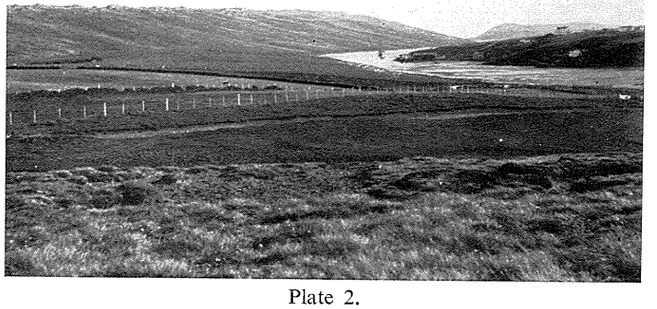


Plate 2.

Port Howard, showing the settlement fields and the harbour (a typical drowned valley).

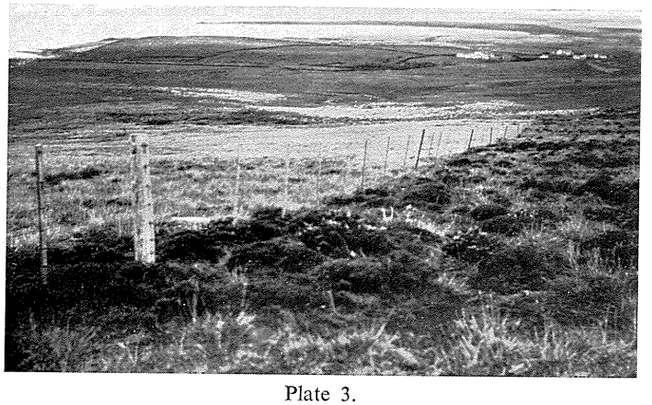


Plate 3.

Hill Cove. Influence of pasture management seen along fenceline.
Left: Cortaderia (white grass) meadow.
Right: Empetrum (diddle dee) heath.

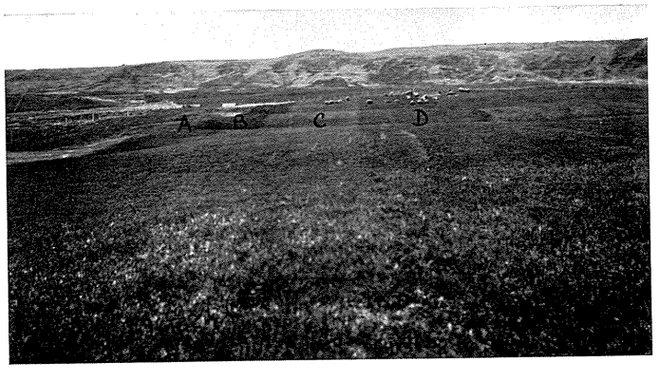


Plate 4.

Port Howard. Plots of Aberystwyth strains of timothy (A), red fescue (B), cocksfoot (C), and rye-grass (D), sown in 1933.

Plate 5.

Port Howard. Stud Corriedales on improved and clover-rich pastures. The high lambing percentage (about 130 per cent) of this flock indicates the value of improved pastures to the colony.

Plate 6.

Port Howard. Typical *Cortaderia* associations (white grass swards).

Plate 7.

Hill Cove. Empetrum—Cortaderia heath (diddle dee and white grass).

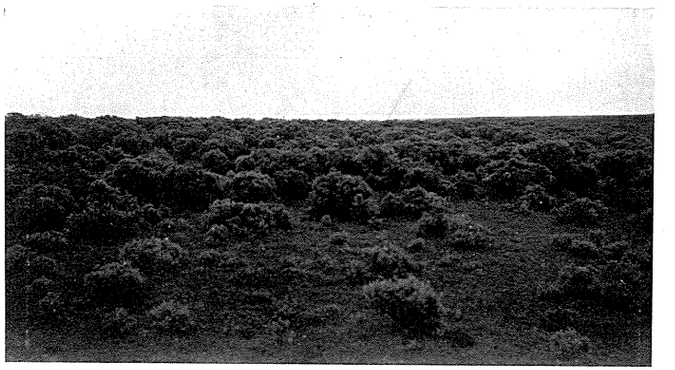


Plate 8.

Rincon Grande. Chiliotrichum—Poa pratensis heath (Fachinal bush with short grass).

Plate 9.

New Island. Poa flabellata (tussac) fully grown plants.

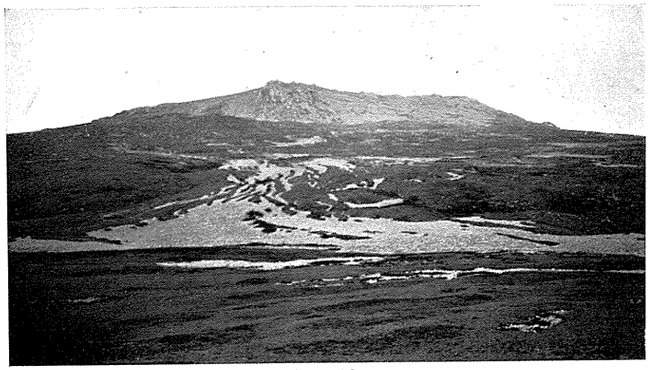


Plate 10.

Mt. Simon (1,600 ft.). Massive stone runs and mountain pastures.

Plate 11.

Douglas Station. Mountain lands: note peat banks and stone runs.

Plate 12.

Close-up of *Cortaderia* (white grass) sward. Note entire lack of clovers.

Plate 13.

Cortaderia with *Agrostis* and *Poa pratensis* (the two latter introduced). When ordinary white grass swards (see Plate 12) are heavily stocked, *Agrostis* and *Poa* invade the grassland and may ultimately dominate it (see Plate 14).

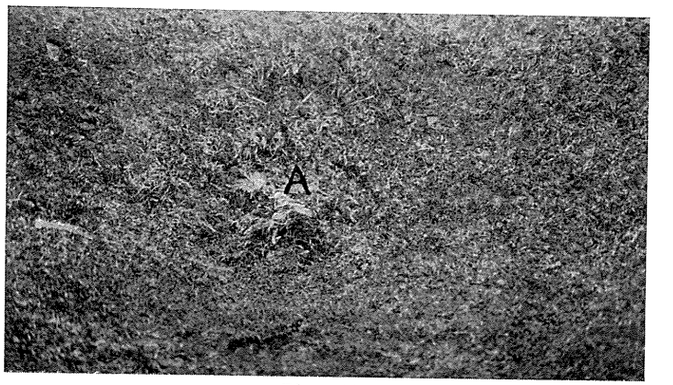


Plate 14.

Close-up *Agrostis—Poa pratensis* sward developed by heavily grazing *Cortaderia* swards, but without the sowing of seeds. At (A) is a dead *Cortaderia* tussock the site of which is in process of being colonized by turf-forming grasses (*Agrostis* and *Poa*).

Plate 15.

The ideal at which to aim: close-up of white clover pasture. The grass is *Agrostis tenuis* (bent or brown top), with *Poa pratensis*.

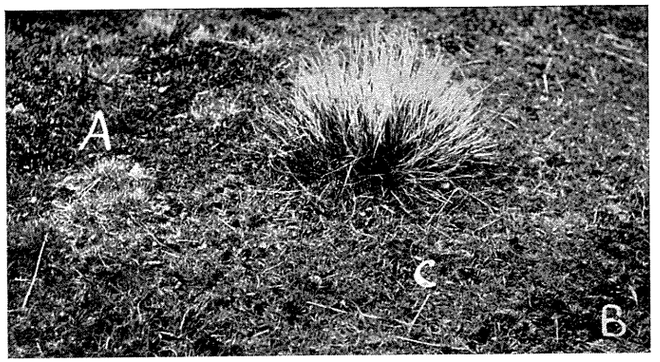


Plate 16.

A single tussock of *Cortaderia* (white grass). The ground flora is small fern (A), pigvine (B), and Yorkshire fog (C). The last-named is from surface sowings made in 1934, and is rapidly spreading over the whole groundwork, thus ousting the relatively worthless fern and pigvine.

Plate 17.

A single row of Yorkshire fog seed sown on bare (dry) peat after burning diddle dee.

Plate 18.

Wind erosion on *Empetrum* (diddle dee) heath. This illustrates what can happen when diddle dee ridges are burnt and bared of vegetation (see Plate 17). The wind removes the dry powdery soil until the subsoil ("clay") is reached. The photograph was taken on a huge ridge of bare "clay" and shows only the remnants of the original vegetation and surface levels. Erosion is still proceeding on such situations.

If it proved impracticable to acquire new land as suggested, a good deal of investigational work might be carried out on selected areas on Stanley Common (including the adjoining Pembroke Peninsula). Its proximity to Stanley (with which all parts have direct land connections), is an obvious advantage from the viewpoint of organization. The Common contains small areas of many types of camp, although the greater of its acreage represents soft camp often with deep peat. It is not known whether the use of even small selected areas for experimental work on the Common is possible, nor how far such use would be an infringement of citizen rights laid down by custom, or in law. The present Department of Agriculture has in fact conducted a number of trials on various parts of Stanley Common.

The acquisition of land such as is suggested would mean considerable initial expense in terms of tractor, harrows, and other implements, as also in connection with fencing and the purchase of farm livestock. Such expense can and should, however, be kept strictly within bounds, and in any case the erection and establishment of costly buildings should be avoided. Any building required would be in the nature of a field laboratory, or field shelter, and could be of the simplest design adequate for its purpose.

A central area of land would be necessary in order to provide facilities for properly controlled experiments dealing particularly with grassland management, manuring, and seeding, and with the measurement of grassland and stock yields obtained as a result of differential treatments. In addition to these more detailed experiments it would also be necessary to conduct simplified trials at as many stations as possible, and on a wide variety of soil and other conditions all over the country. The central research area, however, needs to be somewhere quite close to the town of Stanley, both from the viewpoint of proper administration and also because Stanley is the one place where the majority of camp people conveniently meet.

Laboratory Experiments on "Rotting" of Turf.

Throughout the Falklands I have found that turf does not rot, and that biological activity in the surface soil generally is at a low ebb. I feel that this problem is one that needs to be thoroughly investigated in England, and it is recommended that the Director of the Welsh Plant Breeding Station be asked if he would consider the conduct of such an investigation at his Station. The work would probably require the appointment of a junior assistant for a minimum period of two to

three years, when the continuation of such work might be reconsidered. Ideally, of course, work of this nature would be best done in the Falklands themselves, but the necessary laboratory facilities are not available, and might be altogether too costly to provide. On the other hand, many research stations in Britain will already be equipped for such work.

Peat Investigations in Other Countries.

It is advisable that some appropriate officer should be asked to carry out a short investigation on peat lands in other countries, and in particular in Scandinavia, Finland, and Scotland. In all of these countries a good deal of peat reclamation work is being conducted. It might be of added value if that same officer paid short visits to Iceland, the Faroes, and Ireland. The purpose of these visits would be to report upon the work being conducted on peat lands in those several countries, and to consider that work in the light of the reclamation of soft (peat) camp in the Falkland Islands.

SUMMARY AND GENERAL CONSIDERATIONS

The general grassland problems of the Falkland Islands have been considered with particular reference to the possibilities of improving the herbage and consequently the stock-maintaining capacity of those grasslands. There can be little doubt that many of the natural grazings of the colony are amenable to improvement. The general indications are that such improvements are likely to be best brought about by a substitution of the present species by more suitable introduced plants. There are no native legumes of any kind belonging to the Falklands, but a number of European legumes appear to thrive if once properly established. Notable among these is white clover. Wild white clover may be regarded as the fundamental plant in any scheme of grassland improvement contemplated in the Falklands, indeed, it has been shown to play this role over a very wide area of world grasslands in temperate regions. If white clover is the key species, it remains for Falkland Islanders themselves to find the proper means of introducing and establishing this clover all over their stations, and having regard to local conditions and the economic life of the colony in general.

There is a large number of grasses and grass-like plants (these latter not in the family Gramineae) native to the Falkland Islands. Some of these are very valuable—such as, for example, the native

tussac (*Poa flabellata*). Taking the native grasses as a whole, however, they are of low nutritive value when compared with British grasses grown on the same soil. The case again is formulated in favour of specifically introducing new grasses to replace wherever possible the existing native flora. Many grasses and herbs of British origin are known to flourish under certain conditions in the Falklands. Of immediate interest in this respect the following plants may be quoted : Yorkshire fog, red fescue, timothy, cocksfoot, ribgrass, and yarrow. Experience may show that there are others that are worth while cultivating, and particularly may this be true of a number of clovers and other legumes.

The present system of grassland farming in the Falkland Islands is nothing short of large-scale ranching. Until a methodical and much extended scheme of subdividing existing paddocks is brought about, the potentialities for land improvement throughout the colony will remain all but untapped. There is no doubt at all that closer subdivision with the creation of smaller fields on which a practical form of rotational grazing can be employed is fundamental to pasture improvement. Indeed, it may well be said that a well conceived programme of subdivision is essential to the pastoral industry. The fall in the stock carrying capacity of the pastures and, therefore, in the pastoral wealth of the colony has been remarked upon. The decline is still proceeding and there can be no doubt that deterioration in the grasslands themselves is taking place and is, indeed, the cause of the decline in production. As regards the Falklands, all the evidence suggests that pasture deterioration will take place progressively the more rapidly in proportion as the stock carried becomes less. The hope of the industry lies in increased production and in carrying an ever increasing head of stock.* Increased production means that pastures will have to be improved, and properly maintained improvements of pastures will only be possible after first creating smaller fields and introducing better methods of grazing management.

