SCOTTISH SOCIETY FOR RESEARCH

IN PLANT-BREEDING

REPORT

BY THE

DIRECTORS

TO THE

ANNUAL GENERAL MEETING

22nd July 1937

1937

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SCOTTISH SOCIETY FOR RESEARCH IN PLANT-BREEDING.

REPORT.

THE Directors of the Scottish Society for Research in Plant-Breeding have pleasure in submitting the Sixteenth Annual Report to the members of the Society.

In consequence of the acquisition of additional staff at the Plant-Breeding Station and of the expansion of the work which the Society has in hand, consideration has had to be given to increasing the laboratory and storage accommodation at the Station at Corstorphine. It is anticipated that the additional buildings required will be erected in 1937. More land has also been secured by the Society on the farm of Ainville, Kirknewton, for experimental work. Two acres were obtained last year and another eight acres this year, a total of ten acres all in one field. This ground lies at an elevation of over 800 feet above sea level, and it should be suitable for potato-breeding, one of the main purposes for which it was acquired. About two acres of this area have been set aside for pasture work. As there were no facilities for the testing of grazing strains of grasses in pasture at Corstorphine, the acquisition of this upland ground should help to remedy this defect.

Mr S. G. Stephens, M.A., who was appointed assistant for the cereal-breeding work at the Plant-Breeding Station, took up his duties on 12th July 1936. Miss E. S. Bennett, B.Sc., was appointed assistant for cytological investigations as from 1st October 1936. Advantage was taken of the arrangements

kindly made by Sir Daniel Hall, Director of the John Innes Horticultural Institution, Merton, Surrey, whereby Miss Bennett could receive additional training in cytology at that Institute. Miss Bennett accordingly spent a period of eight weeks there studying cytological technique, and the training she received will be very helpful for the work which she will be undertaking at the Society's Station. Mr Hugh Ferguson, B.Sc., Assistant, Virus Disease Investigations, appointed in April 1936 to succeed the late Mr Alan M. M'Bain, resigned his post on 31st October last on his receiving an appointment with a commercial firm in England. Mr Charles A. Lyall, B.Sc., was appointed to succeed Mr Ferguson, and he took up his duties on 1st November 1936.

In view of the keen interest now taken by many farmers in grassland research, it will be of general interest to mention that work with grasses has now reached a stage when the Society is in a position to offer limited quantities of seed of a new pasture strain of cocksfoot and a new pasture strain of timothy to its members. The amounts of seed applied for this year were in excess of the quantities available, but it is expected that more seed of these two strains will be available for distribution early in 1938. These new strains of grasses were marketed in accordance with the provisional scheme which the Society adopted last year.

The Directors of the Society have pleasure in reporting that an increased grant was received from the Department of Agriculture for Scotland for the year 1936-37. This increase is to help to meet expenditure necessarily incurred through the gradual expansion of the work at the Society's Stations. The Directors hope that they will be able to continue making progress, and they are convinced that the development of the Society's work would be further hastened by an increase in the membership of the Society. The rate of subscription was substantially reduced in 1935, and an increased membership would greatly strengthen the Society's position.

Financial.

The ordinary accounts, as audited at 31st March 1937, show that there is a slight increase in the Society's funds, which now stand at £43,969.

Income from sales is about £117 more than it was in the year ended 31st March 1936, and this is mainly accounted for by additional crops being available for disposal and by the slightly higher prices which prevailed. The income from Annual Membership subscriptions also shows a slight increase over that of last year. The amount of grant received from the Department of Agriculture for Scotland was £2594. The total income for the year was £4726, as compared with £3946 the previous year.

The ordinary expenditure shows an increase of about £647, which is accounted for mainly by salaries of additional staff, additional superannuation contributions, salary increments according to scale, increased expenditure at Ainville, and depreciation. The amount allowed for depreciation is £64 higher than it was in the previous year, and this increase is accounted for by depreciation on temporary buildings. No depreciation had been allowed on these in previous years, but the Directors have agreed that these buildings should now be depreciated a certain percentage each year.

No expenditure of a capital nature was incurred during the year.

The expenditure incurred on the investigations relating to virus diseases of potatoes is shown separately, as it is met by a special grant.

"Dr Wilson" Memorial Fund.

This fund now amounts to £289, 16s. 6d. No payments were made from the fund during the year.

Membership.

The Directors regret to note that in the past year six members died. They have pleasure, however, in reporting that sixteen new members were enrolled in the year ended 31st March 1937. At 31st March the membership consisted of 148 life members and 110 annual members (30 at the 5s. rate and 80 at the 10s. rate). A list of members appears on pages 34 to 41 hereof.

Donors of £10 or over are entitled to become life members without further payment. Donors of £5 or over may become members of the Society by payment of an annual subscription of 5s., and others by payment of an annual subscription of 10s.

Election of Directors.

In accordance with the rules of the Society, the six senior Directors retire at this time. Their names are as follows :—

W. J. Campbell, 61 Fountainhall Road, Edinburgh.
John Chisholm, Gibston, Huntly.
James Cruickshank, Kilmarnock Arms Hotel, Cruden Bay.
Sir John H. Milne Home, Irvine House, Canonbie.
Robert Howie, The Grange, Kirkcaldy.
William Kay, 19 South St David Street, Edinburgh.

To fill the vacancies thus created, the Directors recommend the election of the following :—

Major R. F. Brebner, The Leuchold, Dalmeny House, Edinburgh.
James Cadzow, Duncrahill, Pencaitland.
Howard U. Cunningham (Scottish Agricultural Industries, Ltd.), Leith.
Thomas Hogg, 21 Hope Street, Glasgow.
George G. Mercer, Southfield, Dalkeith.
Principal W. G. R. Paterson, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow.

JOHN STIRTON,
Secretary.

[ABSTRACT OF ACCOUNTS.

ABSTRACT OF ACCOUNTS.

For the year ended 31st March 1937.

INCOME.

