

1920

SCOTTISH SOCIETY FOR RESEARCH IN  
PLANT-BREEDING.

REPORT.

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IN submitting the seventh Annual Report to the Members of the Scottish Society for Research in Plant-Breeding, the Directors have pleasure in recording that the results of the work carried out during the year show that satisfactory progress is being made in the various investigations that are being undertaken.

As an indication of this progress, particularly towards practical ends, it may be mentioned that a new variety of oat—amongst the first of those raised at the Scottish Plant-Breeding Station—was included in several field-trials in the North of Scotland in 1927, and, judging by the results, there is reason to believe it will be a most useful type, especially for late districts.

It is also worthy of note that certain strains of grasses have now reached a stage when it will soon be possible to compare them in field-trials.

The problems that are being studied, and the progress

made with the investigations of these during the year, are reviewed in the Report by the Director of Research, which appears on pages 13 to 32 hereof.

### **Financial.**

The audited accounts for the year ended 31st March 1928 show that, as a result of the year's working, there is very little change in the state of the Society's finances. The funds at the end of the year show an increase of over £640. This increase is entirely due to a sum of £1120 having been received in March 1928 from the Development Commissioners, through the Board of Agriculture for Scotland, as a grant towards maintenance expenditure for the year ending 31st March 1928. In previous years the annual grant with respect to the work of the Society was generally received in the financial year succeeding that to which it applied. It is understood that in future it will be possible to obtain from the Board of Agriculture for Scotland payments of the grant to account, during the year to which the grant applies. This arrangement will be more advantageous to the Society, and will help to obviate the necessity, which occasionally arose in the past, for temporarily using invested funds to meet payments for maintenance expenditure.

The basis on which grants from Government Funds will now be received by the Society has been revised by the Treasury. Under the new scheme two-thirds of the maintenance expenditure of the Society, excluding income tax (which is recoverable) and depreciation, will rank for a grant up to a certain limit fixed by the Board of Agriculture for Scotland. In calculating the amount of grant payable each year, however, half of the Society's income from in-

vestments will be deducted as representing interest upon the £22,500 received from Government sources when the Society was instituted in 1921. On the basis of the year's expenditure, this arrangement in effect works out so that a sum of about one-third of the net annual maintenance expenditure will be received from Government sources. For every £1 the Society spends on maintenance it requires to find 6s. 8d. itself from its "independent" income (*i.e.*, income from funds received from private sources and from subscriptions and donations), or, if that is inadequate, from its capital funds. The total "independent" net income of the Society (at present approximately £1100) is not high enough to permit of the total possible grant being earned, without drawing upon the Society's capital funds. Any diminution of the Society's capital is greatly to be deprecated.

The amounts received or spent in the various accounts approximate fairly closely to those of the previous year. On the income side of the abstract of accounts the amount received for interest shows a slight decrease, which is chiefly due to lesser sums having been on temporary loan and on deposit receipt. The increase in total ordinary income is due, as explained above, to the greater part of the grant for the year ended 31st March 1928 having been received in that year instead of in the succeeding year. On the expenditure side the total ordinary expenditure is higher than that of the previous year by about £135 only. The increased amount for officers' salaries is due to several increases granted to assistants, and the employment of temporary assistants. The chief assistant's salary was increased from £337 to £430, which sum includes Civil Service cost-of-living bonus. The assistant in charge of Root crops at Craigs House received an increase of £25, according to scale. The increase in the

expenses at Ainville is due to the normal expansion of the work and to the increase of £25, according to scale, to the assistant in charge there. Considerable decreases in the expenditure are shown under Labour and Working Expenses. The item for Capital Expenditure is for an addition to the storage accommodation, which was very necessary for the implements and tools at the Plant-Breeding Station.

#### **“Dr Wilson” Memorial Fund.**

This fund now amounts to £241, 5s., showing an increase of £10 for the year. A scheme for the award of prizes of twenty guineas each, out of the proceeds of the fund, was drawn up and approved by the Directors. A prize of twenty guineas was advertised in several Scottish newspapers in August 1927, but no applications were received in response to the advertisement. The money which was available has, therefore, been retained for the time being.

#### **Membership.**

The Society consists of 100 life members and 86 annual members (22 at the 10s. rate and 64 at the £1 rate). One life member and 3 annual members were enrolled during the year, 3 members died, and 4 members resigned. A list of members appears on pp. 33-36 hereof.

Donors of £20 or over (including donations to the Preliminary Fund) are, on application, entitled to become life members 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.