The time has arrived when the Falklands must consider very seriously whether the present ranching policy is to continue, or whether a complete change of methods involving a policy of grassland improvement together with a more intensive system of pastoral agriculture is to be put into effect. Continuance of the existing ranching system cannot but lead to a still greater lowering of carrying capacity, and to the

* This is said with the knowledge that many owners and others connected with the Falklands take the converse view.

decreased wealth of the country as a whole. With a change over in methods and the gradual substitution of a more intensive type of grassland farming the decline in production would cease, and after a time there is no reason why definite and progressive increases should not be recorded. Subdivision of paddocks, the better management of pastures, and the replacement of the present herbage by better plants are all essentials in the developmental scheme.

In a short, but entirely interesting, reconnaissance survey of the kind described in the foregoing report, no more than general indications can be given. Similarly only broad generalizations can properly be made. The sequel to such a reconnaissance should be the setting in motion of properly planned machinery thoroughly to investigate the broad issues that have been raised. It is submitted, therefore, that investigational work dealing specifically with the grassland problems of the Falkland sheep stations should be conducted. Such investigational work would be carried out in the colony under the general supervision of the Director of Agriculture. Specific problems connected with the practical, rather than the purely scientific, aspects of grassland development would obviously take precedence in any such research scheme.

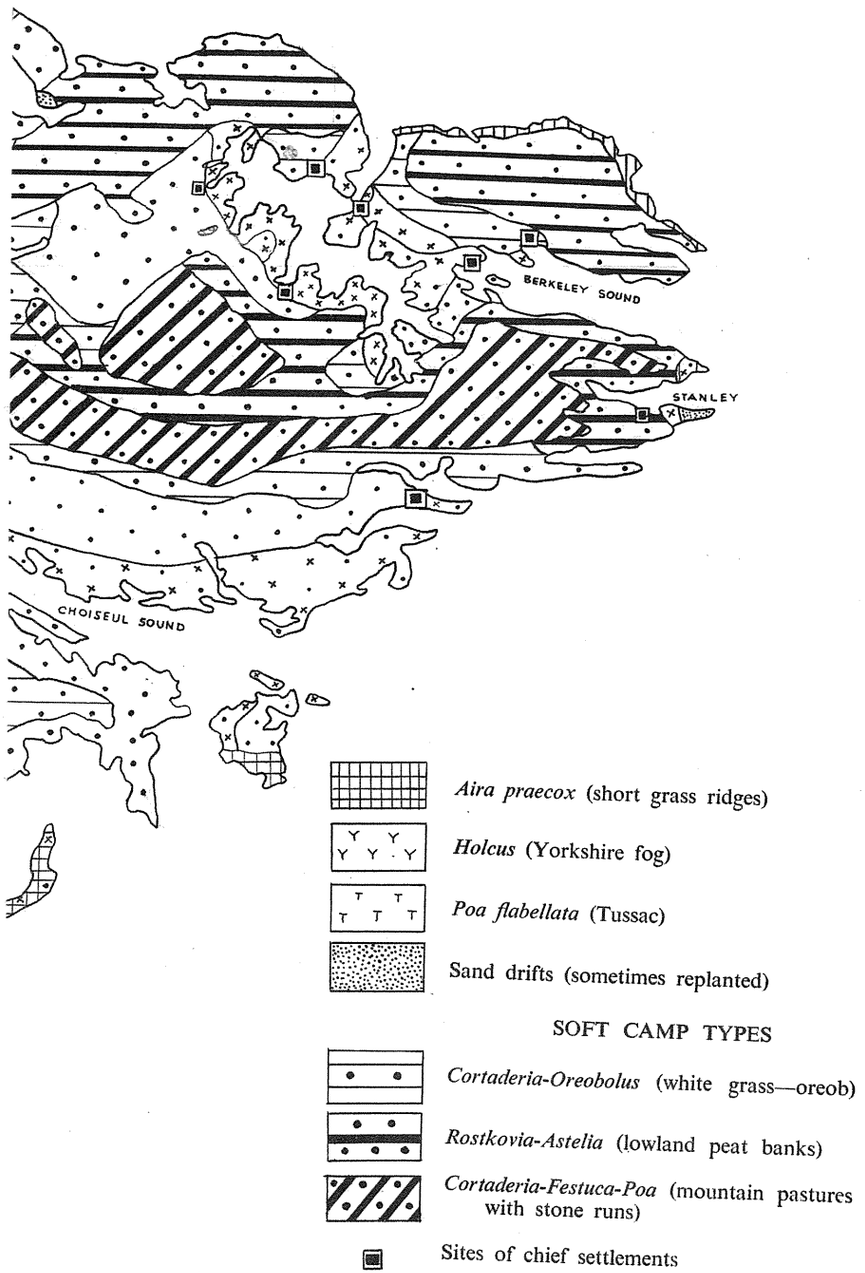
EXPLANATORY NOTE DEALING WITH MAP I (VEGETATION)

The distribution of the chief pasture types found within the colony is shown in Map I. The map is based upon field records made in the course of the several tours through the camp. Wherever possible the data so collected have been verified and where necessary supplemented as a result of consultations with station managers, shepherds, and others possessing special local knowledge. These data were originally entered upon the Admiralty Chart (11) of scale approximately 3·5 miles per inch. The coastal outline of the vegetation map is based upon Baker (2).

On a map of this scale only the broad vegetational zones can be shown. It will be obvious to those who are familiar with particularized areas within the country that many plant associations have been omitted. Some of these are agriculturally important, as for example, the "green valleys" in camp, and the short grass pastures immediately around the camp homesteads. Many small areas of tussac have been similarly omitted, although an attempt has been made to show the larger among the tussac areas. To be fully informative, the grassland

ND ISLANDS

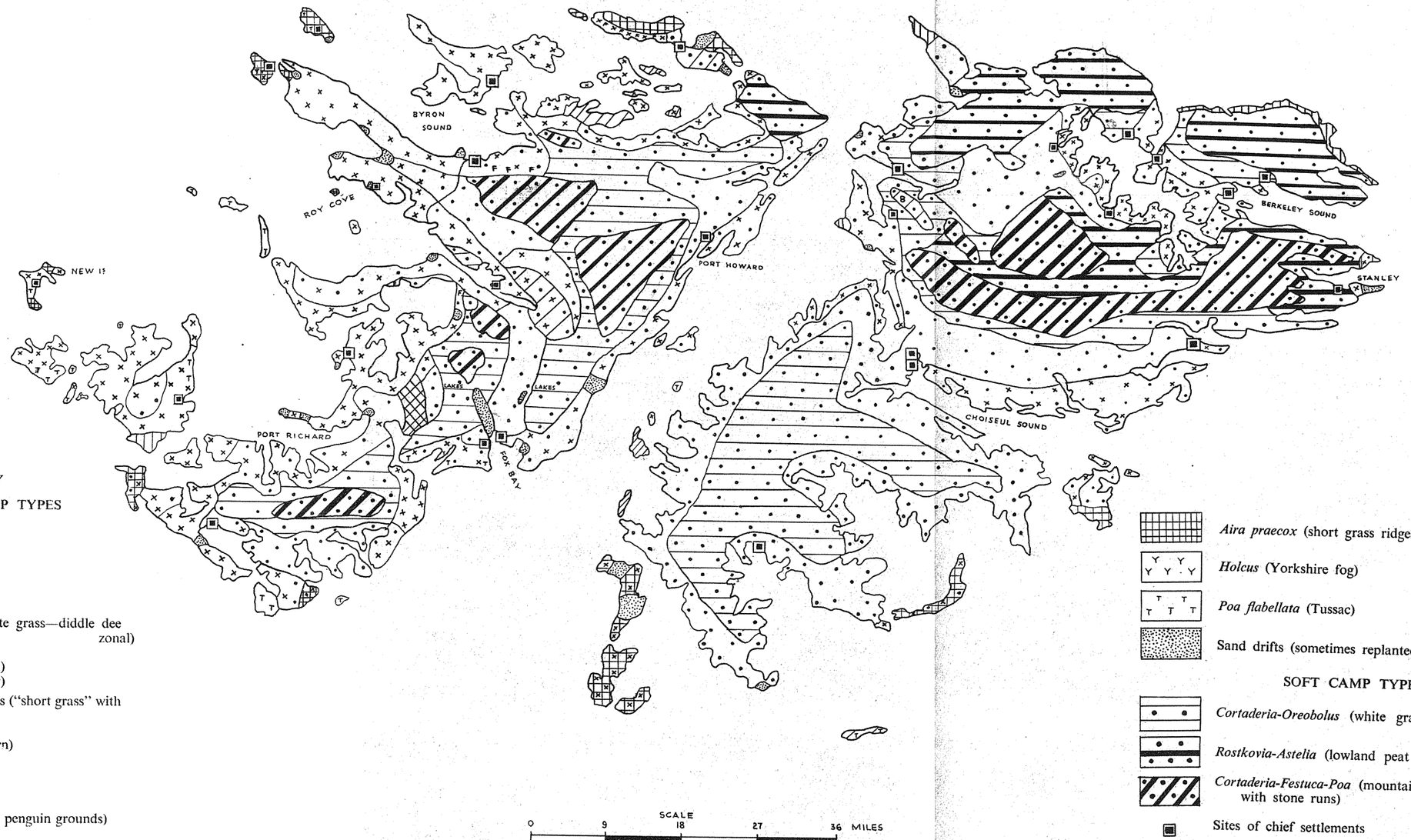
YSTWYTH. *October, 1938*

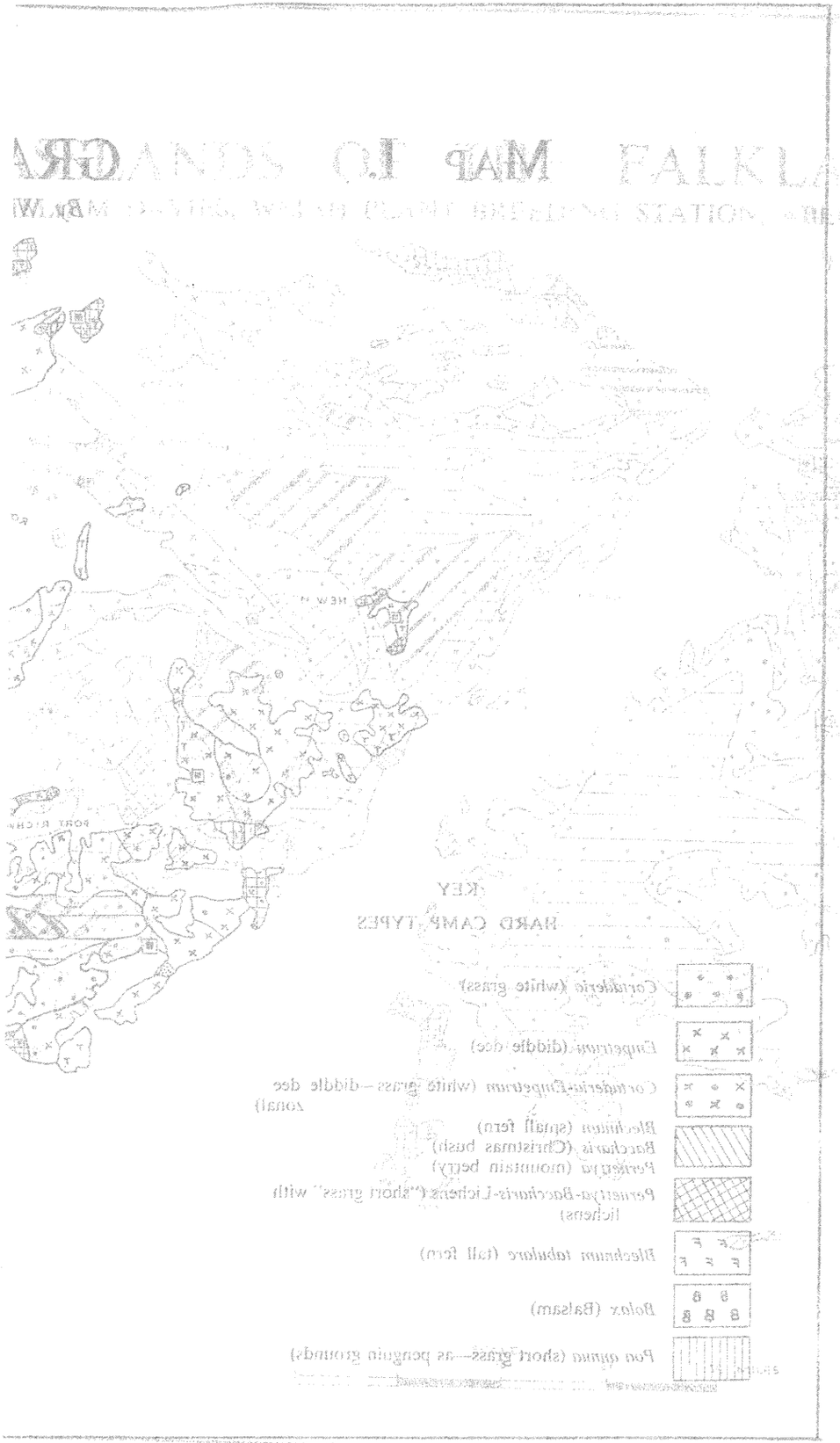


MAP I.

GRASSLANDS OF THE FALKLAND ISLANDS

By WILLIAM DAVIES, WELSH PLANT BREEDING STATION, ABERYSTWYTH. *October, 1938*





map should have been supported by detailed transects showing the composition of the vegetation within each of the zones shown. Neither time nor other facilities were available to make such transects during the course of the 1937-38 survey.

It is to be hoped that the grassland map will be found useful both by the central authorities and the practical man. It should at least be useful in showing where the different types of grassland are to be found, as well as the relative extent of these. It will also show the geographical relationships of hard camp and soft camp respectively (including mountain).