Interest Received			£1,342 3 3
Recoverable Income Tax			258 10 7
			£1,600 13 10
Sales—			
Ordinary, including Stock on Hand	£384 3 4		
Extraordinary—			
Bell Oat Account	6 12 0		
Early Miller Oat Account	16 18 1		
		407 13 5	
Subscriptions—			
Annual	£46 5 0		
Life	10 0 0		
		56 5 0	
Note.—Annual Subscriptions amounting to £2, 5s. are in arrear.			
Donations—			
£10 or over	£10 0 0		
Under £10	9 15 3		
		19 15 3	
Total Ordinary Income			£2,084 7 6
Grant received from Department of Agriculture for Scotland for the year 1936-37			2,594 0 0
Interest on Donations and Life Membership Subscriptions (£1373, 0s. 4d. at 3½ per cent)	£40 6 1		
Recoverable Income Tax	7 15 0		
		48 1 1	
Total Income			£4,726 8 7
Funds at 1st April 1936			43,874 5 5
			£48,600 14 0

EXPENDITURE.

Salaries—			
Officers (including Ainville Sub-Station)			£2,456 2 4
Secretary and Office			230 0 0
			£2,686 2 4
Superannuation Contribution			240 13 4
Labour			624 15 0
National Health and Unemployment Insurance			26 12 8
Seeds and Roots			9 15 6
Manures			119 3 3
Working Expenses, including renewals of Implements and Tools			123 11 10
Laboratory Expenses			39 8 1
Library Expenses			29 3 11
Rates and Insurances			46 11 11
Office Expenses			75 6 0
Heating, Lighting, and Cleaning			29 16 6
Travelling Expenses			58 17 7
Property Repairs			184 9 1
Locality Trials			10 19 9
Advertising (exhibit at Highland and Agricultural Society Show)			10 2 4
Ainville Sub-Station Maintenance Expenses			210 8 7
Depreciation on Temporary Buildings, Implements, Tools, &c.			105 13 3
Total Expenditure			£4,631 10 11
Funds at 31st March 1937, per Balance-sheet			43,969 3 1
			£48,600 14 0

BALANCE-SHEET.

As at 31st March 1937.

LIABILITIES.

I. Accounts Outstanding, due by Society	£272	1 6
II. Subscriptions paid in advance	3	15 0
III. Funds at 31st March 1937	43,969	3 1
	£44,244	19 7

DR WILSON MEMORIAL FUND ACCOUNT.

Value at 31st March 1937.	Funds at 31st March 1937, consisting of—	
£205 0 0	£200 3½ per cent War Stock, 1929-47	£176 5 0
	Sum in Bank on Deposit Receipt	85 0 0
	Sum in Bank on Current Account	28 11 6
		£289 16 6

SHEET.

March 1937.

ASSETS.

I. Houses and Lands, at Cost, *less* Depreciation	£7,950	14 7
II. Implements and Tools, at Cost, *less* Depreciation	612	19 11
III. Laboratory Apparatus, at Cost, *less* Depreciation	102	14 2
IV. Greenhouse, Hut, and Frames at Ainville, at Cost, *less* Depreciation	165	0 9
V. Office Fittings, at Cost, *less* Depreciation	58	6 10
VI. Stocks on Hand, as valued by Directors	95	15 0
VII. Accounts Outstanding, due to Society	176	17 5
VIII. Income Tax Recoverable	266	5 7

IX. Investments, at Cost :—

Value at 31st March 1937.			
£14,483 5 0	1. £14,130, os. 9d. 3½ per cent War Stock, 1929-47	£12,530 0 0	
15,470 0 0	2. £14,000 4 per cent Funding Stock, 1960-90	10,045 0 0	
17,069 0 0	3. £16,900 3½ per cent Conversion Stock	11,140 3 6	
£47,022 5 0			33,715 3 6

X. Cash Balances—

In Bank on Current Account	£298	12 9
In Bank on Deposit Receipt	781	4 2
On Hand	21	4 11
	1,101	1 10
	£44,244	19 7

FUND ACCOUNT.

Funds at 1st April 1936	£282	16 6
Interest for year	7	0 0
	£289	16 6

VIRUS DISEASE

ABSTRACT OF

For the Year ended

INCOME.

Grant from the Department of Agriculture for Scotland	£837 3 8
Funds at 1st April 1936	3380 15 5½
	£4217 19 1½

BALANCE-

As at 31st

LIABILITIES.

I. Accounts Outstanding, due by Society	£7 15 2
II. Funds at 31st March 1937	3149 2 8½
	£3156 17 10½

EDINBURGH, *5th May* 1937.—The undersigned, having had access to all the Accounts, and verified the same with the Accounts and Vouchers relating thereto, now

16 ALVA STREET.

RESEARCH SCHEME.

ACCOUNTS.

31st March 1937.

EXPENDITURE.

Salaries		£487 11 8
Wages		117 10 1½
Superannuation Contribution		65 16 8
Maintenance Expenses—		
Craigs House	£160 1 4½	
Ainville Sub-Station	66 18 7	
		226 19 11½
Depreciation on Temporary Buildings, Apparatus, Tools, &c.		170 18 0
		£1068 16 5
Funds at 31st March 1937, per Balance-sheet		3149 2 8½
		£4217 19 1½

SHEET.

March 1937.

ASSETS.

I. Buildings, Implements, Apparatus, &c., at Cost, *less* Depreciation—		
Craigs House		£2178 8 6
Ainville Sub-Station		940 10 3
		£3118 18 9
II. Cash Balances—		
In Bank on Current Account	£19 7 8	
On Hand	18 11 5½	
		37 19 1½
		£3156 17 10½

Books and Accounts of the Society, and having examined the foregoing Statements of signs the same as found to be correct, duly vouched, and in accordance with law.

W. SLATER BROWN, C.A., *Public Auditor.*

DISTRIBUTION OF MEMBERSHIP

As at 31st March 1937.

Aberdeen	16	Linlithgow	5
Angus	12	Midlothian	46
Argyll	6	Moray	2
Ayr	18	Nairn	—
Banff	2	Orkney	2
Berwick	13	Peebles	3
Bute	1	Perth	13
Caithness	—	Renfrew	5
Clackmannan	—	Ross and Cromarty	8
Dumbarton	4	Roxburgh	6
Dumfries	8	Selkirk	1
East Lothian	27	Stirling	5
Fife	15	Sutherland	—
Inverness	—	Wigtown	1
Kincardine	—	England	7
Kinross	1	Abroad	2
Kirkcudbright	5		258
Lanark	24		

ESTABLISHMENT FOR 1936-37.