### Election of Directors.

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

WILLIAM CUTHBERTSON, V.M.H. (Messrs Dobbie & Co., Ltd.),  
Edinburgh.

Sir J. INGLIS DAVIDSON, Saughton Mains, Corstorphine.

J. M. HANNAH, Girvan Mains, Girvan.

GEORGE G. MERCER, J.P., Southfield, Dalkeith.

G. B. SHIELDS, Dolphingstone, Tranent.

Sir DAVID WILSON of Carbeth, Bart., D.Sc., Killearn.

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

JAMES CRUICKSHANK, Kilmarnock Arms, Cruden Bay.

JAMES W. DRUMMOND (Messrs W. Drummond & Sons, Ltd.), Stirling.

CHARLES E. GREGOR, Innerwick, East Lothian.

J. T. M'LAREN, The Leuchold, Dalmeny.

ROBERT MILLER, Ferrygate, North Berwick.

JAMES PATON, Kirkness, Glencraig, Fife.

JOHN STIRTON,

*Secretary.*

[ABSTRACT OF ACCOUNTS

## ABSTRACT OF

For year ended

| <i>INCOME.</i>   |              |
|--|--------------|
| Subscriptions—   |              |
| Annual   | £70 10 0     |
| <i>Note.</i> —Annual Subscriptions amounting to £14 are in arrear.   |              |
| Donations  | 18 3 3       |
| Interests  | 1,859 4 6    |
| Rents  | 15 0 0       |
| Income Tax Recovered   | 235 10 10    |
| Sale of Produce and Stock on Hand  | 291 14 5½    |
| Total Ordinary Income  | £2,490 3 0½  |
| Grant from Board of Agriculture—for year ended 31st March 1927   | £689 13 3    |
| Grant on Account from Board of Agriculture (including Ainville Sub-Station)—for year ended 31st March 1928 | 1,120 0 0    |
| Total Extraordinary Income   | 1,809 13 3   |
| Total Income   | £4,299 16 3½ |
| Funds at 1st April 1927—   | 43,283 11 11 |

£47,583 8 2½

## ACCOUNTS.

31st March 1928.

| <i>EXPENDITURE.</i>  |                     |
|--|---------------------|
| Salaries—  |                     |
| Officers   | £1,539 14 2         |
| Secretary and Office   | 198 0 0             |
|  | <u>£1,737 14 2</u>  |
| Labour   | 610 0 1½            |
| National Health and Unemployment Insurances                  | 16 2 0              |
| Seeds and Roots  | 18 18 1             |
| Manures  | 118 15 1            |
| Working Expenses, including renewals of Implements and Tools | 144 2 6½            |
| Laboratory Expenses  | 34 10 2½            |
| Library Expenses   | 38 11 6             |
| Rates, Taxes, and Insurances                                 | 280 10 4            |
| Office Expenses  | 111 9 3             |
| Heating, Lighting, and Cleaning                              | 31 10 5             |
| Travelling Expenses  | 41 17 5             |
| Property Repairs   | 83 8 4½             |
| Advertising  | 3 0 6               |
| Expenses in connection with Stall at Highland Show (1927)    | 12 0 4              |
| Depreciation on Implements, Tools, Furniture, &c.            | 66 15 3             |
| Ainville Sub-Station Expenses, including Salary              | 304 19 11½          |
| Total Ordinary Expenditure                                   | £3,654 5 6½         |
| Capital Expenditure—   |                     |
| Houses and Lands   | £49 16 3            |
| Laboratory Apparatus   | 7 0 0               |
| Manures for Crop 1928  | 74 15 11            |
| Total Capital Expenditure                                    | <u>£131 12 2</u>    |
| Funds at 31st March 1928, per Balance-sheet                  | 43,929 2 8          |
|  | <u>£47,583 8 2½</u> |

## BALANCE-

As at 31st

## LIABILITIES.

|  |            |
|--|------------|
| I. Accounts Outstanding . . . . .      | £361 8 11  |
| II. Funds at 31st March 1928 . . . . . | 43,929 2 8 |

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£44,290 11 7

DR WILSON

|                                    |          |
|------------------------------------|----------|
| Funds at 31st March 1928 . . . . . | £241 5 0 |
|------------------------------------|----------|

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£241 5 0

EDINBURGH, 19th May 1928.—The undersigned, having had access to all the Accounts, and verified the same with the Accounts and Vouchers relating thereto, now  
16 ALVA STREET.