On the basis of this map a rough estimate has been made of the aggregate proportion of the several grassland types to which reference is made. These data are presented in Table 6 hereunder, and are expressed on a percentage area basis separately for the East and West Falklands (including adjacent islands in each case) while the data relative to the colony as a whole are shown on both a percentage and an acreage basis. For this purpose the aggregate area of the Falkland Islands is assumed to be the nominal figure of 3,000,000 acres.*

Some interesting points emerge from a study of Table 6, particularly when the East and West Falklands (with adjacent islands in each case) are compared. The aggregate percentage of hard camp types is much higher in the west than in the east (65·72 per cent against 46·86 per cent) and correspondingly there is more soft camp in the East Falkland. This fully confirms the general conception relative to east and west that is to be found among practical men in the camp.

Diddle dee areas, and also white grass with diddle dee ridges, are far more abundant in the west than in the east, while among the soft camp associations the really important difference between east and west lies in the proportion of lowland peat banks. In the East Falklands this type accounts for some 17·80 per cent of the total land surface, with a large concentration north of the Wickham Heights, and along the north coast of the East Falklands generally. Lowland peat banks occupy only 1·70 per cent of the West Falklands—the most extensive area lies in the White Rock peninsula on Port Howard Station. White grass swards again are seen to occupy a much larger area on the East Falklands, largely because of the extensive white grass flats lying immediately to the south of the Wickham Heights and those bordering the Lafonia coast in general.

* The area determined by Cottrell from calculations based on the Admiralty Chart is quoted by Middleton (19) as 2,955,823 acres. A similar determination by Cotton resulted in the figure of 2,841,888 acres.

TABLE 6.

SHOWING THE PERCENTAGE AREA AND THE ESTIMATED ACREAGES OF THE SEVERAL PASTURE ZONES (BASED ON MAP I).

Pasture Type	East Falkland* Per cent	West Falkland* Per cent	Falkland Islands*	
			Per cent	Acres
HARD CAMP.				
Cortaderia (white grass)	29·69	11·19	21·58	647,400
Empetrum (diddle dee)..	2·95	23·41	11·92	357,600
Cortaderia-Empetrum (white grass—diddle dee)	9·11	22·10	14·81	444,300
Blechnum-Pernettya, etc. (small fern—mountain berry—balsam, etc.	0·67	2·69	1·55	46,500
Blechnum tabulare (tall fern)	0·11	0·33	0·21	6,300
Poa annua and *Aira praecox* (penguin grounds and grassy ridges) ..	3·02	2·79	2·91	87,300
Other areas of introduced grasses (including settlement fields and areas of Yorkshire fog) ..	0·15	0·19	0·16	4,800
Tussac lands (including depleted land)	0·37	1·49	0·86	25,800
Sand drifts and dunes (including re-planted sands)	0·79	1·53	1·12	33,600
SOFT CAMP.				
Cortaderia—Oreobolus (white grass—oreob)	23·43	21·98	22·83	684,900
Rostkovia—Astelia (lowland peat banks)	17·80	1·70	10·75	322,500
Mountain pastures	11·91	10·60	11·30	339,000
Total hard camp areas	46·86	65·72	55·12	1,653,600
Total soft camp areas	53·14	34·28	44·88	1,346,400
Grand Total	100·00	100·00	100·00	3,000,000

* Including adjacent islands.

TABLE 7.

TO SHOW THE BOTANICAL COMPOSITION OF A NUMBER OF PASTURE TYPES CHARACTERISTIC OF SOME OF THOSE TO BE FOUND IN THE OPEN CAMP AND IN SETTLEMENT FIELDS IN THE FALKLAND ISLANDS. (PERCENTAGE AREA ANALYSES MADE 1937-38 SEASON.)

(1)		(2)	
Hard Camp. *Cortaderia* (white grass) at Port Howard (1).*		Hard Camp. *Cortaderia-Empetrum* (white grass with diddle dee) at Port Howard (9).	
	Per cent		*Per cent*
Cortaderia pilosa	62	*Cortaderia pilosa*	20
Gunnera magellanica	10	*Empetrum rubrum*	20
Baccharis magellanica	10	*Gunnera magellanica*	15
Aira praecox	5	*Hierochloë magellanica* ..	10
Blechnum penna marina	3	*Rostkovia magellanica* ..	10
Rumex Acetosella	3	*Aira praecox*	10
Festuca erecta..	3	*Baccharis magellanica*	5
Oxalis enneaphylla	3	*Perezia recurvata*	5
Empetrum rubrum	T	Other plants (aggregated) ..	5
Pernettya pumila	T		
Perezia recurvata	T		
Taraxacum spp.	T		
Ranunculus spp.	T		
Oreomyrrhis andicola	T		
Pratia repens	T		
Azorella sp.	T		
Veronica serpyllifolia	T		
Leuceria gossypina	T		
Chiliotrichum diffusum	T		
Sisyrinchium filifolium	T		
Luzula alopecurus	T		
Cerastium arvense	T		
C. vulgatum	T		
Bellis perennis	T		
Taraxacum officinale	T		
Holcus lanatus	T		
Agrostis tenuis	T		
Poa pratensis	T		
P. annua	T		
Bromus mollis	T		
Total	100	Total	100
Bare space No record		Bare space No record	

* Reference number in field records.

TABLE 7—*Continued.*

(3)		(4)	
Hard Camp. *Empetrum* (diddle dee) at Fitzroy (53)		Settlement Field *Bellis—Poa* (daisy with smooth-stalked meadow grass) at Douglas (self-sown) (30)	
	Per cent		*Per cent*
Empetrum rubrum	40	*Bellis perennis*	33
Baccharis magellanica	15	*Poa pratensis*	25
Cortaderia pilosa	12	*P. annua*	15
Blechnum penna marina	5	*Festuca rubra*	5
Pernettya pumila	5	*Rumex Acetosella*	5
Deschampsia flexuosa	5	*Aira caryophyllea*	5
Festuca ovina var. *magellanica*	5	*A. praecox*	5
Bolax gummifera	5	*Mosses* (various)	5
Trisetum spicatum	2	*Oreomyrrhis andicola*	2
Gunnera magellanica	2	*Cerastium vulgatum*	T
Mosses and Bryophytes	2		
Lichens	2		
Cerastium vulgatum	T		
Lycopodium	T		
Total	100	Total	100
Bare space	40	Bare space	5

(5)		(6)	
Settlement field. *Agrostis tenuis* (bent) dominant at Roy Cove (self-sown) (25)		Settlement field. *Holcus lanatus* (fog) dominant at Port San Carlos (sown pasture) (28)	
Agrostis tenuis	55	*Holcus lanatus*	50
Bellis perennis	14	*Poa pratensis*	20
Poa pratensis	9	*P. annua*	7
Rumex Acetosella	5	*Dactylis glomerata*	8
Trifolium minus	5	*Rumex Acetosella*	5
T. repens	3	*Phleum pratense*	4
Poa annua	3	*Trifolium repens*	1
Mosses (various)	3	*Achillea Millefolium*	T
Hypochoeris radicata	3	Miscellaneous plants	5
Plantago Lanceolata	T		
Cerastium arvense	T		
Dactylis glomerata	T		
Holcus lanatus	T		
Acaena lucida	T		
Colonbanthus sp.	T		
Baccharis magellanica	T		
Total	100	Total	100
Bare space	Nil	Bare space	No record

TABLE 7—*Continued.*

(7)		(8)	
Settlement field. *Festuca rubra* (red fescue) dominant at Port Howard (sown pasture) (P.H. 30)		Settlement field. *Trifolium repens—Festuca rubra* (white clover with red fescue) at San Carlos (sown pasture) (26)	
	Per cent		*Per cent*
Festuca rubra	75	*Trifolium repens*	40
Trifolium repens	10	*Festuca rubra*	30
T. minus	10	*Dactylis glomerata*	5
Hypochoeris radicata	5	*Phleum pratense*	5
Rumex Acetosella	T	*Lolium perenne*	5
Bellis perennis	T	*Agrostis tenuis*	5
		Holcus lanatus	5
		Achillea Millefolium	2
		Bellis perennis	1
		Trifolium minus	1
		Poa pratensis	1
		Rumex Acetosella	T
		Other Plants	T
Total	100	Total	100
Bare space	2	Bare space	Nil

(9)		(10)	
Hard Camp (fern ridge) *Blechnum-Baccharis-Pernettya* (small fern, etc.) at Port Howard (7)		Hard Camp (short grass ridge) *Aira praecox* at West Point Island (60)	
	Per cent		*Per cent*
Blechnum penna marina	25	*Aira praecox*	70
Baccharis magellanica	20	*Festuca bromoides*	20
Pernettya pumila	20	*Poa pratensis*	5
Lichens (various)	10	*Holcus lanatus*	4
Cortaderia pilosa	5	*Rumex Acetosella*	1
Empetrum rubrum	5		
Festuca erecta	5		
Perezia recurvata	5		
Bolax gumifera	5		
Cerastium arvense (indig.)	T		
Primula farinosa	T		
Total	100	Total	100
Bare space	No record	Bare space	25

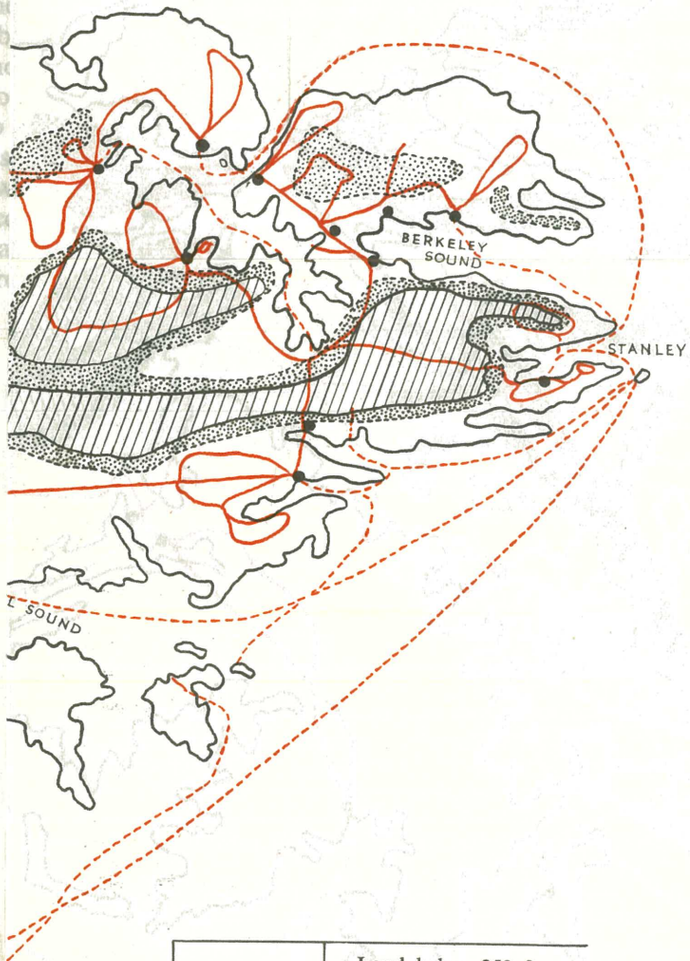
TABLE 7—*Continued.*

(11) Hard Camp (green valley). *Juncus scheuchzerioides* (small rush) dominant at Rincon Grande (45)	*Per cent*
Juncus scheuchzerioides	30
Gunnera magellanica	27
Agrostis magellanica	10
Rostkovia magellanica	5
Pernettya pumila	5
Rumex Acetosella	5
Poa annua	5
P. pratensis	5
Pratia repens	5
Colobanthus sp.	3
Empetrum rubrum	T
Aira praecox	T
Mosses and Bryophytes	T
Cerastium vulgatum	T
Carex sp.	T
Other plants	T
Total	100
Bare space	Nil

(12) Soft Camp. *Cortaderia-Oreobolus* (white grass-oreob) at Horseshoe Bay (44)	*Per cent*
Cortaderia pilosa	35
Oreobolus obtusangulus	30
Myrteola nummularia	5
Marsippospermum grandiflorum	5
Rostkovia magellanica	3
Pernettya pumila	3
Gunnera magellanica	2
Baccharis magellanica	2
Trisetum spicatum	2
Festuca erecta	2
Pratia repens	2
Astelia pumila	2
Sphagnum spp.	2
Lichens (various)	2
Mosses (various)	1
Lagenophora nudicaulis	1
Chiliotrichum diffusum	1
Total	100
Bare space	10

