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- " " [16, 1937]

1932

SCOTTISH SOCIETY FOR RESEARCH IN
PLANT-BREEDING.

REPORT.



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

In each of the departments of the Society's plant-breeding work the various plant-breeding investigations which the Society is promoting were successfully continued during the past year. Further progress has been made in achieving results of practical and of scientific interest.

Certificates of Registration have now been received from the Department of Agriculture for Scotland in respect of two varieties of oats—viz., "Elder" and "Bell"—raised by the Society. The latter of these was registered in January 1932. From reports made on various trials it appears that this variety is adapted for the poorer soils and later districts of Scotland. It is hoped that "Bell" will prove a suitable substitute for the old-established "Sandy" oat, which is still largely grown in certain areas. In response to the circular letter sent to members of the Society regarding this new variety, there was a good demand for the seed. All the seed available from the 1931 crop, excepting that which was required by the Society to sow three acres in 1932, was disposed of to members of the Society.

Seed has now been obtained from several pasture strains of grasses, and it is expected that an initial stock of seed of these grasses will be available towards the end of 1932.

A few promising new varieties of potatoes and swedes have been submitted to the Department of Agriculture for Scotland for inclusion in the Department's official trials this year.

Results of scientific interest are communicated to appropriate journals as occasion arises. A list of papers published and lectures given by members of the staff during the year is given on page 33.

In the section concerned with the study of Virus Diseases of Potatoes a satisfactory year's work has been accomplished. The information that has been gained is, at the present stage, mainly of scientific interest. A full account of this work will shortly be published in the 'Transactions' of the Royal Society of Edinburgh.

Further details of the work in progress at the Plant-Breeding Station are given in the Report by the Director of Research, which appears on pages 15 to 35 hereof.

Financial.

The Society's funds show little difference as a result of the year's working. In the ordinary accounts, as audited at 31st March 1932, the funds show a decrease of about £233 as compared with the funds a year ago, when there was an increase of about £60. The total ordinary income of the Society was about £25 lower than it was in the previous year. The donations received again included one of £10 from His Grace the Duke of Buccleuch.

The total ordinary expenditure ranking for grant amounts to nearly £3649, and this shows an increase of about £206 on that of the previous year. In accordance with recommendations made by the Government through the Department of Agriculture for Scotland, a reduction in the salaries of all the members of the Society's staff took effect from 1st October 1931, the reductions ranging from 3½ per cent to 7½ per cent, according to scale.

The Society has adopted as from the beginning of the finan-

cial year 1931 the Federated Superannuation System for Universities for the members of its technical staff, and the Society's contributions towards superannuation therefore accounted for a part of the increase in expenditure.

The investigations relating to Virus Disease Research have now been in full progress for slightly over one year. The expenditure incurred in carrying out these investigations—in accordance with approved estimates submitted annually to the Department of Agriculture for Scotland—is met by a special grant made through the Department of Agriculture by the Empire Marketing Board, and this expenditure is therefore shown separately.

“ Dr Wilson ” Memorial Fund.

In this account there is a credit balance of £249, 16s. 6d., which sum shows an increase of £10 for the year. No payments were made from the fund during that period.

Membership.

The membership of the Society has, during the past year, increased from 199 to 225, and comprises 128 life members and 97 annual members (25 at the 10s. rate and 72 at the £1 rate). Thirty-three life members who had contributed the necessary amount to the preliminary fund of the Society, and eight annual members, were enrolled during the year. Nine members died, three members resigned, and the names of three members whose subscriptions were in arrears were deleted from the roll. A list of members appears on pages 36 to 41 hereof.

Donors of £20 or over are entitled to become life members of the Society without further payment. Donors of £10 or over may become members of the Society by payment of an annual subscription of 10s., and others by payment of an annual subscription of £1.

In order that the membership list may be kept up to date, changes of addresses should be intimated to the Secretary.

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.
 WILLIAM CUTHBERTSON (Messrs Dobbie & Co., Ltd.), Edinburgh.
 Sir JAMES INGLIS DAVIDSON, Saughton Mains, Corstorphine.
 IAN C. MENZIES, W.S., 22 Rutland Street, Edinburgh.
 GEORGE G. MERCER, Southfield, Dalkeith.
 G. BERTRAM SHIELDS, Rosebery Farm, Gorebridge.

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

JAMES H. ELDER, B.Sc., Cregganore, North Berwick.
 CHARLES E. GREGOR, Innerwick, East Lothian.
 Lieut.-Col. R. G. O. HUTCHISON, D.S.O., M.C., Cannoquhie,
 Ladybank.
 ROBERT MILLER, Ferrygate, North Berwick.
 FRED MILLER (Messrs Roughhead & Park, Ltd.), Haddington.
 JAMES PATON, Kirkness, Glencraig.

JOHN STIRTON,
Secretary.

[ABSTRACT OF ACCOUNTS

ABSTRACT OF

For the year ended

INCOME.

Interest Received	£1,602 5 1
Recoverable Income Tax	279 11 1
	£1,881 16 2
Sale of Produce and Stock on Hand	317 1 10
Rent Received	13 10 0
Income Ranking for Grant	£2,212 8 0
Subscriptions—Annual	81 0 0
<i>Note.</i> —Annual Subscriptions amounting to £7, 10s. are in arrear.	
Donations—	
£10 or over	£10 0 0
Under £10	5 0 9
	15 0 9
Sale of Seed of Elder and Bell Oats	56 16 7
	Total Ordinary Income
	£2,365 5 4
Grant received from the Department of Agriculture for Scotland for the year 1931-32	1,100 0 0
	Total Income
	£3,465 5 4
Funds at 1st April 1931	44,215 7 7
	£47,680 12 11

ACCOUNTS.

31st March 1932.

EXPENDITURE.

Salaries—	
Officers (including Ainville Sub-Station)	£1,950 9 6
Secretary and Office	216 8 9
	£2,166 18 3
Superannuation	198 0 0
Labour	636 14 6½
National Health and Unemployment Insurance	16 11 7
Seeds and Roots	12 6 2
Manures	100 0 11
Sundry Working Expenses, including renewals of Implements and Tools	128 5 7½
Laboratory Expenses	18 16 8½
Library Expenses	41 11 10
Rates and Insurances	40 15 1
Office Expenses	80 11 8
Heating, Lighting, and Cleaning	34 9 7
Travelling Expenses	31 5 1
Property Repairs	32 14 6
Locality Trials	12 7 9
Ainville Sub-Station Maintenance Expenses	97 9 11
	Expenditure Ranking for Grant
	£3,648 19 2½
Depreciation on Implements, Tools, Furniture, &c.	49 19 4
	Total Expenditure
	£3,698 18 6½
Funds at 31st March 1932, per Balance-sheet	43,981 14 4½
	£47,680 12 11

BALANCE-

As at 31st

<i>LIABILITIES.</i>	
I. Accounts Outstanding	£232 7 3
II. Funds at 31st March 1932	43,981 14 4½
	£44,214 1 7½

Value at 31st March 1932.	Funds at 31st March 1932, consisting of—
£204 10 0	£200 5 per cent War Stock, 1929-47— value at date of transfer
	Sum in Bank on Deposit Receipt
	Sum in Bank on Current Account
	£249 16 6

DR WILSON

SHEET.

March 1932.

<i>ASSETS.</i>	
I. Houses and Lands, at Cost	£7,813 16 4
II. Implements and Tools, at Cost, less Depreciation	590 11 1
III. Laboratory Apparatus, at Cost, less Depreciation	132 14 9
IV. Office Fittings, at Cost, less Depreciation	75 7 10
V. Stocks on Hand, as valued by Directors	191 18 0
VI. Accounts Outstanding	151 8 9
VII. Income Tax Recoverable	279 11 1
VIII. Investments, at Cost :—	
Value at 31st March 1932.	
£14,315 0 0	1. £14,000 5 per cent War Stock, 1929-47
13,492 10 0	2. £14,000 4 per cent Funding Stock, 1960-90
14,238 5 0	3. £16,900 3½ per cent Conversion Stock
300 0 0	4. £300 Edinburgh Corporation Loan
£42,345 15 0	£12,390 0 0 10,045 0 0 11,140 3 6 300 0 0
	33,875 3 6
IX. Greenhouse, Hut and Frames at Ainville Sub-Station, at Cost	183 7 6
X. Cash Balances—	
In Bank—	
On Current Account	£126 1 5
On Deposit Receipt	750 0 0
On Hand	44 1 4½
	920 2 9½
	£44,214 1 7½

MEMORIAL FUND.