## SHEET.

March 1928.

## ASSETS.

|   |             |
|---|-------------|
| I. Houses and Lands (at Cost) . . . . . | £7,901 15 3 |
| II. Implements and Tools . . . . .      | 765 17 9    |
| III. Laboratory Apparatus . . . . .     | 169 19 3    |
| IV. Office Fittings . . . . .           | 92 11 2     |
| V. Stocks on Hand . . . . .             | 178 2 0     |
| VI. Accounts Outstanding . . . . .      | 38 6 6      |

## VII. Investments at Cost :—

|                              |   |             |            |
|------------------------------|---|-------------|------------|
| Value at<br>31st March 1928. |   |             |            |
| £14,332 10 0                 | 1. £14,000 5 per cent War Stock,<br>1929-47 . . . . .     | £12,390 0 0 |            |
| 12,442 10 0                  | 2. £14,000 4 per cent Funding<br>Stock, 1960-90 . . . . . | 10,045 0 0  |            |
| 13,055 5 0                   | 3. £16,900 3½ per cent Conversion<br>Stock . . . . .      | 11,140 3 6  |            |
| 300 0 0                      | 4. £300 Edinburgh Corporation<br>Loan . . . . .           | 300 0 0     |            |
| £40,130 5 0                  |   |             | 33,875 3 6 |

|   |         |
|---|---------|
| VIII. Equipment at Ainville Sub-Station . . . . . | 183 7 6 |
|---|---------|

## IX. Cash Balances—

|                              |           |
|------------------------------|-----------|
| In Bank—                     |           |
| On Current Account . . . . . | £335 8 2  |
| On Deposit Receipt . . . . . | 750 0 0   |
| On Hand . . . . .            | 0 0 6     |
|                              | 1,085 8 8 |

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£44,290 11 7

## MEMORIAL FUND.

|                              |   |          |
|------------------------------|---|----------|
| Value at<br>31st March 1928. |   |          |
| £204 15 0                    | £200 5 per cent War Stock, 1929-47—valued at date of transfer | £176 5 0 |
|                              | Interest to date . . . . .                                    | 65 0 0   |
|                              |   | £241 5 0 |

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

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

31st March 1928.

**ANALYSIS OF MEMBERS.**

|                         |    |                             |            |
|-------------------------|----|-----------------------------|------------|
| Aberdeen . . . . .      | 5  | Lanark. . . . .             | 16         |
| Argyll . . . . .        | 3  | Linlithgow . . . . .        | 3          |
| Ayr . . . . .           | 18 | Mid-Lothian . . . . .       | 26         |
| Banff . . . . .         | 1  | Moray . . . . .             | 1          |
| Berwick . . . . .       | 11 | Nairn . . . . .             | ..         |
| Bute . . . . .          | .. | Orkney . . . . .            | 2          |
| Caithness . . . . .     | 1  | Peebles . . . . .           | 3          |
| Clackmannan . . . . .   | .. | Perth . . . . .             | 14         |
| Dumbarton . . . . .     | 2  | Renfrew . . . . .           | 5          |
| Dumfries . . . . .      | 9  | Ross and Cromarty . . . . . | 6          |
| East Lothian . . . . .  | 25 | Roxburgh . . . . .          | 4          |
| Fife . . . . .          | 10 | Selkirk . . . . .           | ..         |
| Forfar . . . . .        | 7  | Stirling . . . . .          | 2          |
| Inverness . . . . .     | .. | Sutherland . . . . .        | 1          |
| Kincardine . . . . .    | 1  | Wigtown . . . . .           | 1          |
| Kinross . . . . .       | 1  | England . . . . .           | 1          |
| Kirkcudbright . . . . . | 7  |                             |            |
|                         |    |                             | <u>186</u> |



## ESTABLISHMENT FOR 1927-28.

## BOARD OF DIRECTORS.

*Trustees.*

THE RIGHT HON. SIR JOHN GILMOUR, Bart., D.S.O., M.P., Secretary of State for Scotland.  
 JAMES ELDER, Athelstaneford Mains, Drem.  
 DAVID BELL, 15 Coburg Street, Leith.  
 JOHN FINLAYSON M'GILL, 69 Kyle Street, Ayr.