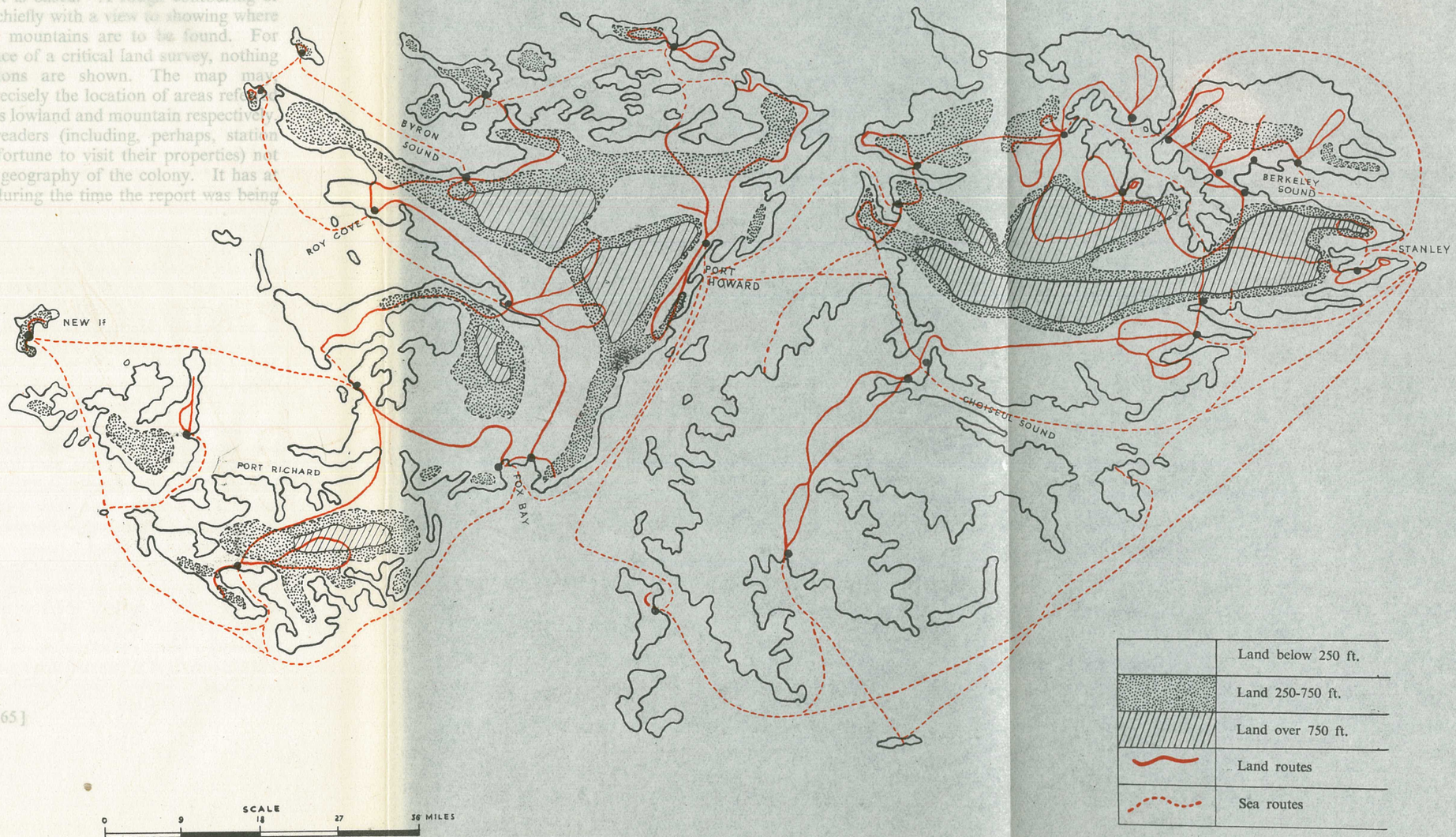
(13) Soft Camp. *Rostkovia-Astelia* (peat bank) at Johnson's Harbour (37)	*Per cent*
Rostkovia magellanica	20
Astelia pumila	18
Cortaderia pilosa	20
Oreobolus obtusangulus	15
Azorella spp. *et al.*	12
Baccharis magellanica	5
Lichens (various)	5
Festuca erecta	3
Drosera uniflora	2
Empetrum rubrum	T
Pernettya pumila	T
Myrteola nummularia	T
Pratia repens	T
Mosses	T
Bryophytes	T
Total	100
Bare space	25

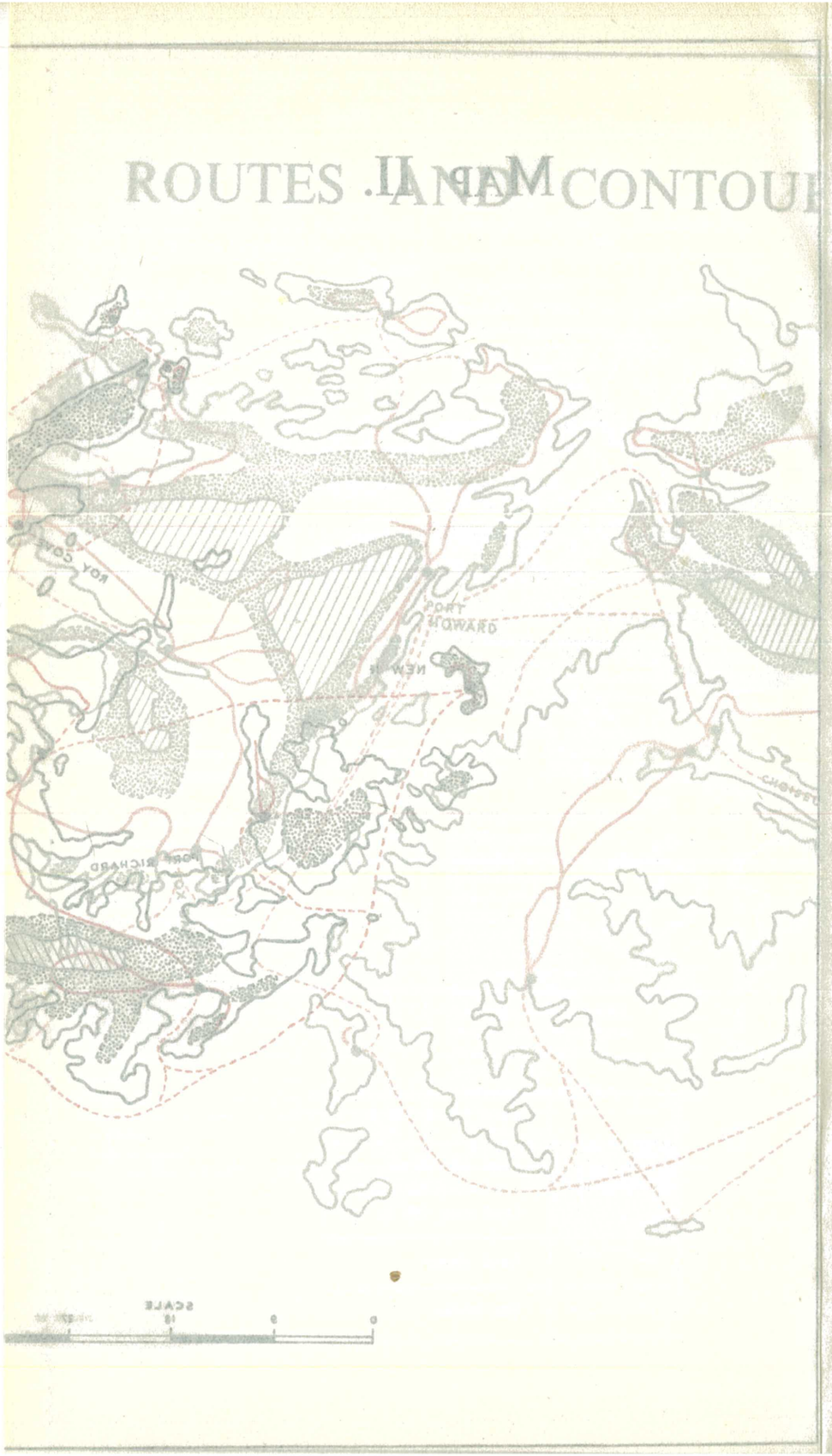
(14) Soft Camp. Mountain pastures at Port Stephens (73)	*Per cent*
Mountain blue grass	30
Astelia pumila	15
Festuca erecta	12
Rostkovia magellanica	10
Empetrum rubrum	5
Drosera uniflora	5
Myrteola nummularia	4
Lichens (various)	5
Callixene marginata	5
Cortaderia pilosa	2
Oreobolus obtusangulus	2
Mosses and Bryophytes	2
Pernettya pumila	1
Azorella spp.	1
Chiliotrichum diffusum	1
Total	100
Bare space	25



MAP II.

ROUTES AND CONTOURS





EXPLANATORY NOTE DEALING WITH MAP II (ROUTE)

Map II shows the routes traversed by the writer over land and sea, both in and around the Falkland Islands, during the conduct of the survey upon which this report is based. A rough contouring of the land surface has been added, chiefly with a view to showing where the main blocks of uplands and mountains are to be found. For obvious reasons, and in the absence of a critical land survey, nothing more than general approximations are shown. The map may, however, help to indicate more precisely the location of areas referred to in the main body of the report as lowland and mountain respectively. Its greatest value may be for readers (including, perhaps, station owners who have never had the fortune to visit their properties) not acquainted at first hand with the geography of the colony. It has at least proved useful to its author during the time the report was being prepared.

SUPPLEMENTARY REPORT

Dealing with Evidence Based upon the Chemical Analyses of Samples of Grasses and other Plants Collected in the Falkland Islands, and Analysed in the Department of Agricultural Chemistry, University College of Wales, Aberystwyth.

The detailed results presented in Table 8 show the chemical composition of sixty-five samples of herbage, all of which have been grown under typical conditions in the Falkland Islands. This material includes forty-nine samples representing twenty-seven native species (consisting of eleven species of grasses and sixteen non-gramineous species, including two species of seaweed or kelp). The remaining sixteen samples also consist of material grown in the colony and representing eight British species (including white clover, three grasses, and four herbs) that are fairly abundant in certain selected habitats, as around some of the chief settlements in the Falkland Islands. They are also, of course, common plants in the pastures of Great Britain. In addition to the chemical analysis of the Falkland grown material, data are, for comparative purposes, also included (Table 8) to show the composition of typical samples of the eight British species concerned when grown under Welsh, as opposed to Falkland, conditions.

With the exception of two samples which represent mixed herbage (see Table 8) all the material that has been collected is based upon pure species. The greater part of these collections were made within easy distance of Stanley where laboratory arrangements were such that the collected material could be carefully examined in the fresh state. The samples were thoroughly air-dried and carefully packed for transit to Aberystwyth. Every care was taken to dry every sample, so that the risk of either fermentation or of mildew attack would be minimised in the course of its passage through the tropics. It is, therefore, satisfactory to record that with only one exception all the herbage samples arrived in Aberystwyth in perfect condition. The sample of sand oatgrass was this exception, and this was slightly mildewed when it was received at its final destination.

On arrival at Aberystwyth a number of the samples were separated into "leaf," "stem," and "burn" (=dead leafage). In these cases

3 PLANTS GROWN IN THE FALKLAND
IVE PLANTS OTHER THAN GRASSES
MPARATIVE COMPOSITION OF BRITISH
JLTS OF WHICH ARE SHOWN BELOW,
OF PROFESSOR T. W. FAGAN, M.A., F.I.C.)

	Ash	Silica	Silica-free ash	Phosphoric-acid (P_2O_5)	Lime (CaO)	Potash (K_2O)	Chlorine (Cl)
	5.44	2.00	3.44	0.304	0.182	1.75	0.950
	4.20	0.60	3.60	0.462	0.168	1.902	0.621
	3.32	0.34	2.98	0.286	0.266	1.902	0.818
	4.88	0.42	4.46	0.351	0.075	2.57	0.843
	10.10	4.15	1.21	1.08	0.095	0.58	0.513
	8.05	1.75	3.17	1.39	0.085	1.68	0.515
White	8.12	2.25	2.70	0.81	0.155	1.61	0.245
	6.88	4.92	1.16	0.280	0.095	0.38	0.107
Mour	8.32	2.34	2.10	0.942	0.182	1.20	0.302
ant	4.25	0.89	3.36	0.414			
	3.90	0.99	2.91	0.216	0.105	1.51	0.550
	3.36	1.27	3.09	0.364	0.168	1.53	0.329
Nati	4.30	2.60	1.20	0.441	0.182	0.24	0.167
	5.15	0.83	4.18	0.250	0.224	2.07	1.092
Lan	6.22	3.14	3.08	0.420	0.210	1.96	1.393
	2.25	4.00	3.35	0.294	0.098	0.21	0.178
Yo	4.88	1.46	3.42	0.322	0.098	1.68	0.746
	5.33	3.40	1.93	0.266	0.126	1.51	0.395
	5.14	3.02	2.12	0.177	0.112	0.96	0.293
	5.52	3.37	2.15	0.205	0.105	1.44	0.249
	5.02	4.40	0.62	0.063	0.084	0.24	0.133
	6.22	3.74	2.48	0.216	0.224	1.23	0.444
	5.12	2.30	2.82	0.226	0.252	1.41	0.675
	6.48	2.89	3.59	0.347	0.322	1.82	0.541
	7.20	6.00	1.20	0.146	0.203	0.24	0.142
	5.22	0.23	4.99	0.322	0.364	1.56	0.746
	6.51	0.24	6.27	0.364	0.224	2.52	1.384

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CHEMICAL ANALYSES
COLLECTED IN THE
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OLLEGE OF WALES,

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TABLE 8.

SHOWING THE DETAILS OF THE CHEMICAL COMPOSITION OF THE DRY MATTER IN A NUMBER OF SAMPLES OF PASTURE PLANTS GROWN IN THE FALKLAND ISLANDS. THESE COMPRISE MATERIAL FROM (1) ELEVEN SPECIES OF NATIVE GRASSES; (2) SIXTEEN SPECIES OF NATIVE PLANTS OTHER THAN GRASSES (INCLUDING TWO SPECIES OF "KELP"), AND (3) TEN SAMPLES REPRESENTING INTRODUCED (BRITISH) PLANTS. THE COMPARATIVE COMPOSITION OF BRITISH GRASS MATERIAL IS GIVEN IN RESPECT OF SOME OF THE INTRODUCED PLANTS. (THE CHEMICAL ANALYSES, RESULTS OF WHICH ARE SHOWN BELOW, WERE CONDUCTED BY THE DEPARTMENT OF AGRICULTURAL CHEMISTRY AT ABERYSTWYTH AND UNDER THE DIRECTION OF PROFESSOR T. W. FAGAN, M.A., F.I.C.)