BOARD OF DIRECTORS.

Trustees.

H.M. SECRETARY OF STATE FOR SCOTLAND, Scottish Office, Whitehall, London, S.W.
JAMES ELDER, 18 Eglinton Crescent, Edinburgh.
DAVID BELL, 15 Coburg Street, Leith.
JOHN FINLAYSON M'GILL, Kyle Street, Ayr.

Ordinary Directors.

1934.

W. J. CAMPBELL, 61 Fountainhall Road, Edinburgh.
JOHN CHISHOLM, Gibston, Huntly.
JAMES CRUICKSHANK, Kilmarnock Arms Hotel, Cruden Bay.
Sir JOHN H. MILNE HOME, Irvine House, Canonbie.
ROBERT HOWIE, The Grange, Kirkcaldy.
WILLIAM KAY, 19 South St David Street, Edinburgh.

1935.

WILLIAM ALLISON, Almond Hill, Kirkliston.
Sir ROBERT B. GREIG, M.C., LL.D., Shaws, Barnton, Edinburgh.
JOHN J. I. HIGHET (J. J. Inglis & Sons), Alloway Street, Ayr.
IAN C. MENZIES, W.S., 22 Rutland Street, Edinburgh.
ALEXANDER NELSON, Ph.D., Royal Botanic Garden, Edinburgh.
Professor Sir WILLIAM WRIGHT SMITH, Inverleith House, Arboretum Road, Edinburgh.

1936.

JAMES H. ELDER, B.Sc., Cregganore, North Berwick.
ROBERT MILLER, Ferrygate, North Berwick.
FRED MILLS (Roughead & Park, Ltd.), Haddington.
JAMES PATON, Kirkness, Glencraig.
J. P. ROSS-TAYLOR, Mungoswalls, Duns.
WILLIAM J. WRIGHT, The Heugh, North Berwick.

Directors Co-opted.

JAMES CADZOW, Duncrahill, Pencaitland.
THOMAS HOGG, 21 Hope Street, Glasgow.
GEORGE G. MERCER, Southfield, Dalkeith.

Directors nominated by the Department of Agriculture for Scotland.

P. R. LAIRD, C.B.,
J. M. CAIE, M.A., B.L., B.Sc.,
T. ANDERSON, M.A., B.Sc., } 29 St Andrew Square, Edinburgh.
ALEXANDER M'CALLUM, M.A., LL.B., 78 Craiglea Drive, Edinburgh.

Chairman of Directors—JAMES ELDER, 18 Eglinton Crescent, Edinburgh.
Vice-Chairman—DAVID BELL, 15 Coburg Street, Leith.
Director of Research—WILLIAM ROBB, N.D.A., F.R.S.E., Craigs House, Corstorphine.
Chief Assistant—JAMES W. GREGOR, Ph.D., F.L.S., Craigs House, Corstorphine.
Assistants—V. M'M. DAVEY, B.Sc., Ph.D., S. G. STEPHENS, M.A., and ELIZABETH S. BENNETT, B.Sc., Craigs House, Corstorphine.
Assistant, Potato-Breeding Sub-Station — WILLIAM BLACK, B.Sc., Ph.D., Ainville, Kirknewton.
Assistants, Virus Disease Scheme—GEORGE COCKERHAM, B.Sc., Ph.D., Craigs House, Corstorphine; and CHARLES A. LYALL, B.Sc., Ainville, Kirknewton.
Temporary Junior Assistant — J. M. S. LANG, B.S.A., Craigs House, Corstorphine.
Secretary—JOHN STIRTON, 8 Eglinton Crescent, Edinburgh.

COMMITTEES.

RESEARCH.

Fred Mills, *Convener.*
William Allison.
T. Anderson.
James Cadzow.
W. J. Campbell.
John Chisholm.
James Cruickshank.
James H. Elder.
Sir Robert B. Greig.
Thomas Hogg.
Sir John H. Milne Home.
Robert Howie.
William Kay.
P. R. Laird.
J. F. M'Gill.
George G. Mercer.
Dr Alexander Nelson.
James Paton.
Professor Sir William Wright Smith.
James Elder, *Chairman, ex officio.*
David Bell, *Vice-Chairman, ex officio.*

MANAGEMENT.

David Bell, *Convener.*
William Allison.
James Cadzow.
J. M. Caie.
John Chisholm.
James Cruickshank.
John J. I. Highet.
Sir John H. Milne Home.
Robert Howie.
William Kay.
Ian C. Menzies.
George G. Mercer.
Robert Miller.
Fred Mills.
James Paton.
J. P. Ross-Taylor.
William J. Wright.
James Elder, *Chairman, ex officio.*

FINANCE.

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W. J. Campbell.
Sir Robert B. Greig.
P. R. Laird.
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Ian C. Menzies.
George G. Mercer.
Robert Miller.
Fred Mills.
Dr Alexander Nelson.
J. P. Ross-Taylor.
Professor Sir William Wright Smith.
William J. Wright.
James Elder, *Chairman, ex officio.*
David Bell, *Vice-Chairman, ex officio.*

REPORT

BY

DIRECTOR OF RESEARCH.

I. Research Programme.

The aim of the Society is to promote research for the improvement of plants and crops in Scotland. Breeding experiments are being carried out on Oats, Barley, Potatoes, Herbage (Perennial Ryegrass, Cocksfoot, Timothy, and Plantain), Swedes, and Kales.

Investigations in various fields of science are yielding results which have an important bearing on the development and progress of agricultural plant-breeding. The cytologist, the physiologist, and the pathologist are all making advances in their respective spheres of study, and it is the duty of the scientific plant-breeder to take advantage whenever possible of any new developments in these or in any other spheres which may help in the creation of improved varieties of crop plants. The cytologist, for example, in studying chromosome behaviour has shed much light on many problems of heredity which are of interest in plant-breeding. The chromosomes are regarded as the carriers of the hereditary factors or genes, and a knowledge of the chromosome contents of the plants with which the breeder is working may be very helpful in guiding the investigator along profitable lines of experiment.