*Ordinary Directors.*

## 1925.

WILLIAM CUTHBERTSON, V.M.H. (Messrs Dobbie & Co., Ltd.), Edinburgh.  
 Sir J. INGLIS DAVIDSON, Saughton Mains, Corstorphine.  
 J. M. HANNAH, Girvan Mains, Girvan.  
 GEORGE G. MERCER, J.P., Southfield, Dalkeith.  
 G. B. SHIELDS, Dolphingstone, Tranent.  
 Sir DAVID WILSON of Carbeth, Bart., D.Sc., Killearn.

## 1926.

D. L. BOWE (Messrs J. H. Bowe & Sons), Dunbar.  
 Professor MONTAGU DRUMMOND, Botany Department, University, Glasgow.  
 JOHN GIBB, Gladstone, Bishopton.

J. H. MILNE HOME, Irvine House, Canonbie.  
 WILLIAM INGLIS (Messrs John Inglis & Sons, Ltd.), Granton House, Edinburgh.  
 Principal W. G. R. PATERSON, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow.

## 1927.

JAMES HISLOP ELDER, B.Sc., Athelstaneford Mains, Drem.  
 THOMAS HOGG (Messrs Alex. Cross & Sons), 19 Hope Street, Glasgow.  
 Major JAMES KEITH, Pitmedden, Udry.  
 Captain A. R. M'DOUGAL, Blythe, Lauder.  
 Professor ERNEST SHEARER, Agriculture Department, The University, Edinburgh.  
 Professor WILLIAM WRIGHT SMITH, Inverleith House, Arboretum Road, Edinburgh.

*Directors Co-opted.*

JAMES CRUICKSHANK, Kilmarnock Arms, Cruden Bay.  
 JAMES W. DRUMMOND (Messrs W. Drummond & Sons, Ltd.), Stirling.  
 ROBERT MILLER, Ferrygate, North Berwick.

*Directors nominated by the Board of Agriculture.*

|                                   |   |
|-----------------------------------|---|
| Sir ROBERT B. GREIG, M.C., LL.D., | } York Buildings, Queen Street,<br>Edinburgh. |
| JAMES WOOD, O.B.E., M.A., B.Sc.,  |   |
| T. ANDERSON, M.A., B.Sc.,         |   |
| ALEXANDER M'CALLUM, M.A., LL.B.,  |   |

*Chairman of Directors*—JAMES ELDER, Athelstaneford Mains, Drem.

*Vice-Chairman*—DAVID BELL, 15 Coburg Street, Leith.

*Director of Research*—WILLIAM ROBB, N.D.A., Craigs House, Corstorphine.

*Chief Assistant*—JAMES W. GREGOR, Ph.D., Craigs House, Corstorphine.

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

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

*Secretary*—JOHN STIRTON, 3 George IV. Bridge, Edinburgh.

## COMMITTEES.

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### RESEARCH.

G. Bertram Shields, *Convener*.  
 T. Anderson.  
 James Cruickshank.  
 William Cuthbertson.  
 J. W. Drummond.  
 Professor M. Drummond.  
 James H. Elder, B.Sc.  
 John Gibb.  
 Sir Robert B. Greig.  
 John M. Hannah.

Thomas Hogg.  
 Major James Keith.  
 Capt. A. R. M'Dougal.  
 J. F. M'Gill.  
 Principal W. G. R. Paterson.  
 Professor Ernest Shearer.  
 Professor W. Wright Smith.  
 Sir David Wilson, Bart.  
 James Elder, *Chairman, ex officio*.  
 David Bell, *Vice-Chairman, ex officio*.

### MANAGEMENT.

David Bell, *Convener*.  
 D. L. Bowe.  
 James Cruickshank.  
 Sir J. Inglis Davidson.  
 J. H. Milne Home.  
 William Inglis.  
 Major James Keith.

G. G. Mercer.  
 Robert Miller.  
 Professor Ernest Shearer.  
 G. Bertram Shields.  
 James Wood.  
 James Elder, *Chairman, ex officio*.

### FINANCE.

J. H. Milne Home, *Convener*.  
 David Bell.  
 John M. Hannah.  
 Thomas Hogg.  
 Alex. M'Callum.  
 G. G. Mercer.

Robert Miller.  
 G. Bertram Shields.  
 Sir David Wilson, Bart.  
 James Elder, *Chairman, ex officio*.  
 David Bell, *Vice-Chairman, ex officio*.

# R E P O R T

BY

## DIRECTOR OF RESEARCH.

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### 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 work at the Station is directed chiefly towards practical ends, but it should be noted, however, that a certain amount of attention has to be given to problems not of immediate practical importance.