Common Name	Type of material used for chemical analyses	Where collected	Date collected 1938	Habitat and soil	Moisture	Crude protein	Ether extract	Fibre	Soluble carbohydrates	Ash	Silica	Silica-free ash	Phosphoric-acid (P_2O_5)	Lime (CaO)	Potash (K_2O)	Chlorine (Cl)
(1) *Native grasses.*																
Cinnamon grass	Young leafage	Surf Bay	22/2	Dry heath peat	6.72	10.59	4.08	28.25	44.92	5.44	2.00	3.44	0.304	0.182	1.75	0.950
Tussac	,,	,,	,,	"Tussac" peat	6.30	6.39	2.92	26.55	53.64	4.20	0.60	3.60	0.462	0.168	1.902	0.621
,,	Mature leaves	,,	,,	,,	6.35	10.85	3.58	29.65	45.65	3.92	0.34	3.58	0.286	0.266	1.902	0.818
,,	Mature bases (leaf sheaths)	,,	,,	,,	7.60	5.60	1.47	20.62	60.11	4.60	0.18	4.42	0.511	0.070	2.57	1.243
Land tussac	Mature plants	Mt. William	20/2	Deep peat (soft camp)	5.47	3.20	2.40	33.37	50.20	5.36	4.15	1.21	0.122	0.098	0.58	0.213
,,	,, stem	,,	,,	,,	5.90	2.80	1.80	38.80	45.78	4.92	1.75	3.17	0.259	0.084	1.68	0.515
,,	,, leaf	,,	,,	,,	5.84	5.86	3.02	33.93	46.45	4.90	2.20	2.70	0.260	0.154	1.61	0.245
,,	,, burn	,,	,,	,,	5.09	2.36	2.34	37.80	46.33	6.08	4.92	1.16	0.080	0.099	0.38	0.107
Mountain blue grass	,, plants	,,	21/2	,,	3.97	4.46	4.45	32.10	50.60	4.45	2.34	2.10	0.012	0.182	1.20	0.302
,,	,, stem	,,	,,	,,	5.44	2.45	1.95	36.66	49.60	3.90	0.99	2.01	0.216	0.105	1.51	0.550
,,	,, leaf	,,	,,	,,	4.81	6.74	5.07	35.94	44.08	4.36	1.27	3.09	0.264	0.196	1.53	0.329
,,	,, burn	,,	,,	,,	4.36	2.28	4.06	39.72	45.78	3.80	2.60	1.20	0.081	0.147	0.24	0.187
Sand oatgrass*	,, plants	Cape Pembroke	20/2	Sandy peat	5.55	7.79	2.50	32.65	46.36	5.15	0.97	4.18	0.250	0.224	2.07	1.092
Salt water grass	Young leaves	Stanley (foreshore)	28/1	Sand and seashore mud	5.80	9.54	3.10	31.00	44.34	6.22	3.14	3.08	0.470	0.210	1.94	1.393
White grass	Composite	Stanley Common	21/2	Deep peat (soft camp)	3.30	5.16	3.30	30.95	50.04	7.25	4.00	3.25	0.094	0.098	0.21	0.178
,,	Young stems with panicles†	,,	31/1	,,	5.17	7.26	2.30	32.35	48.04	4.88	1.46	3.42	0.322	0.098	1.68	0.746
,,	Mature leaves	Johnson's Harbour	31/12/37	,,	8.90	7.53	3.40	31.80	42.99	5.33	3.40	1.93	0.266	0.126	1.51	0.393
,,	Young leaves	Near Stanley	21/2/38	,,	3.35	8.75	3.30	33.35	46.11	5.14	3.02	2.12	0.177	0.112	0.96	0.293
,,	Leaves	,,	21/2	,,	3.80	7.88	3.51	29.90	49.39	5.52	3.37	2.15	0.205	0.105	1.44	0.249
,,	Burn	,,	,,	,,	3.55	2.89	3.08	32.95	52.51	5.02	4.40	0.62	0.063	0.084	0.24	0.133
Native fog	Composite	Stanley Common	,,	,,	2.60	5.16	4.00	36.40	45.62	6.22	3.74	2.48	0.216	0.224	1.23	0.444
,,	Stem	,,	,,	,,	4.30	4.06	3.13	38.71	45.22	5.12	2.30	2.82	0.226	0.252	1.41	0.675
,,	Leaf	,,	,,	,,	5.30	10.06	4.00	32.35	41.81	6.48	2.89	3.59	0.347	0.322	1.82	0.541
,,	Burn	,,	,,	,,	4.06	2.98	3.25	37.30	45.21	7.20	6.00	1.20	0.146	0.203	0.24	0.142
Native sheep's fescue	Youngish leafage	Stanley	22/2	Peaty loam	6.54	9.71	4.57	29.17	45.64	4.46	1.07	3.39	0.542	0.308	1.58	0.408
Hair grass	Young leafage	Stanley Common	,,	Deep peat	6.50	13.65	4.90	29.75	39.40	5.80	1.98	3.82	0.242	0.266	2.13	0.533
Native brown top	Composite	Cape Pembroke	21/2	Sandy peat	5.25	8.33	3.40	29.78	47.44	5.80	2.18	3.62	0.437	0.182	1.54	0.976
,,	Stem	,,	,,	,,	5.80	7.79	3.13	30.98	46.63	5.67	2.24	3.43	0.416	0.119	1.47	0.955
,,	Stem leaves only	,,	,,	,,	3.16	8.84	—	—	—	8.50	4.07	4.43	0.255	0.315	1.15	1.136
(2) *Native plants other than grasses.*																
Sea cabbage	Young leaves	Cape Pembroke	22/2	Sand overlying sandy peat	7.25	11.28	9.13	17.95	44.74	9.65	1.05	8.60	0.478	1.001	2.92	0.719
Christmas bush	Leaves	Stanley Common	15/1	Dry heath peat	7.75	7.70	17.65	11.65	47.13	8.12	0.44	7.68	0.178	0.308	2.13	0.400
Diddle dee	Tips of shoots	,,	,,	,,	6.75	5.25	14.47	19.10	51.71	2.72	0.34	2.38	0.201	0.658	0.72	0.185
Small fern	Young leaf tips	,,	21/2	,,	9.80	11.30	2.45	16.30	53.71	6.44	0.52	5.92	0.540	0.490	2.57	0.754
Native carrot	Leaf	Stanley and the north-east	Jan. and Feb. 1938	,,	5.05	14.70	5.68	14.45	48.46	11.66	1.00	10.66	0.740	1.438	2.92	0.976
,,	Flowering stem			,,	8.05	14.26	4.63	17.09	47.53	8.45	0.41	8.04	0.827	0.952	3.01	0.959
,,	Root			,,	7.90	12.08	6.12	14.85	51.45	7.60	0.68	6.92	0.720	0.924	2.16	0.923
Oreob	Shoot tips	Stanley Common	22/2	Deep peat waterlogged	5.97	5.34	2.22	23.25	54.96	5.26	2.22	3.04	0.343	0.182	0.72	0.767
Fachinal bush	Leaves	Cape Pembroke	21/2	Dry heath peat	2.80	9.89	8.90	29.40	44.26	4.75	0.15	4.60	0.476	0.420	2.06	0.470
Gentian	Composite	Stanley Common	15/2	Deep peat waterlogged	6.70	9.10	10.65	21.65	46.68	5.22	0.23	4.99	0.322	0.364	1.56	0.746
Small rush	Youngish leaves	Cape Pembroke	20/2	Peaty loam	8.85	14.35	3.95	24.10	42.24	6.51	0.24	6.27	0.364	0.224	2.57	1.384
Pigvine	Leaves incl. petioles‡	Stanley	15/1	,,	8.90	14.09	4.70	14.06	53.51	4.74	0.41	4.33	0.297	0.793	1.17	1.305
Scurvy grass	,,	,,	Feb.	Dry heath peat	7.95	13.21	7.80	11.88	52.29	6.87	0.26	6.61	0.512	0.912	2.43	0.586
Celery (A)	,,	New Island	26/1	,,	10.00	10.94	3.10	16.45	45.15	14.36	1.00	13.36	0.901	1.274	2.71	3.523
,, (B)	,,	Kidney Island	7/3	,,	10.56	14.26	5.99	12.95	41.20	15.04	0.04	15.00	0.844	3.276	2.86	3.151
Vanilla daisy	,,	Sapper's Hill	21/2	,,	7.45	10.15	5.63	17.62	45.31	13.85	0.40	13.45	0.576	1.197	3.70	—
Brown swamp grass	Composite	Stanley Common	22/2	Deep peat waterlogged	5.35	5.78	2.40	35.60	48.68	2.19	0.19	2.00	0.204	0.266	0.88	0.213
Leafy kelp (A)	"Leaf"	Surf Bay	,,	Seashore pools	7.28	16.01	1.50	5.76	48.29	20.16	0.16	20.00	0.814	1.148	6.22	5.346
,, (B)	"Stem"	,,	,,	,,	4.99	8.05	1.00	4.93	53.43	27.60	0.05	27.55	0.764	1.029	10.87	9.662
Tree kelp	Portion of huge "fronds"	,,	,,	Deep pools and open water	9.91	6.74	2.05	3.22	55.80	22.28	0.02	22.26	0.305	1.512	2.79	5.546
(3) *British plants (grown in the Falkland Islands).*																
Brown top or bent	Young pasture	Stanley	21/2	Dry heath peat	7.30	19.34	4.75	22.90	34.77	10.94	2.56	8.38	0.550	0.560	3.15	1.429
Yorkshire fog	Very young leaves (1)	Stanley Common	18/3	Deep peat (soft camp dug over)	10.58	29.49	5.85	15.95	29.69	8.44	2.58	5.86	0.406	0.224	2.88	1.162
,,	,, (2)	,,	22/2	,,	11.00	27.43	5.60	16.30	31.03	8.64	2.32	6.32	0.471	0.280	2.98	1.420
,,	(Hay ex E.189) stem	,,	,,	,,	5.53	4.99	2.62	32.07	48.59	6.20	2.19	4.01	0.732	0.322	1.51	1.154
,,	,, leaf	,,	,,	,,	7.43	10.85	5.02	23.40	47.60	7.70	1.72	5.98	0.804	0.560	2.45	1.118
,,	,, burn	,,	,,	,,	6.13	3.50	2.53	35.47	44.58	7.79	4.23	3.76	0.565	0.434	0.71	1.251
,,	Mature growth stem	,,	21/2	,,	7.31	8.14	2.96	27.42	48.16	6.01	1.36	4.65	0.719	0.168	2.21	1.039
,,	,, leaf	,,	,,	,,	7.30	10.76	4.09	21.55	48.63	7.67	1.44	6.23	0.768	0.574	2.50	1.047
Cocksfoot	Leafage 3 in.-4 in. tall	Stanley	22/2	Dry heath peat	7.10	17.33	5.29	25.30	34.85	10.03	2.82	7.21	0.653	0.574	3.39	1.473
White clover	Leaves and petioles	,,	20/2	,,	9.60	23.75	4.60	12.90	39.58	9.57	0.33	9.24	0.626	1.442	2.95	1.270
Bent fescue with clover	Short leafage 75 per cent grass	,,	21/2	,,	8.75	20.21	5.40	20.10	37.25	8.29	1.42	6.87	0.661	0.728	2.40	1.526
White clover with bent	Short leafage 70 per cent clover	,,	22/2	,,	9.53	20.83	5.95	15.67	39.66	8.36	0.45	7.91	0.610	1.33	2.81	1.047
Yarrow	Leaves and petioles	,,	4/2	,,	10.70	26.25	5.63	11.65	30.95	14.82	2.04	12.78	1.212	1.442	5.95	1.668
Creeping buttercup				,,	9.05	16.71	4.30	17.35	39.93	12.66	0.34	12.32	0.876	1.736	3.15	2.270