The Society's staff were frequently at a disadvantage in not having facilities for readily obtaining cytological information regarding their experimental plants. A highly specialised technique has been developed by cytologists to distinguish chromosomes, and considerable experience of examining such

material is indispensable for accurate interpretation. The disadvantage referred to above, however, has now been overcome by the appointment last October of an assistant, qualified to prepare material at the Station for cytological examination, and to help in interpreting the results.

Breeding to secure improved varieties of oats, barley, potatoes, herbage plants, swedes, and kales was continued, and a review of the year's work at the Scottish Plant-Breeding Station is given in these pages.

Grain Crops.

William Robb, *Director of Research*,
and
S. G. Stephens, M.A., *Assistant*.

Oats.

The development of improved varieties of oats resistant to lodging is one of the main objects of the breeding work with this crop plant. The importance of pursuing this line of work was again emphasised by the frequent occurrence of lodged crops in many parts of Scotland in 1936. Examination of trial plots and discussion of the results of these trials with growers has given further encouragement to the view that the development of suitable varieties having comparatively short straw and strong roots would help to reduce the losses incurred through lodging. With a view to breeding varieties more resistant to lodging, an oat known as Semi-Dwarf, a very short-strawed type obtained from Canada, was crossed with the varieties Elder and Early Miller, and first-generation progenies of these crosses were successfully grown in 1936. It is expected that interesting new material will be found in those progenies for study and selection. Elder and Early Miller were also crossed with certain other varieties to see whether improvements on these two could be effected.

In a wet harvest such as was experienced in Scotland in 1936, considerable loss may occur if grain sprouts readily in the stook. If the sprouting develops to any appreciable extent the sheaves become very difficult to dry and depreciation of the value of the grain and the straw results. Observations have indicated that some varieties are liable to sprout

more readily than others. The huskless varieties Liberty and Laurel and some of the Potato types seem to sprout readily in the stook during wet weather, but the old-established variety Sandy appears to be much more resistant. The problem of breeding for resistance to sprouting readily at harvest time is therefore being examined. Experiments are being made to see whether a greater degree of resistance to sprouting at harvest time can be secured. The results described in an article in the New Zealand Journal of Agriculture, Volume 54, No. 1, encourage the belief that this is possible. It is mentioned that the "sowing of 'new season's' Algerian oats in the autumn is attended by the risk of poor germination, and that the danger is often avoided by sowing at a heavy rate, or by using 'old season's' seed." After a period of storage for several months the seeds of this oat are capable of prompt germination. This problem regarding germination is therefore the reverse of what it is in Scotland. In the latter country, where rain during harvest is frequently experienced, it would doubtless be a very useful characteristic of an oat variety if the grain were not capable of germination for some time after harvest.

A large number of unfixed hybrids in F2 and older generations contained an extensive range of different types for selection and comparison. A group of fourth-generation hybrids (Elder × Orion) contained a number of early ripening short-strawed plants which seemed worthy of further selection. In 1935 many plants of this series were damaged by eelworm. Seed from those plants which were not visibly affected was sown in 1936, but whether the plants grown from this seed are resistant to eelworm attack is uncertain as no evidence of attack by this parasite was apparent in the plots in 1936. Further trials, however, may reveal whether these selections are resistant to eelworm attack.

Further attention was given to selecting plants which did not have the defect of bearing blind spikelets. This defect was less prevalent in 1936 than in 1935, but the varieties which are very prone to develop it again showed the defect, though to a less degree.

A few hybrid selections of huskless oats were grown for comparison and selection, the aim being to secure a variety adapted to Scottish conditions and giving a yield of grain approaching that obtained from ordinary standard varieties.

These selections have been chosen from crosses between ordinary hulled oats and the huskless oat Liberty. Small plots of both Liberty and Laurel huskless oats were again grown and interesting results were revealed by the chemical analyses of the grain, which were made by Dr A. M. Smith, Chemistry Department, Edinburgh and East of Scotland College of Agriculture. The huskless oats compared favourably in feeding value with ordinary hulled oats, as is shown in the table which follows :—

TABLE I.

	Liberty *Aa* 412.	Laurel *Aa* 544.	Early Miller *Aa* 644.	Potato *Aa* 10.	*Aa* 683.	233(7) *B.*
Crude Protein (Albuminoids).	13.53	14.56	10.58	11.60	11.24	11.11
Oil(EtherExtract)	5.78	3.86	5.36	5.56	4.48	5.04
Crude Fibre .	3.64	2.28	10.28	9.88	9.20	9.60
Soluble Carbo-hydrates.	64.08	66.14	61.78	60.35	62.41	62.38
Mineral Matter .	2.44	2.25	2.67	3.01	3.31	3.34
Moisture . .	10.53	10.91	9.33	9.60	9.36	8.53

If a high grain-yielding variety of huskless oat with kernels of high feeding value can be secured, the grain should provide a suitable substitute for certain poultry foods.

Twenty-four fixed hybrid selections were grown along with six standard named varieties in replicated trial plots, and the data obtained as regards yield of grain were, as usual, subjected to statistical analysis. In the early part of the growing season drought and cold winds retarded growth, and this doubtless prevented many of the varieties from giving a full yield. The earlier-ripening and shorter-strawed types seemed to be adversely affected to a greater degree by the weather conditions than were the others. Very few of the varieties in the trial showed any tendency to lodge. Six of the unnamed hybrid selections were also included in various trials carried out by the agricultural colleges in various parts of Scotland. Though it is impossible to have these trials carried out in replicated plots they serve a useful purpose in helping to reveal some varietal deficiencies which might not be evident at Corstor-

phine. For example, in one trial in Ayrshire three hybrid varieties were subjected to a severe test for lodging by being grown in a field in which the previous crop had been one of first-early potatoes. The field was in a high state of fertility, and the trial plots and the ordinary crop of oats in the field were very heavy. Two of the trial varieties compared favourably as regards resistance to lodging with the ordinary field crop. Excessively heavy rain in the month of July, however, caused the trial plots to lodge, but this took place later than in the field crop. The grower expressed satisfaction with one of the selections in particular and he thought it was definitely worth further trial in view of its resistance to lodging.