Funds at 1st April 1931	£239 16 6
Interest for year	10 0 0
	£249 16 6

VIRUS DISEASE RESEARCH SCHEME

ABSTRACT OF

For the Year ended

INCOME.

Grant from Empire Marketing Board	£1724 14 4
Funds at 1st April 1931	3249 10 2
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	£4974 4 6

BALANCE

As at 31st

LIABILITIES.

I. Accounts Outstanding	£6 1 6
II. Funds at 31st March 1932	3613 3 7
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	£3619 5 1

EDINBURGH, 30th April 1932.—The undersigned, having had access to all the Accounts, and verified the same with the Accounts and Vouchers relating thereto, now

16 ALVA STREET.

(EMPIRE MARKETING BOARD).

ACCOUNTS.

31st March 1932.

EXPENDITURE.

Salaries and Wages	£1007 12 4
Superannuation	123 2 6
Maintenance Expenses—	
Craigs House	£114 14 2
Huntly Sub-Station	74 19 6
Ainville Sub-Station	12 17 9
	202 11 5
Depreciation	27 14 8
	£1361 0 11
Capital Expenditure—	
Craigs House	£149 11 1
Funds at 31st March 1932	3613 3 7
	£4974 4 6

SHEET.

March 1932.

ASSETS.

I. Buildings, Implements, Apparatus, &c., at Cost, less Depreciation—	
Craigs House	£2298 16 7
Huntly Sub-Station	823 19 6
Ainville Sub-Station	316 19 6
	£3439 15 7
II. Cash Balances—	
In Bank, on Current Account	179 9 6
	£3619 5 1

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.*

ANALYSIS OF MEMBERS

As at 31st March 1932.

Aberdeen	7	Lanark	21
Angus	11	Linlithgow	3
Argyll	5	Midlothian	41
Ayr	14	Moray	2
Banff	2	Nairn	0
Berwick	13	Orkney	2
Bute	0	Peebles	4
Caithness	1	Perth	13
Clackmannan	0	Renfrew	8
Dumbarton	2	Ross and Cromarty	6
Dumfries	7	Roxburgh	5
East Lothian	32	Selkirk	2
Fife	11	Stirling	3
Inverness	0	Sutherland	0
Kincardine	2	Wigtown	2
Kinross	0	England	3
Kirkcudbright	3		
			<u>225</u>

ESTABLISHMENT FOR 1931-32.

BOARD OF DIRECTORS.

Trustees.

THE RIGHT HON. SIR ARCHIBALD SINCLAIR, Bart., C.M.G., M.P.,
Secretary of State for Scotland.
JAMES ELDER, 18 Eglinton Crescent, Edinburgh.
DAVID BELL, 15 Coburg Street, Leith.
JOHN FINLAYSON M'GILL, 69 Kyle Street, Ayr.

Ordinary Directors.

1929.

W. J. CAMPBELL, 61 Fountainhall Road, Edinburgh.
WILLIAM CUTHBERTSON (Messrs Dobbie & Co., Ltd.), Edinburgh.
Sir JAMES INGLIS DAVIDSON, Saughton Mains, Corstorphine.
IAN C. MENZIES, W.S., 22 Rutland Street, Edinburgh.
GEORGE G. MERCER, Southfield, Dalkeith.
G. BERTRAM SHIELDS, Rosebery Farm, Gorebridge.

J. H. MILNE HOME, Irvine House, Canonbie.
WILLIAM KAY, 19 South St David Street, Edinburgh.
J. P. ROSS-TAYLOR, Mungoswalls, Duns.

1931.

WILLIAM ALLISON, Almond Hill, Kirkliston.
Lieut.-Colonel W. T. R. HOULDSWORTH, of Kirkbride, Maybole.
Major JAMES KEITH, Pitmedden, Udney.
ALEXANDER NELSON, Ph.D., Royal Botanic Garden, Edinburgh.
Professor ERNEST SHEARER, Agricultural Department, The University, Edinburgh.
Professor Sir WILLIAM WRIGHT SMITH, Inverleith House, Arboretum Road, Edinburgh.

1930.

D. L. BOWE, Skateraw, Dunbar.
JOHN CHISHOLM, Gibston, Huntly.
JOHN E. B. COWPER, Gogar House, Corstorphine.

Directors Co-opted.

CHARLES E. GREGOR, Innerwick, East Lothian.
WILLIAM LOW of Balmakewan, Laurencekirk.
ROBERT MILLER, Ferrygate, North Berwick.

Directors nominated by the Department of Agriculture.

Sir ROBERT B. GREIG, M.C., LL.D.,
J. M. CAIE, M.A., B.L., B.Sc.,
T. ANDERSON, M.A., B.Sc.,
ALEXANDER M'CALLUM, M.A., LL.B., } York Buildings, Queen Street,
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.

Assistant—V. E. M'M. DAVEY, B.Sc., Ph.D., Craigs House, Corstorphine.

Assistant, Potato-Breeding Sub-Station—WILLIAM BLACK, B.Sc., Ph.D., Ainville Farm, Kirknewton.

Assistants under Virus Disease Scheme—E. C. BARTON-WRIGHT, M.Sc., F.R.S.E., Craigs House, Corstorphine; GEORGE COCKERHAM, B.Sc., Gibston, Huntly; and ALAN M'BAIN, 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.

G. Bertram Shields, *Convener*.
 William Allison.
 T. Anderson.
 W. J. Campbell.
 John Chisholm.
 John E. B. Cowper.
 William Cuthbertson.
 Charles E. Gregor.
 Sir Robert B. Greig.
 J. H. Milne Home.
 Lt.-Col. W. T. R. Houldsworth.

William Kay.
 Major James Keith.
 William Low.
 J. F. M'Gill.
 George G. Mercer.
 Dr Alexander Nelson.
 Professor Ernest Shearer.
 Professor Sir W. Wright Smith.
 J. P. Ross-Taylor.
 James Elder, *Chairman, ex officio*.
 David Bell, *Vice-Chairman, ex officio*.

MANAGEMENT.

David Bell, *Convener*.
 William Allison.
 D. L. Bowe.
 J. M. Caie.
 John E. B. Cowper.
 Sir J. Inglis Davidson.
 Charles E. Gregor.
 J. H. Milne Home.

William Kay.
 Major James Keith.
 George G. Mercer.
 Robert Miller.
 Professor Ernest Shearer.
 G. Bertram Shields.
 James Elder, *Chairman, ex officio*.

FINANCE.

J. H. Milne Home, *Convener*.
 W. J. Campbell.
 Lt.-Col. W. T. R. Houldsworth.
 William Low.
 Alex. M'Callum.
 Ian C. Menzies.

Robert Miller.
 G. Bertram Shields.
 J. P. Ross-Taylor.
 James Elder, *Chairman, ex officio*.
 David Bell, *Vice-Chairman, ex officio*.

R E P O R T

BY

DIRECTOR OF RESEARCH.

I. Research Programme.

“The aim of the Society is to establish a thoroughly equipped Station, and to promote the discovery and the creation of such new and improved races of the leading crop plants as are best suited to Scottish conditions.

“The methods employed at the Station to obtain improved types of plants are, in the main :—

- “ (a) Collection and classification of suitable living material.
- “ (b) Isolation of pedigree strains (pure lines).
- “ (c) Hybridisation of pedigree strains, varieties and species.
- “ (d) Comparative trial of varieties, pedigree strains, &c.”