,, ...	Mature bases (leaf sheaths) ..	,, ..	,, ..	,, ..	7·60	5·60	1·47	20·62	60·11	4·60	0·18	4·42	0·511	0·070	2·57	1·243
Land tussac	Mature plants	Mt. William ..	20/2 ..	Deep peat (soft camp)	5·47	3·20	2·40	33·37	50·20	5·36	4·15	1·21	0·122	0·098	0·58	0·213
,, ...	,, stem	,, ..	,, ..	,, ...	5·90	2·80	1·80	38·80	45·78	4·92	1·75	3·17	0·259	0·084	1·68	0·515
,, ...	,, leaf	,, ..	,, ..	,, ...	5·84	5·86	3·02	33·93	46·45	4·90	2·20	2·70	0·260	0·154	1·61	0·245
,, ...	,, burn	,, ..	,, ..	,, ...	5·09	2·36	2·34	37·80	46·33	6·08	4·92	1·16	0·080	0·099	0·38	0·107
Mountain blue grass ..	,, plants	,, ..	21/2 ..	,, ...	3·97	4·46	4·45	32·10	50·60	4·45	2·34	2·10	0·012	0·182	1·20	0·302
,, ...	,, stem	,, ..	,, ..	,, ...	5·44	2·45	1·95	36·66	49·60	3·90	0·99	2·01	0·216	0·105	1·51	0·550
,, ...	,, leaf	,, ..	,, ..	,, ...	4·81	6·74	5·07	35·94	44·08	4·36	1·27	3·09	0·264	0·196	1·53	0·329
,, ...	,, burn	,, ..	,, ..	,, ...	4·36	2·28	4·06	39·72	45·78	3·80	2·60	1·20	0·081	0·147	0·24	0·187
Sand oatgrass*	,, plants	Cape Pembroke ..	20/2 ..	Sandy peat	5·55	7·79	2·50	32·65	46·36	5·15	0·97	4·18	0·250	0·224	2·07	1·092
Salt water grass	Young leaves	Stanley (foreshore)	28/1 ..	Sand and seashore mud ..	5·80	9·54	3·10	31·00	44·34	6·22	3·14	3·08	0·470	0·210	1·94	1·393
White grass	Composite	Stanley Common	21/2 ..	Deep peat (soft camp)	3·30	5·16	3·30	30·95	50·04	7·25	4·00	3·25	0·094	0·098	0·21	0·178
,, ...	Young stems with panicles† ..	,, ..	31/1 ..	,, ...	5·17	7·26	2·30	32·35	48·04	4·88	1·46	3·42	0·322	0·098	1·68	0·746
,, ...	Mature leaves	Johnson's Harbour	31/12/37	,, ...	8·90	7·53	3·40	31·80	42·99	5·33	3·40	1·93	0·266	0·126	1·51	0·393
,, ...	Young leaves	Near Stanley ..	21/2/38	,, ...	3·35	8·75	3·30	33·35	46·11	5·14	3·02	2·12	0·177	0·112	0·96	0·293
,, ...	Leaves	,, ..	21/2 ..	,, ...	3·80	7·88	3·51	29·90	49·39	5·52	3·37	2·15	0·205	0·105	1·44	0·249
,, ...	Burn	,, ..	,, ..	,, ...	3·55	2·89	3·08	32·95	52·51	5·02	4·40	0·62	0·063	0·084	0·24	0·133
Native fog	Composite	Stanley Common	,, ..	,, ...	2·60	5·16	4·00	36·40	45·62	6·22	3·74	2·48	0·216	0·224	1·23	0·444
,, ...	Stem	,, ..	,, ..	,, ...	4·30	4·06	3·13	38·71	45·22	5·12	2·30	2·82	0·226	0·252	1·41	0·675
,, ...	Leaf	,, ..	,, ..	,, ...	5·30	10·06	4·00	32·35	41·81	6·48	2·89	3·59	0·347	0·322	1·82	0·541
,, ...	Burn	,, ..	,, ..	,, ...	4·06	2·98	3·25	37·30	45·21	7·20	6·00	1·20	0·146	0·203	0·24	0·142
Native sheep's fescue	Youngish leafage ..	Stanley ..	22/2 ..	Peaty loam	6·54	9·71	4·57	29·17	45·64	4·46	1·07	3·39	0·542	0·308	1·58	0·408
Hair grass	Young leafage	Stanley Common	,, ..	Deep peat	6·50	13·65	4·90	29·75	39·40	5·80	1·98	3·82	0·242	0·266	2·13	0·533
Native brown top	Composite	Cape Pembroke ..	21/2 ..	Sandy peat	5·25	8·33	3·40	29·78	47·44	5·80	2·18	3·62	0·437	0·182	1·54	0·976
,, ...	Stem	,, ..	,, ..	,, ...	5·80	7·79	3·13	30·98	46·63	5·67	2·24	3·43	0·416	0·119	1·47	0·955
,, ...	Stem leaves only	,, ..	,, ..	,, ...	3·16	8·84	—	—	—	8·50	4·07	4·43	0·255	0·315	1·15	1·136
(2) *Native plants other than grasses.*																
Sea cabbage	Young leaves	Cape Pembroke ..	22/2 ..	Sand overlying sandy peat ..	7·25	11·28	9·13	17·95	44·74	9·65	1·05	8·60	0·478	1·001	2·92	0·719
Christmas bush	Leaves	Stanley Common	15/1 ..	Dry heath peat	7·75	7·70	17·65	11·65	47·13	8·12	0·44	7·68	0·178	0·308	2·13	0·400
Diddle dee	Tips of shoots	,, ..	,, ..	,, ...	6·75	5·25	14·47	19·10	51·71	2·72	0·34	2·38	0·201	0·658	0·72	0·185
Small fern	Young leaf tips	,, ..	21/2 ..	,, ...	9·80	11·30	2·45	16·30	53·71	6·44	0·52	5·92	0·540	0·490	2·57	0·754
Native carrot	Leaf	Stanley and the north-east	Jan. and Feb. 1938	,, ...	5·05	14·70	5·68	14·45	48·46	11·66	1·00	10·66	0·740	1·438	2·92	0·976
,, ...	Flowering stem			,, ...	8·05	14·26	4·63	17·09	47·53	8·45	0·41	8·04	0·827	0·952	3·01	0·959
,, ...	Root			,, ...	7·90	12·08	6·12	14·85	51·45	7·60	0·68	6·92	0·720	0·924	2·16	0·923
Oreob	Shoot tips	Stanley Common	22/2 ..	Deep peat waterlogged	5·97	5·34	2·22	23·25	54·96	5·26	2·22	3·04	0·343	0·182	0·72	0·767
Fachinal bush	Leaves	Cape Pembroke ..	21/2 ..	Dry heath peat	2·80	9·89	8·90	29·40	44·26	4·75	0·15	4·60	0·476	0·420	2·06	0·470
Gentian	Composite	Stanley Common	15/2 ..	Deep peat waterlogged	6·70	9·10	10·65	21·65	46·68	5·22	0·23	4·99	0·322	0·364	1·56	0·746
Small rush	Youngish leaves ..	Cape Pembroke ..	20/2 ..	Peaty loam	8·85	14·35	3·95	24·10	42·24	6·51	0·24	6·27	0·364	0·224	2·57	1·384
Pigvine	Leaves incl. petioles‡ ..	Stanley ..	15/1 ..	,, ...	8·90	14·09	4·70	14·06	53·51	4·74	0·41	4·33	0·297	0·793	1·17	1·305
Scurvy grass	,, ...	,,	Feb. ..	Dry heath peat	7·95	13·21	7·80	11·88	52·29	6·87	0·26	6·61	0·512	0·912	2·43	0·586
Celery (A)	,, ...	New Island ..	26/1 ..	,, ...	10·00	10·94	3·10	16·45	45·15	14·36	1·00	13·36	0·901	1·274	2·71	3·523
,, (B)	,, ...	Kidney Island ..	7/3 ..	,, ...	10·56	14·26	5·99	12·95	41·20	15·04	0·04	15·00	0·844	3·276	2·86	3·151
Vanilla daisy	,, ...	Sapper's Hill ..	21/2 ..	,, ...	7·45	10·15	5·63	17·62	45·31	13·85	0·40	13·45	0·576	1·197	3·70	—
Brown swamp grass ..	Composite	Stanley Common ..	22/2 ..	Deep peat waterlogged	5·35	5·78	2·40	35·60	48·68	2·19	0·19	2·00	0·204	0·266	0·88	0·213
Leafy kelp (A)	"Leaf"	Surf Bay ..	,, ..	Seashore pools	7·28	16·01	1·50	5·76	48·29	20·16	0·16	20·00	0·814	1·148	6·22	5·346
,, (B)	"Stem"	,, ..	,, ..	,, ...	4·99	8·05	1·00	4·93	53·43	27·60	0·05	27·55	0·764	1·029	10·87	9·662
Tree kelp	Portion of huge "fronds" ..	,, ..	,, ..	Deep pools and open water ..	9·91	6·74	2·05	3·22	55·80	22·28	0·02	22·26	0·305	1·512	2·79	5·546
(3) *British plants (grown in the Falkland Islands).*																
Brown top or bent ..	Young pasture	Stanley	21/2 ..	Dry heath peat	7·30	19·34	4·75	22·90	34·77	10·94	2·56	8·38	0·550	0·560	3·15	1·429
Yorkshire fog	Very young leaves (1)	Stanley Common	18/3 ..	Deep peat (soft camp dug over) ..	10·58	29·49	5·85	15·95	29·69	8·44	2·58	5·86	0·406	0·224	2·88	1·162
,, ...	,, (2)	,, ..	22/2 ..	,, ...	11·00	27·43	5·60	16·30	31·03	8·64	2·32	6·32	0·471	0·280	2·98	1·420
,, ...	(Hay ex E.189) stem	,, ..	,, ..	,, ...	5·53	4·99	2·62	32·07	48·59	6·20	2·19	4·01	0·732	0·322	1·51	1·154
,, ...	,, leaf	,, ..	,, ..	,, ...	7·43	10·85	5·02	23·40	47·60	7·70	1·72	5·98	0·804	0·560	2·45	1·118
,, ...	,, burn	,, ..	,, ..	,, ...	6·13	3·50	2·53	35·47	44·58	7·79	4·23	3·76	0·565	0·434	0·71	1·251
,, ...	Mature growth stem	,, ..	21/2 ..	,, ...	7·31	8·14	2·96	27·42	48·16	6·01	1·36	4·65	0·719	0·168	2·21	1·039
,, ...	,, leaf	,, ..	,, ..	,, ...	7·30	10·76	4·09	21·55	48·63	7·67	1·44	6·23	0·768	0·574	2·50	1·047
Cocksfoot	Leafage 3 in.-4 in. tall	Stanley ..	22/2 ..	Dry heath peat	7·10	17·33	5·29	25·30	34·85	10·03	2·82	7·21	0·653	0·574	3·39	1·473
White clover	Leaves and petioles	,, ..	20/2 ..	,, ...	9·60	23·75	4·60	12·90	39·58	9·57	0·33	9·24	0·626	1·442	2·95	1·270
Bent fescue with clover ..	Short leafage 75 per cent grass ..	,, ..	21/2 ..	,, ...	8·75	20·21	5·40	20·10	37·25	8·29	1·42	6·87	0·661	0·728	2·40	1·526
White clover with bent ..	Short leafage 70 per cent clover ..	,, ..	22/2 ..	,, ...	9·53	20·83	5·95	15·67	39·66	8·36	0·45	7·91	0·610	1·33	2·81	1·047
Yarrow	Leaves and petioles	,, ..	4/2 ..	,, ...	10·70	26·25	5·63	11·65	30·95	14·82	2·04	12·78	1·212	1·442	5·95	1·668
Creeping buttercup ..	,, ...	,, ..	,, ..	,, ...	9·05	16·71	4·30	17·35	39·93	12·66	0·34	12·32	0·876	1·736	3·15	2·270
Dandelion	,, ...	,, ..	21/2 ..	,, ...	9·43	19·29	6·65	11·65	40·07	12·91	0·40	12·51	0·684	1·596	3·26	1·633
Ribgrass	,, ...	,, ..	23/2 ..	,, ...	9·25	14·36	4·75	12·82	44·42	14·40	0·44	13·96	0·799	3·05	3·98	4·014

* *Elymus arenarius* (introduced). † Panicles = flower heads. ‡ Petioles = leaf stalks

(4) *British plants (from material grown in Wales).*

Common Name	Type of material used for chemical analyses	Where collected	Percentage of the dry matter										
			Crude protein	Ether extract	Fibre	Soluble carbo-hydrates	Ash	Silica	Silica-free ash	Phosphoric acid (P_2O_5)	Lime (CaO)	Potash (K_2O)	Chlorine (Cl)
Brown top or bent	Young pasture	Aberystwyth district ..	14·70	3·71	20·00	54·07	7·52	2·10	5·42	0·68	0·64	*	*
Yorkshire fog	,, ...	,, ..	18·90	6·08	26·00	36·85	12·52	3·25	9·25	0·56	0·51	2·06	*
Cocksfoot	,, ...	,, ..	19·10	7·24	29·30	34·11	10·25	2·10	8·15	0·81	0·91	2·71	*
White clover	Leaves and petioles ..	,, ..	26·20	5·30	16·28	43·40	9·82	1·87	8·02	0·79	1·23	3·16	*
Yarrow	,, ...	,, ..	19·90	4·43	24·31	40·75	10·61	0·51	10·10	0·91	1·08	2·81	0·92
Creeping buttercup	,, ...	,, ..	16·22	5·84	16·76	54·80	6·38	0·29	6·09	0·76	1·32	2·07	0·88
Dandelion	,, ...	,, ..	19·36	5·19	17·13	42·82	15·50	1·02	14·48	0·98	1·80	4·09	2·00
Ribgrass	,, ...	,, ..	20·25	4·42	14·84	48·32	12·17	0·45	11·72	1·07	2·25	3·37	2·27

* Not recorded.

the chemical results in respect of these three categories are shown separately, as well as the results for the composite sample.

Discussion of Results.

(*a*) *Proportion of "stem," "leaf," and "burn."*

It is obvious to those with first-hand knowledge of the Falkland grasslands that the majority of the indigenous grasses carry an excessive proportion of burn, or dead leafage. This point is well illustrated by the data presented in Table 9, which show the percentage contribution of stem, leaf, and burn respectively in four of the common native grasses, and in one introduced grass (Yorkshire fog). All five grasses were in an advanced stage of growth when collected.

TABLE 9.

TO SHOW THE STAGE OF GROWTH AND THE PERCENTAGE BY WEIGHT OF STEM, LEAF, AND BURN IN FOUR FALKLAND GRASSES, AND IN YORKSHIRE FOG. (ALL MATERIAL GROWN IN THE FALKLANDS AND HARVESTED FEBRUARY, 1938.)