Pure stocks of three of the Society's new oats, Elder, Bell, and Early Miller, were maintained at the Station, and the seed of all three was readily disposed of.

Barley.

Further comparisons were made of the various types of Scotch Common Barley selected at the Station. Several selections which appeared to be the most productive and to have the stiffest straw were selected, and these will be multiplied in 1937. Several groups of hybrid barleys were grown for study and selection. These hybrid selections included one in which the parent was a six-rowed awnless barley, and two others in which Plumage Archer and Spratt Archer were crossed with Kenia (a Danish variety characterised by high tillering, short straw, and high extract yield). Plumage has also been crossed with a naked barley which has larger grain and which tillers freely.

Beans.

The small-scale experiments with Soya beans and ordinary field beans were continued. The Soya beans were grown on fertile soil, and the plants grew to a larger size than they did in the previous year. The prevalence of wet weather during the autumn was probably detrimental to the formation of seed, and, though the plants appeared fairly well grown, very little seed was produced by any of the varieties. Several selections of field beans were grown, and from these four were selected for further multiplication and comparative trial.

Potatoes.

Assistant in Charge—William Black, B.Sc., Ph.D. (Ainville Sub-Station).

Certain of the wild tuber-bearing Solanums have been extensively used as parents. Although the investigations are still in the early stages, the utilisation of these species seems to offer wide scope for the improvement of the potato. The collection of species at the Station is not large, but from some of the species many interesting and promising hybrid types have been derived. The results so far obtained suggest that wild species have a positive value in potato-breeding work, and that they possess characters which would be of value in commercial varieties. Although most of the wild species yield poor crops of tubers some of the hybrid derivatives have proved highly productive. *S. demissum*, for example, usually gives a very small crop of tubers, but several F2 (second generation) plants as well as seedlings obtained from the first back-cross, yielded up to 5.5 lb. per plant in 1936, the average yield of control varieties being 3.9 lb. per plant. The majority of these high-yielding forms were also resistant to blight. Yields of tubers up to 5.0 lb. per plant were also obtained from F1 (first generation) hybrids of *S. andigenum* and of *S. Rybinii* crossed with cultivated varieties.

Observations, under controlled conditions, were made during 1936 on the resistance of potato seedlings to one strain of the fungus causing blight (*Phytophthora infestans*). A greenhouse was set aside for the purpose, and over 500 plants were tested. A large proportion of the material was derived from wild Solanum species, and many of the plants proved to be immune from the disease. The F1 hybrids of *S. demissum* were all resistant, while the F2 seedlings and back-crosses contained about 30 per cent susceptible plants. The seedlings bred from cultivated varieties showed various degrees of susceptibility, but no complete resistance.

In 1936, about 2500 new seedlings were raised to provide material for comparison and selection and for the study of the various genetical problems under investigation. These seedlings may be classified into three major groups according to their derivation—viz., (*a*) from the inter-crossing of cultivated varieties, (*b*) from species hybridisation and back-crossing, and (*c*) from inbred lines.

(*a*) The seedlings obtained by inter-crossing cultivated varieties provided material for immediate test and selection as economic types. This group contained a large number of promising plants which will be multiplied and tested further in 1937. A particularly good progeny was obtained by crossing two first-early seedlings, both of which had Kerr's Pink as their maternal parent. Great Scot, crossed with 70 (13), a Bishop seedling, provided another outstanding series. Several high-yielding, blight-resistant forms were obtained from seedling 967*c* (38) crossed with The Alness.

(*b*) The F1 hybrids of *S. demissum* × Shamrock all remained free from blight, but the yields of tubers were comparatively low. A large proportion of the seedlings in this group, however, was obtained by back-crossing *S. demissum* hybrids to cultivated varieties, and many prolific blight-resistant forms were in evidence. The hybrid plants from *S. Rybinii* × Kerr's Pink were very vigorous, but all were susceptible to blight. Male sterility seemed to be absolute and the rest period of the tubers proved to be very short. Hybrid progenies of *S. andigenum* contained many distinctive plants and a very wide range of tuber colours.

(*c*) The effects of repeated self-fertilisation of varieties and of inter-crossing selfed lines continue to be noted. A substantial proportion of hereditary degenerate plants appeared as in previous generations, and hybridisation of these as well as of normal plants has been made. Several lines have shown a tendency towards complete degeneracy, and in those cases alternative parent plants of the preceding generation were utilised.

The second-year seedling selections contained a number of attractive varieties, and these will be multiplied further in 1937. Arran Pilot and Dunbar Cavalier crossed with The Alness gave high proportions of seedlings meriting further trial. They were grown, together with the older and more advanced seedlings, in trial plots at Ainville and at Craigs House.

A number of the more advanced seedlings were included in the trials carried out by the Department of Agriculture for Scotland at East Craigs and of the Ministry of Agriculture and Fisheries at Ormskirk. The East Craigs trials contained eight of the Society's varieties, and four of them—viz., 134 (5), 134 (139), 139*a* (67), and 318 (38)—were recommended for

further trial in 1937. A few notes referring to these four are given in Table II. Variety 967*c* (38), which showed a high degree of resistance to blight, was included in the final year registration trials, but failed to attain the standard necessary for registration. A further group of five new varieties consisting of the following: 322 (80), 384*a* (14), 387*b* (56), 398*a* (41), and 451*a* (20) was selected for inclusion in the registration trials in 1937. Notes on these selections are also given in Table II.

A very favourable report was obtained in respect of the seedlings sent to Ormskirk in 1936, and a number of selections have again been forwarded for inclusion in the 1937 trials.

TABLE II.