The crop plants on which breeding experiments are being carried out are chiefly Oats, Potatoes, Herbage (Perennial Ryegrass, Cocksfoot, Timothy and Plantain) and Swedes. A review of the work done and the results obtained during the past year follows.

Within recent years much progress has been made in the study of the chromosome content of plant cells. This is a highly specialised line of work, and while it has a very important bearing on various plant-breeding problems, it has not been possible, so far, to undertake any work of this kind on an appropriate scale at the Scottish Plant-Breeding Station.

In view of recent developments in plant-breeding technique, however, this line of work deserves full consideration. The present time is perhaps inopportune to initiate additional investigations, but if the best progress is to be made, it is most essential to apply and develop any new lines of research work that are likely to yield practical results. It is the writer's view that whenever it is possible to extend the Society's research programme, first consideration should be given to providing an additional trained assistant to undertake an extensive examination of the chromosome content of the crop plants in which the Society is directly interested. Such work would undoubtedly be very helpful in detecting important hereditary differences, and would thereby facilitate the production of new and improved races of agricultural plants.

A. CEREALS.

Oats.

The object of the breeding experiments with oats is to produce improved varieties in which characteristics such as upstanding straw and early maturity are combined as far as possible with adaptability and productiveness. In continuing this work all the ground available for oats at the Plant-Breeding Station was utilised for the oat-breeding experiments, and about the usual amount of hybrid material was grown for detailed comparison and selection.

Among the second-generation families certain of these were examined in detail particularly for the presence of plants with 'grey' grain. Plants with grey grain have been persistently appearing in some of the later generations of certain crosses between black-grained and white-grained plants. They do not seem to be present simply as an admixture, but as hybrids. Their presence, even in small amount, in a sample of seed grain depreciates the value of the sample, and it is therefore necessary to ascertain definitely the origin of these types with a view to preventing, if possible, their occurrence in certain new strains which are being multiplied.

In addition to selecting plants mainly of interest from a genetical point of view, plants of interest from a practical standpoint were also chosen for further experimental breeding and selection. Many single plants were again selected from

crosses which are as yet unfixed, and some promising plants were obtained from the following crosses:—

Victory × Superb.	Sandy × Orion.
Orion × Superb.	Star × Marvellous.
Orion × Record.	Orion × Castleton Potato.
Orion × Victory.	Yielder × Sparrowbill.

Several selections from the undernoted crosses were apparently breeding true to type in 1931, and the plants within each selection were threshed in mass and the seed retained for inclusion in the preliminary trials in 1932. The crosses represented by these hybrids are:—

- (1) Castleton Potato × Yielder.
- (2) Victory × Bathurst.
- (3) Orion × Sandy.

Some of the selections from the first-mentioned cross possess short upstanding straw, with panicles which are well furnished (see Fig. 1 (a), page 19). Among the selections from the second cross mentioned immediately above, there are some early-ripening types which have plump grain, and which give indications of being highly productive. In the selections from No. 3 there are a few very early-ripening types, which will be tried in late districts to see whether any of them are hardy enough to withstand the conditions prevailing there. One of these has black grain, but all the others have white grain. It is understood that there is a considerable demand every year for seed of black-grained oats grown in the north-east of Scotland, and it is hoped to obtain comparisons of this black-grained hybrid with the varieties that are usually grown there.

In preliminary field trials at the Plant-Breeding Station several promising hybrids of different types were grown for further observation and comparison. A short-strawed, late-ripening plant of the Elder type and of the same parentage was crossed with a white-grained, early-ripening hybrid the parents of which were Black Mesdag and Victory. Among the progeny obtained by crossing these two hybrids there were a few plants resembling Elder in type, but distinctly earlier in ripening, and one of these is now marked for propagation. Several other early-ripening selections from a

cross between the varieties Potato and Record were included in some of the larger trial plots at the Plant-Breeding Station in 1931. These early-ripening strains produce fine samples of white plump grain and also a type of straw that does not readily lodge. A few of them are already undergoing trial at the Plant Registration Station. One, in which there was a larger quantity of grain available, is also being tried in oat experiments in various counties in Scotland in 1932. It was reported, in a trial at Craibstone, Aberdeen, in 1931, that this variety stood up well, that it was fully earlier than either Yielder or Pure Line and that the grain was comparatively short, plump and of white colour. This variety is being included in the Registration Trials of the Department of Agriculture for Scotland this year.

Three of the Society's unnamed hybrid selections were included in the Registration Trials of the Department of Agriculture for Scotland in 1931. Two of them were from the same cross—viz.: Castleton Potato \times Beseler's Prolific. The other was from a cross between Sandy and Leader. The weaker-strawed hybrid of the two from the first-mentioned cross is not being further grown, but the other one, which has upstanding straw and a good quality of grain, is again being included in the Department's Registration Trials in 1932. The variety selected from the cross, Sandy \times Leader, has been included in the Registration Trials for four years, and it has been found to be a distinct hybrid variety. In January 1932 it was registered by the Department of Agriculture for Scotland under their Scheme for the Registration of Cereals, and it is now known as "Bell." In the Certificate of Registration the description given of the Bell oat is:—

"An early variety having many of the characters of Sandy Oat; of good tillering habit; very early in ear, maturing slowly; earlier in ripening than Sandy or Potato oat; having a moderately good yield of medium grain, faintly pink tinged; not liable to shed; having a large yield of good straw not so liable to lodge as Sandy; suitable for poorer soils and late districts."

The Bell oat was selected as a possible substitute for the old-established variety Sandy, and, as previously reported, in various trials in the North of Scotland where the Sandy oat

cross between the varieties Potato and Record were included in some of the larger trial plots at the Plant-Breeding Station in 1931. These early-ripening strains produce fine samples of white plump grain and also a type of straw that does not readily lodge. A few of them are already undergoing trial at the Plant Registration Station. One, in which there was a larger quantity of grain available, is also being tried in oat experiments in various counties in Scotland in 1932. It was reported, in a trial at Craibstone, Aberdeen, in 1931, that this variety stood up well, that it was fully earlier than either Yelder or Pure Line and that the grain was comparatively short, plump and of white colour. This variety is being included in the Registration Trials of the Department of Agriculture for Scotland this year.

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FIG. 1.

Two well-furnished hybrid oat panicles—

(a) From Castleton Potato \times Yelder.

(b) From Victory \times Argentine.



FIG. 2.

Several hybrid oat plants over 6 feet 6 inches high.

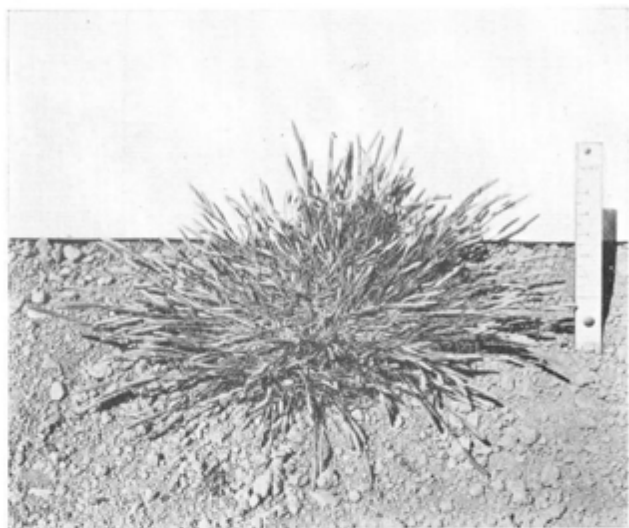


FIG. 3.
Prostrate type of diploid Timothy.