“ 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 Plants (Perennial Ryegrass, Cocksfoot, and Timothy), and Swedes.

#### A. CEREALS.

##### *Oats.*

The problems remain unchanged and the methods of breeding are now more or less standardised. The progress made

during the year towards solving the problems on hand is indicated in the following paragraphs.

*Hybridisation.*—For the purpose of obtaining additional hybrid material, several varieties of oats, named and unnamed, were cross-pollinated by hand. The weather during the summer was unfavourable for obtaining hybrid grains, but in comparison with the results obtained in more favourable seasons, a fair proportion of the cross-pollinated florets set seed. Some of the hybrid grains have as one of their parents a very early-ripening variety, a few others have a stiff-strawed unnamed variety which has been raised at the Plant-Breeding Station. This unnamed variety may, in some districts, be rather late in ripening, and it has therefore been hybridised to obtain, if possible, an earlier ripening form which will also be stiff-strawed. The black-grained variety, Orion, and several other early-ripening varieties, have been used during the last few years as parents, and some promising hybrid plants have been obtained.

*Pedigree Cultures.*—Of the first generation hybrid grains secured in 1926, fourteen were sown in 1927. As in previous years the plants were grown under glass, as a precaution against damage by vermin.

All the grain produced by eight first generation hybrid plants in 1926 was sown in order to obtain as large a second generation of hybrid progenies as possible for comparison and selection. The individual plants of two different hybrids in the second generation—Beseler's Prolific  $\times$  Orion and Dala  $\times$  Douglas Haig—were compared in order to discover whether there was any difference between the progenies of the earlier and the later formed grains of each panicle of the first generation plants. The data obtained did not reveal that any hereditary difference existed. All the plants of each of the progenies of the undernoted hybrids, all in the second generation, were examined individually and classified for certain characteristics: Castleton Potato  $\times$  Yelder, No. 139  $\times$  Bathurst, Dala  $\times$  Victory, Dala  $\times$  Yelder, Victory  $\times$  Bathurst. Many plants from these hybrids have been retained for further breeding, and they represent a wide range of types.

From the second generation hybrid progenies grown in 1926 grain from about 200 plants was sown in 1927. In three of the hybrids—viz.: Castleton Potato  $\times$  Orion,



FIG 1.

Side view of a rod-row of one of the stiff-strawed hybrids in 1927, photographed shortly before it was harvested. Length of straw was about 3 feet 6 inches to 4 feet.



FIG 2.

End view of several rod-rows in 1927, showing stiff-strawed hybrids beside weaker strawed varieties which had become laid.

Orion × Sandy, Beseler's Prolific × Orion, the colour of the grain of every plant was noted, also its glabrous or pubescent nature for the purpose of obtaining data regarding the inheritance of these characters. In the Orion-Sandy hybrid all the plants in over 90 different selections were examined. In the second generation plants of this hybrid, certain types occurred very infrequently. Only one white-grained plant appeared in 276 plants of the second generation. This result is not only of interest genetically, but also emphasises the importance of having a large second generation of plants for selection. A large third generation progeny was grown in 1927 to verify the classification of the second generation parent plants. When examining the third generation plants certain types were set aside for breeding, preference being given to early-ripening white-grained plants.

Of the hybrid progenies in various generations beyond that of the third, grain from over 130 single-plant selections was sown. Some promising types have been obtained from the following hybrids: Victory × Black Mesdag, Potato × Record, Tam Finlay × Beardless Propsteier, Record × Tam Finlay, No. 80 × Orion, Sandy × Storm King, Sandy × Victory. A few of the selections from these hybrids appeared to be breeding true to type, and these will be multiplied in 1928 for the initial comparative trials later.

*Trials of New Varieties.*—Samples of the hybrids which were apparently breeding true to type were included in various trials at the Plant-Breeding Station and at other centres.

Nine selections were sent to the Plant Registration Station, Corstorphine, for preliminary trials there.

Ten selections were grown in rod-rows at the Plant-Breeding Station and compared with standard named varieties. Some of these selections compared very favourably with the control varieties—Potato, Victory, and Sandy—in yield of grain and strength of straw. (See illustrations on page 15 hereof.)