Reference Number.	Parentage.	Maturity.	Tuber.		Cooking Quality.
			Shape.	Colour.	
134(5)	Abundance × Flourball	2nd-Early	Oval	White	Good
134(139)	Abundance × Flourball	1st-Early	Oval	White	Good
139*a*(67)	Bishop × Flourball	Early-Maincrop	Oval	White	Very Good
318(38)	May Queen × 121(2)	1st-Early	Oval	White	Good
322(80)	966*f*(1) × Herald	Maincrop	Oval	White	Very Good
384*a*(14)	Kerr's Pink × The Alness	Maincrop	Kidney	White	Very Good
387*b*(56)	May Queen × 188*a*(91)	1st-Early	Oval	White	Good
398*a*(41)	Up-to-date × The Alness	Maincrop	Kidney	White	Very Good
451*a*(20)	Epicure × Pepo	Early-Maincrop	Kidney	White tinged Pink	Very Good

The Alness potato was again multiplied in 1936 under arrangements made with Mr John Chisholm, Gibston, Huntly. About half an acre was planted, and a Stock Seed Report in respect of the crop was granted by the Department of Agriculture for Scotland. All the tubers suitable for seed (amounting to 4 tons 13 cwt.) were taken up by members of the Society.

Herbage Plants.

Assistant in Charge—J. W. Gregor, Ph.D., F.L.S.

In Scotland considerable areas of potentially valuable enclosed grassland support a poor bent-dominated herbage. The renovation of these is a matter of importance, and although various short-cuts have been advocated for their improvement, the method of ploughing followed by an interim period of arable crop rotation before again seeding down to grass still appears the most satisfactory way of achieving success. On some farms, however, it is not economically possible to tackle the cultivation of additional arable crops, and other methods of effectively disposing of the *Agrostis* mat previous to the sowing of the small-seeded perennial herbage species require consideration. A limited experience of pasture renovation in the East of Scotland leads us to suggest that success would be more certain if, in the preliminary stages of the improvement process, large-seeded, quick-growing plants capable of surviving a wide range of sowing depths were to be used. For instance, annual *pasture* crops might be usefully grown until such time as the mat is either dead, or, at least, is no longer an obstacle to the establishment of permanent pasture species. High productivity is, of course, the ultimate aim of pasture improvement, but the more productive pasture plants frequently require the best cultural treatment, a condition which might necessitate the raising of the fertility to a level consistent with the requirements of species such as perennial ryegrass. Pasture renovation by vegetational stages may therefore be visualised as follows: (I.) a pasture consisting of large-seeded annual plants, (II.) a wild white clover or soil fertility raising phase, and (III.) a long duration pasture comprising perennial species of high productivity.

To find plants suitable for the 1st stage—*i.e.*, plants suitable for pasture purposes under adverse conditions of soil tilth—

various annuals have been examined at the Plant-Breeding Station. One of the most promising plants found so far is an oat of great vegetative vigour which has been bred at the Station. A pasture strain of timothy, the time of development and maximum seasonal productivity of which coincides with that of wild white clover, has also been raised, and may prove to be a useful variety for the 2nd stage of pasture improvement. However, the practical application of these theoretical considerations must perforce be postponed until such time as seed stocks of the promising varieties have increased sufficiently to allow of field trials being carried out.

The breeding of " top " and " bottom " varieties of timothy, cocksfoot, and perennial ryegrass forms part of the herbage programme of the Station. In assessing the economic value of pasture varieties of a species it is not correct to judge varieties on productivity standards alone. For instance, of two varieties of timothy raised at this Station, one, a hexaploid " top-grass " type, yields almost twice as heavily under conditions of high soil fertility as another, a diploid " bottom-grass " type, yet both possess characteristics of pasture value. The primary function of a " top-grass " variety is to supply abundant herbage and that of a " bottom-grass " is to maintain a soil-covering, thus preventing the invasion of weeds and also to provide organic matter at the time of ploughing. The performance of " bottom grass " varieties of these three palatable pasture species should therefore be compared with that of the varieties which they are intended to replace—*e.g.*, Crested Dogstail. While the breeding of " bottom-grass " types of timothy received particular attention last year, the " top-grass " forms bred the previous year are once again due for consideration this season.

Seed multiplication.

Timothy.—4¼ acres of a " bottom-grass " diploid timothy are being grown for seed, 4 acres under contract and ¼ acre at the Plant-Breeding Station. One acre of a " top-grass " hexaploid variety was sown this spring, while another hexaploid variety was included in the initial multiplication plots.

Cocksfoot.—7 acres of a new variety are being grown under contract for seed.

Perennial Ryegrass.—One variety has now reached the initial multiplication stage.

New Varieties.

(1) *Timothy, Cb* 191, is a diploid timothy for pasture. This is a true "bottom-grass" which establishes itself and attains its maximum seasonal growth-period at the same time as does wild white clover. In field trials in the North of Scotland this timothy was readily eaten by both cattle and sheep, and it has been favourably reported upon in a trial in the South-east of Scotland. In Eastern districts of Scotland a seeding at the rate of 5 lb. per acre has been suggested.

(2) *Cocksfoot, Cc* 180, is a pasture cocksfoot with broad, soft leaves; it is later flowering than ordinary Danish. Vegetatively, it commences growth early in the spring, continues to produce leafage over a long period of the growing season, and is readily eaten by cattle and sheep. This cocksfoot has done well in the Border district.

In previous reports it has been mentioned that the research programme included the examination of "wild" *ecotypes*—*i.e.*, races of plants adapted to particular situations. This work has been continued, and an introductory account of the methods employed in studying racial characteristics has been published in the 'New Phytologist' recently (Gregor, J. W.; Davey, V. M'M.; and Lang, J. M. S., Vol. 35, No. 4, 1936). Another paper dealing with the distribution of ecotypes of the sea-plantain in Britain will be published shortly. Notwithstanding the comparative scarcity in Scotland of long-established, widely distributed ecotypes of the valuable agricultural grasses, strictly localised ecotypes have already provided foundation stock for the breeding of new agricultural varieties.

Root Crops.

Assistant in Charge—V. M'M. Davey, B.Sc., Ph.D.

The main purpose of the experiments with swedes is the examination of various methods of selection and comparison of individual plants intended for use in breeding with a view to obtaining varieties which may show improvements as regards productive capacity, feeding quality, uniformity of type, and resistance to disease.

In comparison with cereal-breeding, the work of obtaining pure-breeding plants of swede, or of kale, is handicapped

both by the biennial nature of these crops and by their cross-fertility. The necessity for artificial isolation, generally in the form of pollen-proof bags, limits the number of strains which can be handled simultaneously. The results of yield trial tests with swedes, as with other crops, need to be confirmed in several seasons, but such trials are also subject to greater risks from unfavourable weather conditions.