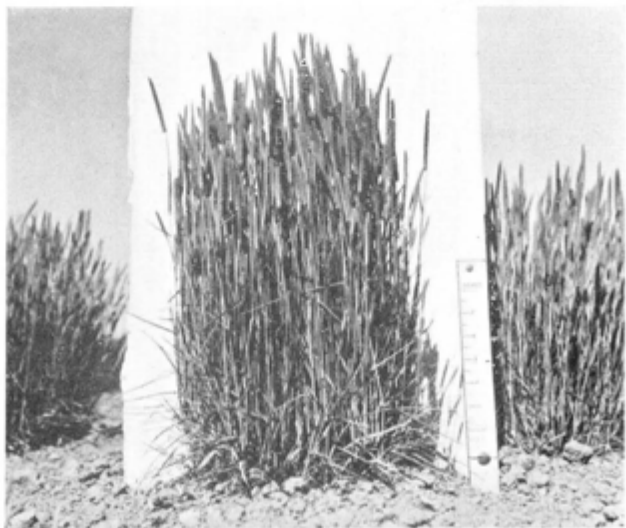


FIG. 4.
Erect type of diploid Timothy.

is largely grown, Bell has compared favourably with that variety.

About 20 tons of seed of Elder oats, which had been grown under contract for the Society, were received from the growers. The crop of nine acres grown by Mr James Young, Meadowfield, Corstorphine, for the Society gave an average yield of about 30 cwt. of grain per acre. The crop grown for the Society in East Lothian did not yield so heavily, but it provided a good seed sample of grain. About two and a third acres of Bell oats were grown by Mr Young, Meadowfield, Corstorphine, for the Society in 1931, and the yield of grain from this area was about 20 cwt. per acre. There was a heavy crop of straw, and while there was a certain amount of lodging, the grain was attractive and made an excellent seed sample.

The Elder oats, which were grown under contract for the Society in 1931, were all inspected under the Scheme arranged by the Department of Agriculture for Scotland in connection with the Registration of Cereals, and all the grain which has been sold for seed was certified as to purity and germination by the Department.

Members of the Society were informed early in 1932 that grain of the two new varieties, Elder and Bell, was available for seed, and they were invited to apply for seed grain, the price being fixed by the Directors of the Society at 21s. per cwt. for Elder oats and 25s. per cwt. for Bell oats. In response to the invitation, about nine tons of Elder oats were disposed of for seed. All the available grain of the Bell oat was taken up by members of the Society. In view of the demand this season for seed of the Bell oat, three acres of it are again being grown for seed by the Society in 1932.

Wheat and Barley.

The comparison and selection of several wheat and barley hybrids has been continued by Mr J. M. S. Lang, Temporary Junior Assistant. Several varieties of barley of hybrid origin have been received from Mr Thomas Anderson, Director of the Seed-Testing Station, Corstorphine, and they will be grown in 1932 for observation and comparison. Most of the varieties have an attractive type of grain, and some of them are early-ripening types. In view of the possible advantages that may accrue to barley growers in the North of Scotland,

through growing suitable early-ripening varieties, attention will be concentrated mainly on the selection of the best early-ripening strains.

B. POTATOES.

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

Further potato-breeding experiments were carried out in 1931. Many new seedlings were raised, and the older seedlings were submitted to the usual tests. On the economic side an endeavour continues to be made to obtain improved productive early and main-crop types, immune from wart disease and possessing shapely tubers of good culinary quality. On the theoretical side additional data have been collected as regards the heredity of certain characters with a view to devising improved breeding methods.

First Year Seedlings.—Fully 2200 seedlings were obtained from crossed plants and 1160 from self-fertilised parents. Amongst the parent varieties of the hybrid seedlings the following combinations may be mentioned:—

Abundance \times No. 120(64)—the latter a Great Scot seedling.

Ally \times No. 120(3)—the latter a Great Scot seedling.

America \times No. 135(10)—the latter an Abundance \times Majestic seedling.

Majestic \times No. 135(10)—the latter an Abundance \times Majestic seedling.

British Queen \times No. 70(13)—the latter a Bishop seedling.

Kerr's Pink \times No. 70(13)—the latter a Bishop seedling.

British Queen \times Majestic.

May Queen \times Flourball.

Many early-maturing seedlings were obtained from the America and from the May Queen crosses.

Second Year Seedlings.—The majority of the 305 second year seedlings were obtained from crossed parents. At the Ainville Sub-Station growth was slow and development under the average, and, in consequence, selection of the best economic types was rendered more difficult. Many of the seedlings have, however, been retained for further trial. From the relative proportions of promising plants in the different progenies it

was concluded that the undernoted combinations gave the most satisfactory results in 1931 :—

Abundance × Flourball.	Epicure × No. 135(10).
Bishop × Flourball.	Kerr's Pink × No. 160(48).
British Queen × No. 120(4).	Majestic × Flourball.
Epicure × Flourball.	Up-to-Date × No. 120(4).

Apparently useful types of early and mid-season maturity were also obtained from self-fertilised lines, derived originally from Abundance × Majestic and from King Edward VII. × No. 39(15). Many of the seedlings from Epicure, British Queen and Up-to-Date crosses were susceptible to wart disease, and were therefore discarded.

Third Year Seedlings.—The size of the field plots varied from six to forty-two plants, partly according to the apparent relative value of the selections but mainly to the quantity of seed tubers available. Several of the well-known commercial varieties were used as controls. A few early-maturing seedlings of promise were noted, and among these mention may be made of No. 144a(32), a first-early from Epicure × Flourball, and No. 115(39), a second-early from Kerr's Pink × No. 966b(4). Outstanding seedlings among the early main-crop varieties were No. 139a(38) from Bishop × Flourball and No. 153(16) from King Edward × No. 39(15). Several seedlings of a desirable type were also obtained from Ally × Flourball. These are chiefly of main-crop maturity, and in the field trials No. 182a(79) was slightly superior to the others. Another main-crop seedling, No. 184a(23), from Bishop × No. 120(42), gave an excellent yield of finely shaped tubers. No. 138(69), from Abundance × No. 121(6), turned out very well in the trials, and has proved to be of excellent cooking quality.

Hybridisation.—In 1931 flowers on potatoes were fewer than usual, and viable pollen was scarce at Ainville. Flourball, for example, which usually flowers profusely, failed completely to produce a single fully developed flower. From certain plants which had been planted later than usual, however, flowers and viable pollen were obtained, and a sufficient number of successful hybridisations were made.

An important object of these investigations is to ascertain the relative merits of different pairs of varieties as parents. In general, varieties which are equally good from a com-

mercial point of view are not necessarily of equal value as parents. Consequently it is impossible to predict at all accurately the different types and the relative proportions of these that may occur as a result of crossing any two varieties. The most conclusive method of ascertaining the relative values of different pairs of varieties as parents is by diallel crossing, but the chief drawback at the present time to this method is the degree of sterility present in the majority of potato varieties. Until the parental value of different pairs of varieties is more fully determined breeding must necessarily be empirical to a large extent. The worth of a variety as a parent depends not so much on its visible characters as on the capacities it transmits to its progeny. Hence the importance of finding out which pairs of varieties when crossed will produce the best combinations of desirable characters. In this connection the work on inbreeding should ultimately be helpful in getting a greater number and more true-breeding types of parent plants.

Inbreeding.—In several lines further inbred generations were grown and, where possible, individual plants in each line were again self-fertilised. Several self-fertile lines breeding true for many of their characters have now been obtained. In general, loss of vigour has not been conspicuous in selfed progenies up to the present. It is probable that the more vigorous of the inbred plants that occur are still very heterozygous.

Virus Diseases.—No difficulty was encountered in maintaining the stocks in an apparently healthy condition. Apart from a few exceptional cases, the selections in the experiments have not yet shown any of the ordinary symptoms of virus diseases since they were raised—the oldest six years ago. Symptoms of leaf-roll, however, were observed in a considerable proportion of the seedling plants of two progenies derived from leaf-roll parents. In certain other progenies from leaf-roll parents, however, similar results were not obtained.

Trials.—The more promising seedlings were grown at the Plant-Breeding Station, Craigs House, to ascertain their commercial value in comparison with the two varieties, Great Scot and Kerr's Pink. The crops in general were good. Altogether 330 selections were compared, and the more promising ones retained for further trial.

A large group of seedlings was sent for inclusion in the preliminary trials carried out by the Department of Agriculture for Scotland, and forty-three of these were recommended for further trial.