Species	Stage of growth	Stem	Leaf	Burn	Total
White grass (*Cortaderia pilosa*)	Mature leafage	T	40.4	59.6	100
Mountain blue grass (*Poa antarctica*)	Mature in seed	22.0	41.6	36.4	100
Native fog (*Trisetum spicatum*)	„ „ „	39.3	21.3	39.4	100
Land tussac (*Festuca erecta*) ..	„ „ „	12.2	18.6	69.2	100
Yorkshire fog (*Holcus lanatus*)	Advanced "hay"	84.2	8.4	7.4	100
„ „ „ „	Mature leafage	62.1	33.4	4.5	100

The percentage of burn is extremely high in each of the four native grasses. In the case of land tussac "burn" formed 69·2 per cent of the whole sample. Yorkshire fog, when in a mature stage, and particularly during the autumn (the season when the present collections were made) develops much more "burn" than most British grasses. Compared with many Falkland grasses, however, it has a low content of "burn." In the present instance two separate collections of Yorkshire fog contained 7·4 per cent and 4·5 per cent of "burn" respectively. The four indigenous grasses showed corresponding figures ranging from 36·4 per cent to 69·2 per cent, with an average of 51·2 per cent of burn.

The proportion of "burn" in any species is an important matter, for, as will be indicated below, the nutritive value of "burn" is usually low. It is, in fact, extremely low in the Falkland grasses, and much lower than that associated with "burn" in the British grasses when grown under Falkland conditions. (See Table 8.)

(*b*) *Consideration of the Chemical Evidence.*

A complete chemical analysis has been conducted on all the samples that were collected. These data are of particular practical interest and serve to indicate not only the differences in composition that appear between the different species of grasses and herbs, but also the distinction between different parts of the same plant. In this latter respect the present results are in general agreement with similar evidence obtained in relation to pasture plants in Britain.

The Indigenous (Native) Grasses.

The data presented in Table 8 with regard to the native grasses of the Falklands show that these are in general very low in nutrient value. This is true almost throughout the list in respect of the percentages of crude protein, phosphoric acid, lime, and potash, all of which are essential elements in the proper nutrition of stock. The phosphoric acid and lime are particularly low in the native grasses when compared to normal pasture grasses in Britain. This point was emphasized by Orr (24) in relation to composite pasture samples collected (in the Falklands) irrespective of botanical composition. The nutritive value will of course depend to an appreciable degree not only upon the stage of growth of the plants, but also upon the proportion of leaf, stem, and burn. This fact has been consistently shown by the work of Fagan at Aberystwyth in relation to British pasture plants in general. The present data are in conformity with these results, for they show that leaf is more nutritious than stem, and that stem has a higher food value than "burn" in the great majority of Falkland grasses.

It is of interest to record that both hairgrass and native sheep's fescue are relatively rich in nutrients, compared with the majority of other native grasses. These two species are highly valued as grazing plants in the Falklands, and they form the bulk of the so-called "fine grasses" whose depletion on many areas of hard camp is so often deplored by the Falklands stock manager. They are both very palatable relative to other species found growing with them. Both of

these grasses are, however, present on most areas of hard camp and especially on diddle dee camp where they are partially protected from over-grazing in and around the bushes of diddle dee.

The chemical composition of tussac (*Poa flabellata*) will be of interest to practical men in the Falklands. This grass provides valuable feed, especially in winter. Horses are said to fatten readily upon it. The low content of crude protein, especially in the leaf bases* and in the young leaves is somewhat surprising, in view of the value placed upon tussac in practice. The present result may, therefore, need confirmation, and it is only to be hoped that facilities for such will be made available at a later date. Material over a wider range of conditions should be collected for further chemical analysis. The material collected in the present instance came from a tussac plantation at Surf Bay near Stanley, and to all appearances was quite typical of tussac growing in other parts of the colony. If it be assumed that this material is typical, tussac grass does not appear to be strikingly high in nutritive value, although the figures show it to be well above the average of Falkland grasses in this respect.

The data for white grass (Table 8) show this plant to be of inferior nutritive value. Even the carefully selected young green leaves cut from "bogs"† of white grass are low in food value. Table 10 compares the composition of white grass (young green leaves) with cocksfoot, white clover, and Yorkshire fog (very young leafage). The comparable figures for a sample of white grass typical of that offering on normal white grass camp are also given.

TABLE 10.

TO COMPARE THE CHEMICAL COMPOSITION OF WHITE GRASS, COCKSFOOT, WHITE CLOVER, AND YORKSHIRE FOG. (ALL FALKLAND-GROWN MATERIAL. COLLECTED FEBRUARY, 1938.)

Species	Crude protein	P_2O_5	CaO	K_2O	Cl
White grass (young leafage)	8.75	0.177	0.112	0.96	0.293
Cocksfoot „ „	17.33	0.653	0.574	3.39	1.473
White Clover „ „	23.75	0.626	1.442	2.95	1.270
Yorkshire fog „ „	27.43	0.471	0.280	2.98	1.420
White grass (ordinary sample) ..	5.16	0.094	0.098	0.21	0.178

* = leaf sheaths.
† That is clumps.

These data show that young leafage of cocksfoot, white clover, and Yorkshire fog may be expected to be twice or even three times as rich in protein as the best white grass. The contrast is even more pronounced when the figures for phosphoric acid, lime, potash, and chlorine are examined. On the other hand, young green leaves of white grass are not strikingly higher in nutritive value when compared with an ordinary sample typical of the white grass herbage offering to the grazing animal on normal camp. Having regard to the abundance of white grass in Falkland pastures these data are of the utmost significance, and should be carefully considered in relation to the whole matter of pasture development in the colony. The case in favour of specifically introducing new pasture plants is made very much the stronger when the chemical evidence is taken into consideration.

Native "Non-Gramineous" Plants.

Many of the herbs of British grasslands have been shown by Fagan (10) to be appreciably richer in minerals than the usual grasses and clovers growing in association with them. On the basis of these findings a collection was made of a number of miscellaneous plants which are common constituents of pastures in the Falkland Islands. Some of these plants were observed to be very palatable and much sought after by the grazing animal, while other species also included in the list of plants brought back to Aberystwyth for chemical analysis were either not eaten at all, or only eaten at certain times of the year. Among the plants of outstanding palatability may be quoted the native carrot (*Oreomyrrhis andicola*), the small rush (*Juncus scheuchzerioides*), and celery (*Apium australe*), while among the least palatable in the list are sea cabbage (*Senecio candicans*), oreob (*Oreobolus obtusangulus*), gentian (*Gentiana magellanica*) and brown swamp grass (*Rostkovia magellanica*). Having regard to the chemical data brought together in Table 8 the first obvious point of interest is that many of these Falkland herbs are markedly richer in protein and minerals than the native grasses. This is particularly true of the carrot, small rush, and celery, each noted as being highly palatable. Small rush is, however, not rich in phosphoric acid and lime. The leaves of both celery and carrot are particularly rich in lime. The majority of the herbs are rich in potash, while celery is outstandingly rich in chlorine. Among the least useful of these plants, judged by standards of grazing value, oreob, gentian, and brown swamp grass are each very low in protein and minerals ; Christmas

bush (leaves) and diddle dee (young shoot tips) are unusually low in phosphoric acid, while Christmas bush (leaves) is low in lime content. Diddle dee, oreob, and brown swamp grass are all low in potash.

The Chemical Composition of "Kelp" (Seaweed).

Two samples of "kelp" were collected. One of these (leafy kelp) was separated into "stem" and "leaf," while the other represented portions of the huge fronds of the tree kelp common in Falkland waters. Both species of kelp are said to be much sought after by livestock during the winter months. Masses of kelp are thrown up around the Falkland coasts after winter gales, and it is then that the sheep and cattle are said to "live on the shores." During the course of the grassland survey now reported upon, opportunities arose to study this question, but only occasionally were grazing animals found on the shores, and only in one or two cases were they seen foraging among even fresh kelp. The evidence in favour of their consuming kelp during the winter, however, is very strong, and was admitted by everyone to whom the question was put. In some cases it was strongly suggested that the carrying capacity of a Falkland sheep station is determined to an appreciable extent by the length of sea beaches easily accessible to livestock and abutting directly upon the open ocean. For obvious reasons more kelp will be thrown up on the ocean beaches than on the beaches of land-locked bays.

Having regard to all the verbal evidence given by station men in relation to the value of kelp it is extremely interesting to find that the three samples which have been analysed (Table 8) are rich in nutrients, compared with many land plants native to the Falklands. In the case of leafy kelp in particular, the percentage of crude protein is appreciably higher than in most Falkland grasses, while the lime and phosphoric acid contents compare not unfavourably with British grasses and clovers. The percentages of both potash and chlorine are very high, and this is in accord with expectation. Tree kelp, however, does not appear to be as nutritious as the leafy kelp, although on analysis the figure of 1·512 per cent of lime is higher than in leafy kelp. On the basis of this one analysis of leafy kelp there is a suggestion that "leaf" in kelp is of higher nutritive value than "stem." In this sample "leaf" is seen to contain twice as much crude protein and more lime and phosphoric acid. "Stem" is the richer in both potash and chlorine.

The Composition of Introduced (British) Plants.

Table 8 (Section 3) shows the composition of certain British grasses when grown in the Falklands under soil and climatic conditions in every way identical with those under which the native grasses are to be found. These data refer only to bent or brown top (*Agrostis tenuis*), fog (*Holcus lanatus*) and cocksfoot (*Dactylis glomerata*), but they are very significant and show that their nutritive value, as determined by the chemical evidence, is far in excess of that of the native grasses in general. Not only is the crude protein content much higher, but the percentage of phosphoric acid, lime, and potash is substantially greater in the three British grasses concerned. This is not to be attributed entirely to the greater proportion of leaf (as opposed to stem and "burn") in the British grasses, although it is entirely true to say that in most instances these are much more leafy than the native grasses. More than this, however, the data show that the British grasses are inherently richer in food value when leaf is compared with leaf than are the indigenous species. The data in Table 11 below in respect of the leaf, stem and "burn" in Yorkshire fog (*Holcus lanatus*) and native fog (*Trisetum spicatum*) are interesting in this connection. The two samples concerned were very similar in stage of growth when collected, a point which is confirmed by the similarity in the figures for crude protein. The comparison is further made the more significant because the two grasses show many similarities in an agronomic sense. Their similarity is such that their identity will often be confused by the practical grazier—this is implied in the name "native fog."

TABLE 11.

TO SHOW THE CHEMICAL COMPOSITION OF (1) LEAF, (2) STEM, AND (3) "BURN" IN YORKSHIRE FOG (*Holcus lanatus*) and NATIVE FOG (*Trisetum spicatum*) BOTH GROWN ON DEEP PEAT, STANLEY COMMON, FALKLAND ISLANDS. SAMPLES COLLECTED FEBRUARY 21-22, 1938.

Species		Crude protein	P_2O_5	CaO	K_2O	Cl
Yorkshire fog—	leaf	10.85	0.804	0.560	2.45	1.118
	stem	4.99	0.732	0.322	1.51	1.154
	"burn"	3.50	0.565	0.434	0.71	1.251
Native fog—	leaf	10.06	0.347	0.322	1.82	0.541
	stem	4.06	0.226	0.252	1.41	0.675
	"burn"	2.98	0.146	0.203	0.24	0.142

Native fog is among the most highly valued of the grasses indigenous to the Falklands, whereas Yorkshire fog is of low relative agronomic value among the British grasses. The figures for phosphoric acid, lime, and potash as given in Table 11 are significantly higher in Yorkshire fog ; in the majority of cases more than twice, and in some instances well over three times as high. It is interesting to note that in respect of phosphoric acid and lime, "burn" in Yorkshire fog is appreciably richer than even leaf (the richest part) in native fog.

The Chemical Composition of Certain British Pasture Plants when Grown in the Falkland Islands and Britain Respectively.

Certain British pasture plants when grown in the Falklands have been shown to be considerably higher in nutritive value than most of the indigenous Falkland grasses. It is of further interest to study the chemical composition of these plants with comparative data from British-grown material. These data are provided in Table 8 (Section 4). Taking the data as a whole, the difference in general composition as regards protein and minerals is not as great as might be expected. Falkland soils have been shown by Orr (24) to be particularly low in lime. It is, therefore, of considerable significance to note that the data for Falkland as against British-grown material is not widely different. In fact, as regards yarrow, buttercup, and ribgrass, the figures for lime are actually higher for the Falkland-grown specimens, but lower in the case of white clover and dandelion.

With regard to phosphoric acid, yarrow, buttercup, and white clover all give the higher figure from the Falklands, while ribgrass and dandelion are higher in the British samples quoted. Similar trends are to be seen relative to potash, chlorine, and the percentage of crude protein.

The samples of Falkland-grown brown top (*Agrostis*), cocksfoot, and Yorkshire fog, as well as the samples of short leafy grass and short leafy clover respectively, all appear to have provided results typical of British-grown herbage in a similar stage of growth and within the same species. This is true of the percentage crude protein and each of the mineral ingredients shown in Table 8.

General Discussion.

One of the most valuable points brought out by the chemical evidence reviewed above is that white clover as well as grasses such as cocksfoot, brown top, and Yorkshire fog, when grown in the Falkland

Islands are more or less similar in composition to the same species grown in Britain. The majority of native grasses are, on the other hand, relatively very low in value as animal food, whilst the native plants of highest nutritive value are found among the herbs. Outstanding among these are celery and carrot, both of which are highly palatable to stock. There is little doubt that many of these very palatable plants are now less common in the colony than in earlier days. Celery may now be said to be almost restricted to areas not readily accessible to sheep, but carrot is still widespread throughout areas of hard camp although seldom abundant, except on ungrazed or infrequently grazed areas as around many of the homesteads. Wherever sheep gain access carrot is "grazed to the bare earth."