Instead of working entirely on empirical lines, it is most important that various methods of breeding, not commonly employed, should be carefully examined in detail. At the same time practical ends are always kept in view, and as many as possible of the apparently valuable strains are propagated, while uneconomic material which may be very desirable for control purposes is kept to a minimum.

Ten years' work on productive capacity and feeding quality, as determined by dry-matter percentage, was discussed in a report laid before the Society's Root Sub-Committee last autumn. Two lines of investigation had reached stages upon which conclusions might be drawn. Firstly, the productivity of pedigree lines, or strains derived by repeated selection and self-fertilisation of single plants, has been compared with that of the varieties most closely akin to them. Since high dry-matter percentage is usually associated with low bulb weight and *vice versa*, the two properties have to be considered together, and the amount of dry-matter content in the bulb is taken as the criterion of value. There were roughly equal numbers of superior, equivalent, and inferior pedigree lines in the various comparisons, so that inbreeding was found not to entail detrimental effects. The superiority was usually not very great. This method of breeding seems to be practicable when it is wished to obtain a strain which is more uniform than the parent variety and of equal or somewhat enhanced value. It was concluded, however, that the chances of obtaining by this method (*a*) a strain of considerably greater value, or (*b*) a strain of good value, yet so distinctive in appearance that it could be classed as a new variety, are at best remote possibilities, and for one success many failures would be experienced. It was also noted that there was a tendency for strains selected by appearance alone to have greater bulb weight but lower dry-matter than the variety—*i.e.*, to be of earlier type.

The second line of investigation dealt with the use of the dry-matter test for making original selections. Large numbers

of plants were individually tested for dry-matter and bulb weight. Certain of them were selected because of their performance and seeded, and the progenies were afterwards compared in yield trials. It was found that the preliminary test did not give satisfactory indicative results. Too often the dry-matter value, or bulb weight of a parent bulb bore no relation to the performance of its progeny. It was therefore concluded that this uncertainty combined with the heavy mortality among plants which had been sampled by coring made the test unprofitable. It seems preferable to make the original selections by eye and to obtain information as to dry-matter percentages by testing plots of the descendant lines in the early generations, followed by more precise yield trials when sufficient seed is available to sow plots for this purpose. Other lines of investigation, the selection from varietal crosses and the effects of hybrid vigour, were also discussed in the report, but these have not yet reached a stage from which conclusions can be drawn.

Pedigree Breeding.—About 240 strains of swedes were sown in various groupings with certain commercial varieties as controls. The smaller samples and all the pedigree lines were sown in small plots on the flat, special precautions being taken to ensure even sowing. A second series comprising pedigree lines and various unfixed strains was sown in larger plots or in yield trials. Brairding was slow on account of the prolonged drought in May. A feature of interest was the complete suspension of germination in an area of about one acre until rain fell about three weeks after sowing. The older pedigree lines have reached their seventh generation of self-fertilisation, and they comprise a series of different types. No evidence has yet been obtained of swedes degenerating as a result of enforced inbreeding. Some lines are better and some not as good as the variety from which they were selected. On the other hand, crossing seems to lead to an increased bulb weight in the first-generation hybrid, the dry-matter percentage of the bulb being intermediate between the percentages of the parents.

Controlled Seeding.—During the most severe winter (1935-36) yet experienced at the Station, casualties among the breeding plants were very great, and only 80 samples of swede seed were obtained by self-fertilisation. Reserve seed from previous harvests will be available to replace most of the losses.

The expansion of the kale investigations led to the successful

seeding of 25 plants under bag isolation. A new series of crossings was undertaken and 50 samples of seed were secured. These crosses were made for various purposes. Some were between swede varieties and are intended for future selection work, while others involved species hybridisations which were made for cytological as well as for practical purposes. Swede, Turnip, Rape, Kohl-rabi, Thousand-headed, and Marrow-stem Kales were employed in these crosses.

Diseases.—A number of strains of swede, turnip, and kale were grown in the severely infected finger-and-toe disease plot. Only a few apparently healthy plants were found towards the end of the season, and these were kept for seeding to produce progenies for further trial for resistance to finger-and-toe disease. Mildew and dry-rot diseases were not severe this season, though a few strains showed great susceptibility to dry-rot.

Yield trials.—Two small yield trials were laid out for the comparison of sixteen lines with control varieties. Estimations were made of yield, total dry-matter, and in one trial soluble solids. In addition, tests were made in single plots of numerous lines so as to ascertain their type. Wide ranges of values were obtained and some of the lines showed promise in respect of dry-matter yield.

Virus Disease Research.

Potatoes.

George Cockerham, B.Sc., Ph.D., *Assistant, Craigs House.*
Hugh Ferguson, B Sc., *Assistant, Ainville Sub-Station (resigned 31st October 1936).*
Charles A. Lyall, B.Sc., *Assistant, Ainville Sub-Station.*

Plant-Breeding Station, Craigs House, Corstorphine.—Classification of Potato Varieties in Relation to their Reaction to Virus Diseases.—The classification of named potato varieties and promising seedlings according to their various reactions to potato viruses has been continued in respect of virus X and virus Y, and extended to a study of the reactions of the varieties to virus A and the complex A + X. 162 varieties have been examined and classified arbitrarily into groups according to their reactions to the individual viruses. An extensive breeding programme has been based upon the results of this classificatory work, with the object of obtaining

material for genetical study and of aggregating in single varieties the most resistant qualities towards individual viruses that have been found in the parental material.

Genetical Studies.—The genetical investigation has been continued through a study of the reaction to virus X of 379 seedlings in 9 progenies, derived by self-fertilisation and cross-fertilisation from 7 parent varieties. In addition to a dominant factor controlling a lethally necrotic reaction to this virus, evidence has been obtained of further factors which confer a positive resistance against the expression of mosaic symptoms. These factors are at present under investigation, and 350 seedlings have been inoculated in the present year. Seed of selected parentage has been sown and will shortly provide new material for extension of this work.

The inheritance of reaction to virus Y has also received attention. The results of controlled infection have been studied, and the data obtained have provided evidence of a complex form of inheritance controlling reaction to this virus.