Four varieties were grown in the Registration Trials, Department of Agriculture for Scotland, three in the First Year and one in the Second Year Trials. References to these four varieties follow :—

No. 93(53) is an early main-crop seedling from Great Scot \times Bell. It gave an excellent crop of finely shaped, oval, white tubers. The haulm resembles that of Great Scot. This seedling made a very satisfactory appearance in the Second Year Registration Field Trials, but, as its cooking quality did not come up to the standard, it was consequently not recommended for further trial.

No. 94(107) is a main-crop seedling of the same parentage as No. 93(53). It is an excellent cropper, producing roundish-oval tubers of good size and appearance. Like No. 93(53), its cooking quality was barely up to the required standard, and, in consequence, it could not be recommended for further trial.

No. 966f(1) is a main-crop seedling from Bishop \times No. 724(2). The tubers are a smooth kidney shape, a little flat but of good size. This variety gave satisfactory yields of good quality tubers, which, however, were rather yellow in the flesh. On account of its flesh colour it was not recommended for further trial.

No. 135(10) was bred from Abundance \times Majestic; it was recommended for trial in 1932 and to be tested against British Queen, Great Scot and Catriona. It has finely shaped, oval, white tubers of good cooking quality; its maturity is second early.

Samples of first-year seedlings were again included in the Wart Disease Tests carried out by the Department of Agriculture for Scotland.

C. HERBAGE PLANTS.

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

The study of the timothy grasses, *Phleum pratense* L. and *P. alpinum* L., which constituted the major part of the herbage

plant investigations in 1931, has resulted in the classification of these two species in accordance with the system advocated by Turesson, and in the identification of two distinct groups within the *P. pratense* section. This division is of much agricultural importance on account of the facts that each group is suited to a different environment, and that intersterility will greatly help to maintain the individual identity of each group during the process of multiplication by seed.

The main groups into which agricultural timothy has been divided are :—

Cœnospecies, *Phleum pratense-alpinum*.

Ecospecies, *P. pratense diploidium*.

P. pratense hexaploidium.

The diploidium group contains the "wild" forms, many of which are suited to pasture conditions, while the hexaploid group is composed of the forms of timothy in common agricultural use.

The units within these ecospecies have been critically examined in order to discover the environmental preferences of certain combinations of characters. It seems probable that, in the breeding of obligatory cross-fertilising plants such as many of the grasses, the association of types (ecotypes) resulting from the action of environmental influences constitute a basis for the further improvement of agricultural strains. It is hoped that by such investigations it will be possible to devise methods which will facilitate the production of agricultural grass strains possessing definite environmental preferences.

The ecotypes of *P. pratense*, which have been examined, suggest that each unit consists of a collection of cross-fertilising plants of different genetic constitution which are capable of resisting elimination under the environmental conditions of the locality where they occur. These ecotypes represent portions of the species-population which are able to survive under the effects of a particular set of habitat factors. The habitat is regarded, in general, mainly as a passive agent supplying a population of suitable hereditary constitution with a medium of livelihood, not as an active agent in the origin of specially adapted types. The establishment of ecotypes in the wild is, therefore, primarily the result of natural elimination bringing about a state

of isolation which in turn maintains and accentuates ecotypic uniformity. By the more intense method of conscious selection of certain portions of an ecotype, an agricultural ecotype suitable to the requirements of agricultural practice should ultimately be obtained by the plant breeder.

Alpine timothy and sea plantain have been extensively employed during the year for the investigations devised to obtain precise information concerning the grouping of natural units in relation to their geographical position, and to the environmental factors of their habitats. Populations of these species have been grown from seed obtained from various habitats in Britain, Canada, The Faroes, Finland, Germany, Greenland, Iceland, Norway, Sweden and the northern islands in the Baltic, Switzerland and the United States of America. As far as possible parallel series of both species are being simultaneously examined. Although work on this subject has already extended over several years, definite results regarding its agricultural value cannot be expected until considerably more material has been examined.

Multiplication of New Strains.—Pasture strains of cocksfoot, perennial ryegrass and timothy (ecospecies *P. pratense diploidium*) are being multiplied at the National Institute of Agricultural Botany, Cambridge, and at Corstorphine. Seventeen pounds of seed of the strain of timothy has this year been distributed for preliminary trial in various districts in Scotland.

In addition to these three strains, a second strain of pasture timothy is now in the first year of multiplication at Corstorphine.

Perennial Ryegrass and Cocksfoot.—Several other strains of these two species have been examined for grazing types.

D. ROOT CROPS.

(*Swedes and Turnips.*)

Assistant in Charge—V. E. M⁴M. DAVEY, B.Sc., Ph.D.

The primary purpose of the experiments with swedes is the examination of various methods for selecting and comparing individual bulbs intended for use in breeding, with a view to obtaining improved strains or varieties.

Pedigree Breeding.—About 160 strains of swedes were sown in small plots with certain commercial varieties as controls, while larger plots of most of these were sown in various groupings for the purpose of comparative trials. Observations were made periodically on all the plots during the season, and in autumn representative selections were made for propagation. The "Roots" Sub-Committee inspected the trials in November, when it was decided that two strains should be submitted for registration. Accordingly these strains were submitted to the Plant Registration Station of the Department of Agriculture for Scotland, but it has subsequently been agreed to test only one, Ds 21, there in 1932. There was a shortage of seed of the other strain, Ds 22, and it was arranged that it should be sown only at the Plant Breeding Station in 1932. The Colleges of Agriculture at Edinburgh and Aberdeen have agreed to include Ds 21 in their field trials.

The pedigree strains under examination were mainly bronze- and green-tops, some of which were in the fifth selfed generation from selections originally made in 1921. New lines were started by extensive selections from segregating generations of intervarietal crosses, in particular from a cross between Green Globe \times Purple Tankard. The first hybrid generation of this had been multiplied in mass on the recommendation of the Sub-Committee, and with the pound of seed obtained almost a quarter of an acre had been sown, yielding a crop of bulbs of all sizes, shapes and colours. From this extensive population thirty non-purple segregates were selected as a nucleus for a family breeding experiment, while twenty-two other selections were made as the result of dry-matter analyses, and these will be self-fertilised.

Controlled Seeding.—About 170 strains of swede were harvested, comprising 160 self-fertilisations, 7 hand-crossings and 3 mass-multiplications in natural isolation. A few turnip and rape strains were also obtained. Seventy of the swede strains were pedigree lines selfed for periods ranging from two to five generations. Nine were new selections from commercial stocks. The remainder were products of hybridisation selected for one or more generations.

Analysis of Hereditary Characters.—By sowing a replication early it was shown that the differences in bolting tendency of some true swede lines were maintained in the present generation. One of the short-necked strains may be of agricultural

value. The earlier stages of this experiment were referred to in the Report for 1930.

The "bulbless bolter" investigation was also carried a stage further. When a swede \times rape hybrid was back-crossed with swede it was found that the offspring frequently possessed large bulbs up to 5 lb. in weight, though these were generally disfigured by badly "fanged" roots, and that the dry matter might range from 12 per cent to 20 per cent. The danger from intercrossing of this sort is not negligible. It would seem that if rape adulteration, through crossing, were allowed to remain in a swede stock, yellow-fleshed plants with large but fibrous roots might soon appear, and that, on the basis of dry-matter content, these might stand some chance of being selected. It is thought that one or two of the "half-bulbed" bolters obtained for experimentation may have been of this nature. A few second segregating generations of swede \times rape were examined, and white and yellow flesh colours were found in the proportions of 15:1. The yellow-fleshed plants had dull orange-yellow flowers, while most of the white-fleshed plants had the typical bright lemon flower-colour. A pale yellow flower colour, introduced by one of the rape parents, also occurred, however; this is one of the less common rape flower-colours described by Dr Sylvén, Svalof, Sweden.

Skin colours were noted in a number of second generations. As previously found, in crosses between purple- and bronze- and between purple- and green-top swedes, the second generations segregated in the proportions three purple to one non-purple. Among the non-purple bulbs bronze- and green-tops were difficult to separate.