The high relative nutritive value of introduced grasses and clovers grown in the Falklands, and under conditions where no specific manures have been applied, is a matter of great significance and cannot be overemphasized. Of particular significance in this respect is the high mineral content of the introduced plants when compared with the native grasses. These findings are of immediate practical importance in relation to the general nutrition of livestock, because these grasses, as also white clover, can be grown successfully over a wide range of conditions in the colony. It now becomes obvious that the main interest of the grassland improver in the Falklands should be concentrated upon establishing the appropriate introduced species. In view of the low mineral status of the great majority of native pasture plants attempts should be made to provide the grazing animals with sown pasture as part of their normal ration. This might be done by introducing strips of a grass-clover-weed mixture into each paddock on the station. Alternatively, a part of each paddock might be fenced off, sown out with an appropriate seeds mixture, and the animals given frequent access to the improved pasturage for short periods. This latter method would require more shepherding, and would also entail the extra expense of fencing, but would have the advantage of a better control of the grazing. Under existing conditions it is likely that the strip method which involves no specific fencing will be the more generally applicable.

The chemical evidence has shown that kelp is richer in both lime and phosphoric acid than the herbage normally offering on the pastures. This finding lends support to the prevailing viewpoint of station managers and others who have laid emphasis upon the value of kelp as winter fodder in the Falklands. Enormous quantities of kelp

appear to be thrown upon the beaches annually, and its importance as a potential source of manure carried on to the land should not be lost sight of. Now that caterpillar tractors have invaded the colony the question of hauling the kelp from shore to land should present little difficulty.

Summary.

(1) Grasses indigenous to the Falkland Islands are shown to be of low mineral content and of poor nutritive value generally when compared with British pasture plants. The proportion of "burn" is much higher in Falkland than in British grasses.

(2) Many of the miscellaneous (non-gramineous) herbs native to the Falklands have a much higher mineral content ; some of these are quite rich in both lime and phosphoric acid, although growing on soils that appear to be markedly deficient in one or both of these minerals.

(3) Eight species of pasture plants show on analysis a similar protein and mineral content, whether grown in the Falkland Islands or in Britain. These include three grasses, one clover and four herbs, all of which are common pasture plants in Britain.

(4) Kelp is richer in protein and in mineral content than the native grasses. Leafy kelp is more nutritious than the big tree kelp. It is suggested that measures should be taken to haul kelp for manurial purposes.

PLANTS COMMONLY FOUND IN THE FALKLAND ISLANDS LISTED ACCORDING TO THEIR BOTANICAL NAME

GRAMINEAE : Botanical Name	*GRASSES : Common Name*
Agrostis canina var. *Falklandicus*	Velvet bent
A. magellanica	Native bent
A. tenuis	Bent (or brown top)
Aira caryophyllea	Larger goosegrass
A. praecox	Goosegrass
Alopecurus pratensis	Meadow foxtail
Anthoxanthum odoratum	Sweet vernal grass
Avena elatior	Tall oat grass
Bromus mollis	Soft brome
Cortaderia pilosa	White grass
Cynosurus cristatus	Crested dogstail
Dactylis glomerata	Cocksfoot
Deschampsia flexuosa	Hairgrass
Festuca erecta	Land tussac
F. elatior	Tall fescue
F. Myuros	Ratstail fescue
F. ovina var. *magellanica*	Native sheep's fescue
F. pratensis	Meadow fescue
F. rubra	Red fescue
Hierochloë magellanica	Cinnamon grass
Holcus lanatus	Yorkshire fog
Lolium italicum	Italian rye-grass
L. perenne	Perennial rye-grass
Nardus stricta	Mat grass
Phleum pratense	Timothy
Poa antarctica	Mountain blue grass
P. alopecurus	Native timothy
P. annua	Annual meadow grass
P. flabellata	Tussac
P. pratensis	Smooth-stalked meadow grass
P. trivialis	Rough-stalked meadow grass
Trisetum spicatum	Native fog

LEGUMINOSAE : Botanical Name	*CLOVER : Common Name*
Lotus major	Bird's-foot trefoil
Medicago lupulina	Yellow trefoil
M. maculata	Spotted medick
M. sativa	Lucerne
Trifolium dubium	Suckling clover
T. fragiferum	Strawberry clover
T. hybridum	Alsike clover
T. pratense	Red clover
T. procumbens	Hop clover
T. repens	White clover
T. subterraneum	Subterranean clover

OTHER GENERA :	*OTHER PLANTS :*
Botanical Name	*Common Name*
Acaena ascendens	Prickly burr
A. laevigata	Prickly burr
A. lucida	Native yarrow
Achillea Millefolium	Yarrow
Anagallis alternifolia	Pimpernel
Armeria macloviana	Sea clover
Astelia pumila	—
Aster Vahlii	Marsh daisy
Azorella caespitosa et al.	Cushion plants or "moss"
Baccharis magellanica	Christmas bush
Bellis perennis	Field daisy
Blechnum penna marina	Small fern
B. tabulare	Tall fern
Bolax gummifera	Balsam bog
Calceolaria Darwinii	Lady's slipper
C. Fothergillii	Lady's slipper
Callixene (*Enargea*) *marginata*	Almond
Caltha sagittata	Marsh marigold
Carex fuscula	Sedge
C. trifida	Sword grass
Cerastium arvense	Star grass
C. vulgatum	Mouse-ear chickweed
Chenopodium macrospermum	Sea orache
Chiliotrichum diffusum	Fachinal bush
Chloraea Gaudichaudii	Yellow orchid

Botanical Name	*Common Name*
Codonorchis Lessonii	White orchid
Colobanthus crassifolius et al.	Pearlwort or "moss"
Crantzia lineata	Waterweed
Drosera uniflora	Sundew
Empetrum rubrum	Diddle dee
Euphrasia antarctica	Eyebright
Gaimardia australis	"Moss"
Galium antarcticum	Bedstraw
Gentiana magellanica	Native gentian
Gleichenia cryptocarpa	Umbrella fern
Gnaphalium affine	Cudweed
Gunnera magellanica	Pigvine
Hamadryas argentea	Silver-leaved buttercup
Hypochoeris radicata	Catsear
Juncus scheuchzerioides	Small rush
Lagenophora nudicaulis	—
Leuceria gossypina	Vanilla daisy
Luzula alopecurus	Native cotton grass
Marsippospermum grandiflorum	Tall rush
Myrteola nummularia	Malvina berry
Nanodea muscosa	—
Nertera depressa	—
Oreobolus obtusangulus	Oreob
Oreomyrrhis andicola	Native carrot
Oxalis enneaphylla	Scurvy grass
Perezia recurvata	Lavender
Pernettya pumila	Mountain berry
Plantago barbata	Sea plantain
P. lanceolata	Ribgrass
P. major	Broad-leaved plantain
Polygonum maritimum var. *chilense*	Sea persicaria
Pratia repens	Land cress
Primula farinosa	Dusty miller
Ranunculus biternatus	Crowfoot
R. maclovianus	Crowfoot
R. repens	Buttercup
Rostkovia magellanica	Brown swamp rush
Rubus geoides	Native strawberry

Botanical Name	*Common Name*
Rumex Acetosella	Sorrel
R. magellanicus	Native sorrel
Senecio candicans	Sea cabbage
S. falklandicus	Yellow daisy
S. Littoralis	Yellow daisy
Sisyrinchium filiofolium	Pale maiden
Spergula arvensis	Spurry
Stellaria debilis	Stitchwort
S. media	Chickweed
Taraxacum officinale et al.	Dandelion
Tillaea moschata	Sea stonecrop
Veronica elliptica	Native box
V. serpyllifolia	Speedwell
Viola maculata	Native pansy

PLANTS COMMONLY FOUND IN THE FALKLANDS LISTED ACCORDING TO THEIR COMMON NAMES

GRASSES : Common Name	*GRAMINEAE : Botanical Name*
Annual meadow grass	*Poa annua*
Bent (or brown top)	*Agrostis tenuis*
Cocksfoot	*Dactylis glomerata*
Crested dogstail	*Cynosurus cristatus*
Cinnamon grass	*Hierochloë magellanica*
Goosegrass	*Aira praecox*
Hair grass	*Deschampsia flexuosa*
Italian rye-grass	*Lolium italicum*
Land tussac	*Festuca erecta*
Larger goosegrass	*Aira caryophyllea*
Mat grass	*Nardus stricta*
Meadow fescue	*Festuca pratensis*
Meadow foxtail	*Alopecurus pratensis*
Mountain blue grass	*Poa antarctica*
Native bent	*Agrostis magellanica*
Native fog	*Trisetum spicatum*
Native sheep's fescue	*Festuca ovina* var. *magellanica*
Native timothy	*Poa alopecurus*
Perennial rye-grass	*Lolium perenne*
Ratstail rye-grass	*Festuca Myuros*
Red fescue (including creeping red fescue)	*Festuca rubra*
Rough-stalked meadow grass	*Poa trivialis*
Smooth-stalked meadow grass	*Poa pratensis*
Soft brome	*Bromus mollis*
Sweet vernal grass	*Anthoxanthum odoratum*
Tall fescue	*Festuca elatior*
Tall oat grass	*Avena elatior*
Timothy	*Phleum pratense*
Tussac	*Poa flabellata*
Velvet bent	*Agrostis canina* var. *Falklandicus*
White grass	*Cortaderia pilosa*
Yorkshire fog	*Holcus lanatus*

CLOVER :	*LEGUMINOSAE :*
Alsike clover	*Trifolium hybridum*
Bird's-foot trefoil	*Lotus major*
Hop clover	*Trifolium procumbens*
Lucerne	*Medicago sativa*
Red clover	*Trifolium pratense*
Spotted medick	*Medicago maculata*
Strawberry clover	*Trifolium fragiferum*
Subterranean clover	*T. subterraneum*
Suckling clover	*T. dubium*
White Clover	*T. repens*
Yellow trefoil	*Medicago lupulina*

OTHER PLANTS : Common Name	*OTHER PLANTS :* Botanical Name
Almond	*Callixene* (*Enargea*) *marginata*
Balsam bog	*Bolax gummifera*
Bedstraw	*Galium antarcticum*
Broad leaved plantain	*Plantago major*
Brown swamp grass	*Rostkovia magellanica*
Buttercup	*Ranunculus repens*
Catsear	*Hypochoeris radicata*
Chickweed	*Stellaria media*
Christmas bush	*Baccharis magellanica*
Crowfoot	*Ranunculus biternatus*
Crowfoot	*R. maclovianus*
Cudweed	*Gnaphalium affine*
Cushion plant, or "moss"	*Azorella caespitosa et al.*
Dandelion	*Taraxacum officinale et al.*
Diddle dee	*Empetrum rubrum*
Dusty miller	*Primula farinosa*
Eyebright	*Euphrasia antarctica*

OTHER PLANTS : Common Name	*OTHER PLANTS :* Botanical Name
Fachinal bush	*Chiliotrichum diffusum*
Field daisy	*Bellis perennis*
Lady's slipper	*Calceolaria Darwinii*
Lady's slipper	*C. Fothergillii*

Common Name	*Botanical Name*
Land cress	*Pratia repens*
Lavender	*Perezia recurvata*
Malvina berry	*Myrteola nummularia*
Marsh daisy	*Aster Vahlii*
Marsh marigold	*Caltha sagittata*
Mountain berry	*Pernettya pumila*
Mouse-ear chickweed	*Cerastium vulgatum*
Native box	*Veronica elliptica*
Native carrot	*Oreomyrrhis andicola*
Native cotton grass	*Luzula alopecurus*
Native gentian	*Gentiana magellanica*
Native pansy	*Viola maculata*
Native sorrel	*Rumex magellanicus*
Native strawberry	*Rubus geoides*
Native yarrow	*Acaena lucida*
Oreob	*Oreobolus obtusangulus*
Pale maiden	*Sisyrinchium filifolium*
Pearlwort	*Colobanthus crassifolius et al.*
Pigvine	*Gunnera magellanica*
Pimpernel	*Anagallis alternifolia*
Prickly burr	*Acaena ascendens* and *A. laevigata*
Ribgrass	*Plantago lanceolata*
Scurvy grass	*Oxalis enneaphylla*
Sea cabbage	*Senecio candicans*
Sea clover	*Armeria macloviana*
Sea orache	*Chenopodium macrospermum*
Sea persicaria	*Polygonum maritimum* var. *chilense*
Sea plantain	*Plantago barbata*
Sea stonecrop	*Tillaea moschata*
Sedge	*Carex fuscula*
Silver-leaved buttercup	*Hamadryas argentea*
Small fern	*Blechnum penna marina*
Small rush	*Juncus scheuchzerioides*
Sorrel	*Rumex Acetosella*
Speedwell	*Veronica serpyllifolia*
Spurry	*Spergula arvensis*
Star grass	*Cerastium arvense*

Common Name	*Botanical Name*
Stitchwort	*Stellaria debilis*
Sundew	*Drosera uniflora*
Sword grass	*Carex trifida*
Tall fern	*Blechnum tabulare*
Tall rush	*Marsippospermum grandiflorum*
Umbrella fern	*Gleichenia cryptocarpa*
Vanilla daisy	*Leuceria gossypina*
Waterweed	*Crantzia lineata*
White orchid	*Codonorchis Lessonii*
Yarrow	*Achillea Millefolium*
Yellow daisy	*Senecio falklandicus* and *S. litoralis*
Yellow orchid	*Chloraea Gaudichaudii*
Seaweeds :	
Leafy kelp	*Macrocystis* spp.
Tree kelp	*Durvillea* spp.

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No. 252/38.

(It is requested that, in any reference to this letter, the above Number and the date may be quoted).

COLONIAL SECRETARY'S OFFICE,
STANLEY, FALKLAND ISLANDS,

2nd November, 1939.

Sir,

I am directed by the Governor to transmit for your information the accompanying copy of a Report by Mr. W. Davies, M.Sc., on the Grasslands of the Falkland Islands.

I am,
Sir,
Your obedient servant,

M. L. Craigie Halkett
Colonial Secretary.

The Manager,
Port San Carlos,
EAST FALKLAND.