Natural Infection in the Field.—Field investigations have been conducted upon similar lines to those followed in 1935. In the leaf-roll trial 136 named varieties and 784 seedlings were subjected to a second year test for infection and 660 seedlings were placed in the trial for the first time. The total infection with the leaf-roll virus during 1935 has been estimated at 38.71 per cent, almost all of which was unobserved until 1936, and hence was considered to have taken place late in the 1935 season when symptoms were not readily discernible.

The material used in investigating the degree and rate of spread of infection with virus Y comprised 117 named varieties, 348 seedlings in the second-year test, and 144 seedlings in the first-year test. The spread of the Y virus under the conditions of experiment in 1935 was much greater than that of the leaf-roll virus and extended to 74.69 per cent of the seedlings subjected to test. Fully 20 per cent of this infection was unobserved in the season in which it was contracted.

Notes on Variations of Aphis Populations.—In view of the importance of the relationship between the aphis population and the spread of the insect-borne viruses, a detailed study of the numbers and species of aphides was undertaken. The data were collected at weekly intervals over the whole growing season from the two localities in which the potato research of the Society is carried out—viz., Corstorphine and Ainville.

The chief vector of viruses, *Myzus persicæ*, was found to be the predominant species at each centre. Aphides were scarce during the early summer, but increased rapidly in numbers during August, to reach maxima of 574 aphides and 1023 aphides per 100 leaves at the end of the first week in September, the figures referring to Ainville and Corstorphine respectively. The slow rate of multiplication of aphides during the early summer affected adversely the spread of viruses over this period, whilst the incidence of a heavy infection of blight on 8th August precluded any further observations of disease symptoms during the latter part of the season when the aphides multiplied and spread rapidly. An estimate of the spread of disease will not be available, therefore, until the material under trial is grown in 1937.

The observations within the leaf-roll plants, together with the results of controlled infection of potato seedlings through the sprouts, have been examined in relation to the results of the Y virus trial, and it is of interest to find that seedlings remaining free from infection in one trial are, on the whole, those which remain free in others. This fact indicates that for some unknown reason these plants are enabled to avoid infection in contra-distinction to their being resistant to the pathogens. These distinctions will be examined in detail during the forthcoming season.

The Effect of Virus Diseases on Sexual Reproduction and on Yield of Tubers.—The effects of virus diseases upon vigour and sexual reproduction in potatoes has been studied intensively and the results placed upon a statistical basis. The data obtained bear out the tentative conclusions suggested in previous reports, and show that viruses affect yield in the order X virus (least effect), A + X complex, Y virus, and leaf-roll (greatest effect). The extent of reduction in each case is dependent upon varietal factors. Thus in the variety President the reductions amounted to 2.9 per cent, 66.8 per cent, 68.6 per cent, and 95.6 per cent for the viruses X, A + X, Y, and leaf-roll respectively, whilst in Arran Victory the reductions were 15.1 per cent, 45.8 per cent, 44.5 per cent, and 59.7 per cent. The reductions caused by the X virus were in neither case statistically significant. As regards sexual reproduction, each virus has been found to cause a reduction in flowering capacity through a reduction in number of flower trusses. The numbers of flowers per truss have been shown to be reduced by Y and A + X infection of the

plants whilst the numbers have been little affected by leaf-roll and X.

Ainville Sub-Station, Kirknewton.—The Sub-Station at Ainville continued to be used for the maintenance of pure stocks of named varieties and seedlings, for the raising of seedling progenies, for breeding, and for a continued study of hereditary degeneracy.

The collection of named varieties was increased during the year to 175 by the addition of 29 new varieties. The examination of the varieties in this collection for the presence of virus diseases has been continued and 171 inter-varietal grafts have been made. 12 varieties were discarded on account of virus infection throughout the stocks.

Approximately 1420 seedlings in 17 progenies of varying size and parentage were raised from seed and the usual botanical details obtained during the season. The seedlings may be divided into four groups of which three were raised for inclusion in the genetical investigation into the reaction to viruses X, Y, and A. The fourth and largest group contains seedlings raised for inclusion in the field trials at Craigs House.

The year proved quite favourable for breeding amongst the later maturing varieties, but unfavourable for early varieties. Seed has been obtained from 48 hybridisations and 30 controlled self-fertilisations, the latter including several of inbred parentage.

A collection of degenerate types was grown for observation and breeding. Each plant was tested, by grafting, for the presence of viruses, but in only one case out of 120 was there a reaction on the test plant. Breeding amongst these plants was not successful owing to the lack of flowers and pollen, but a few natural set berries have been obtained.

II. Publications and Lectures by Staff, for the Year ended 31st March 1937. Publications (P) and Lectures (L).

J. W. Gregor, Ph.D., F.L.S. :—

"The Variety or Strain in Crop Plants." Lanark Agricultural Discussion Society, 16th November 1936, and Biggar Agricultural Discussion Society, 24th November 1936. (L)

J. W. Gregor, V. M'M. Davey, and J. M. S. Lang :—

" Experimental Taxonomy. I. Experimental Garden Technique in relation to the recognition of the Small Taxonomic Units." 'The New Phytologist,' Vol. 35, No. 4, 1936. (P)

Visits.

William Black, B.Sc., Ph.D. :—

Potato Virus Research Station, Cambridge.

George Cockerham, B.Sc., and Hugh Ferguson, B.Sc. :—

Potato Virus Research Station, Cambridge. (Annual Conference of Virus Diseases of Plants Committee and Workers.)

III. Demonstrations.

During the summer visitors were conducted round the experimental plots, and various aspects of the work were described by members of the staff. On the occasion of the Centenary Meeting of the Botanical Society of Edinburgh, 1st July 1936, an exhibit was staged at the Royal Botanic Garden, Edinburgh, illustrating the scope and some of the uses of Experimental Taxonomy.

IV. Acknowledgments.

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Department of Agriculture for Scotland, per T. Anderson, Director, Seed-Testing Station, Corstorphine, Edinburgh.

Drummond, Wm., & Sons, Ltd., Seedsmen, Stirling.
Elder, James (Messrs Dods & Son), Haddington.
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WILLIAM ROBB,
Director of Research.

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