Observations were continued on other characters, and on resistance to finger-and-toe disease.

Yield Trials.—Four yield trials were carried out during 1931, pedigree lines being compared with each other and with controls of parent varieties. Two of the trials were connected with the joint investigation which has been in progress since 1927, and in which the Edinburgh and East of Scotland College of Agriculture have co-operated. In 1931, however, the work was confined to the Plant-Breeding Station, where some of the strains, now in their second generation of self-fertilisation, were compared for weight, dry matter and soluble solids. The third trial included some miscellaneous pedigree

lines, one of them mass-multiplied for the purpose of estimating its degree of utility. The fourth trial consisted of nine comparatively young lines and three commercial controls, and was intended to indicate the relative values of the lines. The trials were laid out as usual in randomised blocks replicated four times, and in one instance five times. Crop weight and percentage dry matter were estimated, and in three trials percentage sugar was also estimated.

Other Analyses.—Dry-matter analyses were carried out on 350 single bulbs for the purpose of selecting seed parents. Experiments in methods of coring were also continued.

E. VIRUS DISEASE RESEARCH.

(Under Empire Marketing Board Grant.)

E. C. BARTON-WRIGHT, M.Sc., F.R.S.E., *Chief Assistant, Craigs House.*

GEORGE COCKERHAM, B.Sc., *Assistant, Huntly Sub-Station.*

ALAN M. M'BAIN, B.Sc., *Assistant, Ainville Sub-Station.*

At the Corstorphine Station the main line of investigation was concerned with the carbohydrate metabolism of healthy and leaf-roll infected potatoes. This work included a study of the efficacy of insect transmission with the aphid *Myzus persicae*. This vector was found to be highly efficient for the transmission of the disease, and complete infection was found with the varieties tested (Arran Victory and President). In the greenhouse the infected plants all gave rise to secondary symptoms.

A study of the carbohydrate formation in healthy and leaf-roll plants showed that in the early stages of the disease the heavy accumulation of starch in the blades of the leaf lead to almost complete suppression of photosynthesis, with the result that a cyclic series of reactions occurred leading to hydrolysis of starch to glucose and conversion of glucose to cane sugar. The cane sugar in turn was converted back to starch. It was found that in healthy plants the sugar translocated to the tubers, *via* the phloem, was cane sugar, whereas in leaf-roll plants the sugar of translocation was glucose. It was also noted that in the diseased plants the phloem had suffered necrosis, and this fact led to the glucose

being translocated slowly to the tubers down through the ground parenchyma of the petiole. A paper giving a full account of this investigation will shortly be published in the 'Transactions' of the Royal Society of Edinburgh.

Field experiments were also carried out on a small scale in an attempt to discover the method and nature of the spread of a wide variety of different types of virus disease (*e.g.*, mosaic, crinkle, streak and leaf-roll). The results of this work will be available this year (1932).

A stock of healthy virus-free tubers of the varieties Arran Victory and President have now been built up, and this year fresh varieties (Arran Pilot, Arran Banner, Great Scot, Majestic and Dunbar Cavalier) are being tested to obtain virus-free units.

During the winter, experiments on Golden Wonder were initiated in an endeavour to see whether it were possible to cure mosaic and crinkle. The tested tubers have now been planted in isolation among swedes.

At the Huntly Sub-Station during the summers of 1930 and 1931 data have been obtained on the relation between virus diseases in parents and the health of the progenies. The seedlings obtained from the selfed seed of plants infected with mosaic, crinkle and "seedling leaf-roll" were examined frequently, and observations were made on vigour and health, the results being compared with those for the progenies of healthy parents. It was established that although a few "degenerate" plants are to be found amongst the seedlings derived from healthy parents, the proportion of "degenerate" plants in seedling progenies derived from parents infected with virus diseases is considerably larger. Three types of "degenerate" seedlings were distinguished—*viz.*: seedlings with coarse, lanceolate and often highly coloured leaves; seedlings with leaves rolled inwards, resembling leaf-roll, and therefore in absence of data on the nature of the rolling described as "seedling leaf-roll"; and seedlings of the "curly dwarf" type, with very small leaves and having a rosette-like appearance. Tubers were only rarely obtained from the above three types of plant. A fourth type of degeneracy in which the margins of the leaves had a marked "wavy" appearance was also observed. The latter type was often only a modification of the normal type of plant, and in some cases the "waviness" disappeared towards the end of the growing

season. No marked effect on the yield was observed in the case of these plants.

The data for the whole range of seedlings—*i.e.*, for the progenies derived from both healthy and diseased parents—showed that in general (1) seed becomes less viable with age; (2) there is an inverse relationship between viability of seed and the number of degenerate seedlings in the progeny; (3) seed from diseased plants is less viable and produces more degenerate seedlings than seed from healthy parents; and (4) the vigour of seedlings derived from diseased plants is considerably less than the vigour of seedlings derived from healthy parents.

Other work on virus diseases has been confined to a study of the mosaic diseases of the potato. Interspecific inoculations of various mosaics were made between seven species of solanaceous plants. With the conditions obtaining at the North of Scotland Sub-Station, Henbane, *Hyoscyamus niger*, was found to be of most value in discriminating between mosaics and also in determining the presence of latent viruses of the mosaic and necrotic types in apparently healthy plants.

Preliminary studies on the physiology of healthy and mosaic-infected plants were continued, and stocks of healthy and mosaic-infected President, Arran Victory and Majestic were raised for the purpose of prosecuting metabolism investigations in 1932.

A preliminary investigation into the nitrogen relations of normal and leaf-roll potatoes was undertaken during the winter. The results demonstrated that the nitrogen metabolism of leaf-roll plants is considerably interfered with, and the data suggested that the nitrogenous constituents of plants are of primary importance when considered in relation to virus diseases.

The principal work carried out at the Ainville Sub-Station was the multiplication of stocks of tubers infected with crinkle and the new virus disease described by Dr R. N. Salaman—paracrinkle—for this year's (1932) investigations. One curious fact emerged from this work. It was found that when tubers of Arran Victory were "core-grafted" with healthy King Edward, a variety which is a carrier of the disease paracrinkle, although the resulting Arran Victory plants appeared to be healthy, yet they matured three to four weeks earlier than

the controls. This work is being repeated this year to see whether this earliness of maturity is transmitted to the tubers, and it has also been extended to other varieties such as an early (Arran Crest) and a late main-crop (President) to test whether they react in the same way as Arran Victory.

II. Publications and Lectures by Staff, for the Year ended 31st March 1932.

PUBLICATIONS (P) AND LECTURES (L).

Director of Research :—

“ The Breeding of Herbage Plants.” Lanark Agricultural Discussion Society, 16th December 1931. (L)

“ Plant Breeding.” (a) Dalkeith Agricultural Society, 14th January 1932 ; (b) Neilston Farmers' Discussion Society, 7th March 1932. (L)

J. W. Gregor, Ph.D., F.L.S., Chief Assistant :—

“ Experimental Delimitation of Species.” *New Phytologist*, Vol. XXX., No. 3, 1931. (P)

“ Growth Forms in Timothy.” Edinburgh University Agricultural Society, 2nd February 1932. (L)

V. E. M'M. Davey, B.Sc., Ph.D., Assistant :—

“ Colour Inheritance in Swedes and Turnips and its bearing on the Identification of Commercial Stocks.” *Scottish Journal of Agriculture*, Vol. XIV., No. 3, July 1931. (P)

“ Inheritance of Colour in *Brassica Napus*.” *Journal of Genetics*, Vol. XXV., No. 2, February 1932. (P)

E. C. Barton-Wright, M.Sc., F.R.S.E., Chief Assistant (Virus Disease Research Scheme) :—

“ Recent Advances in Botany.” J. & A. Churchill, London, 1932. (P)

VISITS.

V. E. M'M. Davey, B.Sc., Ph.D., Assistant :—

Craibstone Experimental Farm. Turnip Trials, November 1931.

E. C. Barton-Wright, M.Sc., F.R.S.E., Chief Assistant (Virus Disease Research Scheme) :—

Virus Disease Conference, Cambridge, July 1931.

Ormskirk Potato Trials, August 1931.

III. Demonstrations.

Several agricultural parties and a number of research workers visited the Station at different periods throughout the year. The visitors were conducted round the experimental plots, and various aspects of the work at the Station were described by members of the staff.

IV. Acknowledgments.

Grateful acknowledgment is made to the undernoted departments, institutes, firms and individuals for gifts of samples or other material for experiment :—

Anderson, Thomas, Esq., Director of the Seed-Testing Station, Corstorphine.

Bell, David, Esq., J.P., 15 Coburg Street, Leith.

Biggar, J. M. R., Esq. (Messrs T. Biggar & Sons), Dalbeattie.

Buza, B., Esq., Warsaw, Poland.

Carter, Messrs James, & Co., Raynes Park, London.

Clausen, Dr J., Carnegie Institute, Stanford University, California, U.S.A.

Elder, James, Esq. (Messrs William Dods & Son), Haddington.

Findlay, W. M., Esq., Marischal College, Aberdeen.

Gams, Dr H., Innsbruck-Hötting, Austria.

Gartons, Ltd., Messrs, Warrington, England.

Hockey, J. F., Esq., B.S.A., Kentville, Nova Scotia.

Inglis, Messrs J. J., & Sons, Alloway Street, Ayr.

Institute of Potato Culture, Malahowka, Korenevo, Moscow.

- Knappe, P. T., Esq., Vec Vale, Juanvale, *via* Valmiera, Latvia.
- Larsen, L. P. M., Esq., Royal Danish Agricultural Society, Copenhagen.
- Levy, E. Bruce, Esq., Department of Agriculture, Palmerston North, New Zealand.
- M'Conkey, Dr O., Ontario Agricultural College, Guelph, Canada.
- M'Gill, J. F., Esq. (Messrs M'Gill & Smith), Kyle Street, Ayr.
- Malzew, Professor A. I., U.S.S.R.
- Marie-Victorin, Professor, University of Montreal, Canada.
- Marsden-Jones, E. M., Esq., F.L.S., Potterne Biological Station, Devizes, Wiltshire.
- Morrison, Dr B. Y., United States Department of Agriculture, Washington.
- Murphy, Professor P. A., Glasnevin, Dublin, Ireland.
- Nissen, Øivind, Esq., Ås, Norway.
- Pardy, A., Esq., College of Agriculture, Aberdeen.
- Pethybridge, Dr G. H., Plant Pathological Laboratory, Harpenden.
- Plant-Breeding Station, Svalof, Sweden.
- Runcieman, William, Esq., Castleton, King Edward.
- Salaman, Dr R. N., Cambridge.
- Sharp, Messrs C., & Co., Sleaford.
- Smith, Dr Kenneth M., Cambridge.
- Turrill, Dr W. B., Royal Botanic Gardens, Kew, Surrey.
- Vavilov, Professor N. I., 44 Herzen Street, Leningrad, U.S.S.R.
- Vilmorin-Andrieux et Cie, Paris.

Thanks are also due to the Director of the Seed-Testing and Plant-Registration Station, Corstorphine, for carrying out laboratory tests on potato seedlings for susceptibility to wart disease; and to members of the staffs of the three Scottish Agricultural Colleges who arranged and supervised the trials of certain of the Society's new varieties of oats.

WILLIAM ROBB,
Director of Research.

LIST OF MEMBERS as at 31st March 1932.

- Alison, John P., D'Arcy, Dalkeith.
 Allison, William, Almond Hill, Kirkliston.
 Arnot, David, Templewood, Edzell.
-
- Baird, Major W. A., Lennoxlove, Haddington.
 Baird, W. J., Deanscroft, Oakham, Rutland.
 Ballantyne, Sir Henry, Monkkrigg, Haddington.
 Barclay, George, Thornhill, Johnstone.
 Barrie, Walter, Sundhope, Selkirk.
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 Corbett, Hon. T. G. P., Rowallan, Kilmarnock.
 Cowan, Alex., Valleyfield, Penicuik.
 Cowper, H. S., Montrose.
 Cowper, John E. B., Gogar House, Corstorphine.

- Crawford, Robert, Drumbeg, Turnberry.
 Crichton, Jas. B., of Luthrie Bank, Cupar.
 Cruickshank, James, Kilmarnock Arms Hotel, Cruden Bay.
 Cunningham, Howard U. (Scottish Agricultural Industries, Ltd.),
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 Cunningham, Thomas (of John G. Cunningham), 26 Murrayfield
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 Currie, William, Greenhill, Deskford, Cullen.
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- Dale, J. R., Auldham, North Berwick.
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 Davidson, Sir Leyburn F. W., Huntly Lodge, Huntly.
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 Drummond, Professor Montagu, Botany Department, The Univer-
 sity, Manchester.
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 Duncan, John, Castlehill, Maybole.
 Duncan, J. Bryce, Newlands, Dumfries.
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 Elder, James H., Cregganore, North Berwick.
 Elder, Thomas, of Stevenson, Haddington.
 Elliot, Captain Thomas, Thirlestane, Lauder.
 Ellis, Charles M., Mains of Moy, Forres.
- Fleming, William, Meinfoot, Ecclefechan.
 Fletcher, Captain Andrew M. Talbot, of Saltoun, Pencaitland.
 Forbes, Alexander, of Rettie, Banff.
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 Gibson, Walter H., Camptoun, Drem.
 Gill, William Hope, Tomich, Invergordon.
 Gilmour, The Right Hon. Sir John, Bart., Montrave, Leven.
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- Gray, James, 74 Osborne Street, Glasgow.
- Gregor, Charles E., Innerwick, Dunbar, East Lothian.
- Gregor, David Clunie, Innerwick, Dunbar, East Lothian.
- Groig, Sir Robert B., Department of Agriculture for Scotland,
Edinburgh.
- Hannah, John M., Girvan Mains, Girvan.
- Harper, Thomas, Charlotte Street, Stranraer.
- Hay, Major J., Belton, Dunbar.
- Henderson, John, Annandale Estate Office, Moffat.
- Herbertson, Robert H., Fans, Earlston.
- Highet, John J. I. (Messrs J. J. Inglis & Sons), Alloway Street,
Ayr.
- Hill, William James, 19 St Vincent Place, Glasgow, C.1.
- Hogg, Thomas (A. Cross Seed Co., Ltd.), 21 Hope Street, Glasgow.
- Hogg, William, Birkenhead, Earlston.
- Home, J. H. Milne, Irvine House, Canonbie.
- Hope, Sir Harry, M.P., Kinnettles, Forfar.
- Hope, William W., Linton Lodge, Prestonkirk.
- Houldsworth, Lieut.-Colonel W. T. R., of Kirkbride, Maybole.
- Howie, Robert, Drumfork Farm, Helensburgh.
- Howie, Robert, The Grange, Kinghorn.
- Hunter-Weston, Sir Aylmer, Hunterston, West Kilbride.
- Hunter, A. Thornton (Alexander Jack & Sons, Ltd.), Maybole.
- Hunter, James Adam, Inchmartine, Inchtute.
- Hutchison, A. (R. Hutchison & Co.), Kirkealdy.
- Hutchison, Lieut.-Colonel R. G. O., D.S.O., M.C., Cunnoquhie,
Ladybank.
- Inch, John (Robert Inch & Son), 46 Timber Bush, Leith.
- Inglis, Wm. (J. Inglis & Sons), Leith.
- Irvine, Charles, sen. (C. Irvine & Sons), 1 Market Place, Jedburgh.
- Jack, Archibald G., Hermiston, Currie.
- Johnston, W. L., Oxnam Neuk, Jedburgh.
- Kay, William, 19 South St David Street, Edinburgh.
- Keith, Major James, Pitmedden, Udney.
- Kerr, H. R. (Forage Supply Co., Ltd.), Springfield Mills, Leith.
- Kerr, T. B. B., 63 Queen Street, Glasgow.
- Laing, Robert Paterson (Thomas Bernard & Co., Ltd.), Seafield,
Leith.
- Laird, W. P. (Laird & Sinclair, Ltd.), 9 Nothergate, Dundee.
- Law, Andrew, Bankrugg, Gifford.
- Law, William, Windyedge, Perthshire.
- Leitch, James Mackessack, Carden and Inchstolly, Alves, Forres.
- Linlithgow, The Marquess of, Hopetoun House, South Queensferry.

Lobnitz, Sir Frederick, K.B.E., Ross Hall, Crookston, near Glasgow.

Low, William, of Balmakewan, Laurencekirk.

Lyburn, R., 8-10 Germiston Street, Glasgow.

M'Alister, A. W., Potato Merchant, Dumfries.

M'Arthur, A. (J. & A. M'Arthur), 204 Hunter Street, Glasgow.

M'Corquodale, A. C., Meddat, Kildary.

M'Dougal, Captain Arthur Robert, Blythe, Lauder.

M'Gill, John F. (M'Gill & Smith, Ltd.), Ayr.

Mackie, Maitland, North Ythsie, Tarves.

M'Laren, J. T., 7 Park Place, Stirling.

Maclennan, George, 34 North Bridge, Edinburgh.

Maclennan, George, Redheugh, Gorebridge.

M'Nab, J. B., Newtonmill, Brechin.

Macpherson, D. J. R., B.Sc. (Scottish Agricultural Industries, Ltd.), 19 Hope Street, Glasgow, C.2.

Marshall, H. B., Rachan, Broughton.

Marshall, Robert C., Burntshields, Kilbarchan.

Mather, Charters J. (Laing & Mather), Kelso.

Mather, Matthew, Silverknowes, Davidson's Mains.

Meiklejohn, John A., 86 St Vincent Street, Glasgow, C.2.

Menzies, Ian C., W.S., 22 Rutland Street, Edinburgh.

Menzies, J. C. (Scottish Agricultural Industries, Ltd.), Council Chambers, Charlotte Street, Leith.

Mercer, George G., Southfield, Dalkeith.

Miller, Hugh, West Fortune, Drem.

Miller, Jas. W., Lochhead Farm, East Wemyss (*last known address*).

Miller, Robert, Ferrygate, Dirleton.

Mills, Fred (Messrs Roughead & Park, Ltd.), Haddington.

Milne, Frank G., Southesk Granaries, Montrose.

Mitchell, Lieut.-Colonel A., Tulliallan, Kincardine, Fife.

Mitchell, James, B.Sc., East Craigs, Corstorphine.

Montgomerie, A. W., Lessnessock, Ochiltree.

Montgomery, Andrew Mitchell, Netherhall, Castle Douglas.

Morrison, John A., West Fenton, Drem.

Motherwell, Andrew (A. Motherwell, Ltd.), Gorbals, Glasgow.

Muir, Sir A. Kay, Bart., of Blair Drummond, Perthshire.

Munro, Henry, 36 Tay Street, Perth.

Munro, James, Crook, Bilbster, Wick.

Murdoch, Alexander, East Hallside, Hallside, Glasgow.

Murray, James C. (Lothian Coal Co., Ltd.), Newbattle Collieries, Newtongrange.

Murray, T. P. D., Dryburgh, Dundee.

Nagel, F. J. (Peter Lawson & Sons, Ltd.), 1A George IV. Bridge, Edinburgh.

Nelson, Alexander, Ph.D., Royal Botanic Garden, Edinburgh.

Nelson, John M., Pleasants, Dunbar.

Novar, Right Hon. Viscount, of Raith and Novar, K.T., Raith, Kirkealdy.

- Paterson, Principal William G. R., West of Scotland Agricultural College, Glasgow.
- Paton, James, Kirkness, Glencairg.
- Pattullo, I. N., Langlogie, Meigle.
- Paul, Andrew (Paul & Weir), 14-16 Caithness Street, Garscube, Glasgow.
- Pollok, Mrs Gladys, Ronachan, Clachan.
- Rae, W. A., Douglasfield, Murthly, Perth.
- Ramsay, Charles, High Drummorie, Drummorie.
- Ratray, Colonel P. Burn Clerk, C.B.E., Craighall Ratray, Blairgowrie.
- Reid, A. T., Auchterarder House, Auchterarder.
- Reid, W. J., Bridge of Dun, Montrose.
- Reynard, James N., Manuel House, Linlithgow.
- Riddell, John (Andrew Riddell & Co.), 5 Grassmarket, Edinburgh.
- Robertson, A., 125 Willowbrae Road, Edinburgh.
- Robertson, John, Drumnagair, Laurencekirk.
- Robertson, Peter D., of Castlecraig, Nigg.
- Robertson, Wilson Mathieson, Saughton Mains, Corstorphine.
- Sanderson, Charles William, Birnieknowes, Cockburnspath.
- Scarlett, James W., Sweethope, Inveresk, Musselburgh.
- Scott, D., Ferneyhill, Kelso.
- Scott, James, Fearn, Ross-shire.
- Shearer, A. (Macfarlan, Shearer & Co.), Greenock.
- Shearer, Professor Ernest, The University, Edinburgh.
- Shields, Mrs E. H., The Farm, Longniddry.
- Shields, G. Bertram, Rosebery Farm, Gorebridge.
- Simpson, Major J., Glencarse.
- Simpson, Mark F., Duddingston Farm, Portobello.
- Simpson, R. C., Renton Hall, Haddington.
- Simpson, Robert G., Monktonhall, Musselburgh.
- Simpson, William D., Highfield, North Berwick.
- Smith, Mrs Ida F., Whitechester, Duns.
- Smith, Professor Sir William Wright, Inverleith House, Arboretum Road, Edinburgh.
- Speirs, A. A. Hagart, of Elderslie, Houston House, Houston.
- Stanhope, John M. Spencer, of Glenure, Argyllshire.
- Stevens, Alexander B., Queenstonbank, Dirliton.
- Stevenson, A. Harvey, Saltcoats, Gullane.
- Stevenson, Allan, Luffness Mains, Aberlady.
- Stewart, Sir Hugh Shaw, Bart., Ardgowan, Inverkip.
- Stirling, Hugh B., Allanbank, Edrom.
- Stirling, Captain John, of Fairburn, Muir of Ord.
- Stodart, Charles, Leaston, Humbie.
- Stodart, Colonel Thomas, C.I.E., I.M.S., Kingstoun, North Berwick.
- Tait, Charles William (J. & W. Tait), Kirkwall.
- Taylor, J. P. Ross-, Mungoswalls, Duns.
- Thom, A. S. (T. Imrie & Sons), Ayr.

- Thomson, John (Thomson Bros.), 106 Taylor Street, Glasgow.
 Thomson, Moffat S., of Lambden, Greenlaw.
 Thomson, T. (J. Donaldson & Co.), 24 St Giles Street, Edinburgh.
 Thorburn, M. G., Glenormiston, Innerleithen.
 Tullis, R., Strathenny, Leslie.
 Tweedie, R. W., Phantassie, Prestonkirk.
- Usher, Sir Robert, Bart., Wells, Hawick.
- Wallace, Falconer L., of Candacraig and Balcairn, Strathdon.
 Wallace, Sir Matthew G., Terreglestown, Dumfries.
 Watson, Professor J. A. S., School of Rural Economy, Oxford.
 Whitburgh, Lord, Whitburgh, Ford.
 Willison, Douglas, Acharn, Killin.
 Wilson, Emma, Lady, Kippen House, Dunning.
 Wright, William J., The Heugh, North Berwick.
 Wyllie, J. G. C. (Dan Wyllie & Co.), 197 High Street, Ayr.
 Wyllie, James (James Wyllie & Sons), Corn Exchange, Dumfries.
- Younger, H. G. (W. Younger & Co., Ltd.), Abbey Breweries,
 Edinburgh.
- Young, James G., Cadboll, Fearn.