The most promising selections, twenty in all, from the previous year's rod-row trials, were compared with standard varieties in small field-plots. The size of each plot was  $\frac{1}{4} \times \frac{1}{6}$  acre, and each selection was repeated three times if there was grain available. The yield of grain from each plot was determined, but on account of the abnormally wet season

in 1927 the figures obtained for the yield of grain were not regarded as reliable. More accurate comparisons of strength of straw and of period of ripening could be made, however, and the selections in which these characteristics were not satisfactory were discarded without further trial. The majority of the selections grown in  $\frac{1}{4}$ -acre plots in 1927 will be tried again in 1928. In multiplying a variety beyond the rod-row stage, the trial-plots and the multiplication plot of the variety are kept separate. This method tends to ensure greater purity of stocks than when small replicate trial-plots are used also for multiplication.

The methods adopted for comparing and multiplying new varieties at the Station were outlined in the previous report. They were employed with satisfactory results in last year's experiments.

*Locality Trials.*—A few "locality" trials were carried out in 1927. Arrangements were made with Aberdeen and the North of Scotland Agricultural College to have a new variety—the first of those raised at and sent out from the Plant-Breeding Station for trial—tried on a field-scale at five farms in the North of Scotland. This new variety was raised from a hybrid between the varieties Sandy and Leader. It bears more resemblance to Sandy than to its other parent. On this account it was desired to have it compared in districts where the old-established and hardy variety—*i.e.*, Sandy, is still largely grown. In comparison with Sandy this new variety ripens earlier, the straw is stiffer, and the grain is larger. Reports on the trials were kindly furnished by the County Organisers of the North of Scotland Agricultural College, in whose districts the trials were made. The reports of the trials are, on the whole, favourable, this variety being distinguished by its early-ripening quality and the stiffness of its straw. The following extracts, taken from two of the reports, may suffice to indicate the important characteristics of the variety:—

(1) "The varieties—Victory, Potato, and Sandy—were all badly laid before the grain began to fill, and the grain in these varieties was of inferior quality, as seen from bushel weight—Victory, 36 lb.; Potato, 35 lb.; Sandy, 37 lb.; Hybrid, 39 lb.

"The hybrid variety appears to have a stiff straw which

resists bad weather conditions well. This, combined with its early ripening, makes it a useful variety for high-lying late districts."

(2) "The Aa605 variety appeared on 'brairding' to be on the thin side. It, however, improved as the season advanced, and produced quite a good crop at harvest time. It stood very well throughout the season until just before cutting, when the stormy weather caused a little of it to go down. It could all have been cut with the binder. It was a shade earlier, if anything, than Castleton Potato. The farmer's own 'Potato' adjoining was very much laid.

"There was a considerable amount of Wild White Clover in the grass seed of the previous crops."

Arrangements have been made with each of the three Agricultural Colleges in Scotland to have five new selections of oats, including the one tried in the North of Scotland in 1927, tried in different districts in each of the respective College areas in 1928.

*Museum.*—The collection of named varieties was increased by the addition of over twenty varieties—mainly of foreign origin. Small samples of most of the named varieties grown at the Station are available for exchange.

## B. POTATOES.

### *Assistants in Charge—*

J. W. GREGOR, Ph.D. (Plant-Breeding Station).

WILLIAM BLACK, B.Sc. (Ainville Sub-Station).

The work with potatoes included investigations into (a) the heredity of several characters, (b) the effects of selfing on the production of "relatively" pure-breeding parent varieties, (c) the maintenance of healthy stocks of seedlings, (d) the relative merits of various pairs of varieties as parents for producing new immune varieties, and (e) the relative agronomic value of the more promising types of seedlings that are raised in the experiments.

The investigations are being conducted, as in the previous year, at two centres. Comparisons of the probable economic



value of the more promising seedlings are made chiefly at the Plant-Breeding Station, Corstorphine, but all the other investigations are being carried out at the Sub-Station at Ainville Farm, Kirknewton.

*Heredity.*—The results obtained by breeding from various varieties have indicated that attention should be directed to the raising of seedling potatoes only from healthy plants, if possible. With this object in view twenty-three named varieties, apparently free from virus diseases, were obtained in 1927 from Mr W. M. Findlay of the North of Scotland Agricultural College, Aberdeen. These varieties, with one exception, were apparently quite healthy when grown in 1927, no symptom of virus disease being apparent to the naked eye. Only healthy plants of named varieties and a few healthy seedlings were selfed or hand-pollinated, and precautions were taken to prevent accidental cross-pollination. Berries were obtained from many of the self- and cross-pollinated flowers.

Among the varieties selfed were Flourball, Shamrock, and Templar, and of those crossed the following may be mentioned: Abundance  $\times$  Flourball, Epicure  $\times$  Flourball, Majestic  $\times$  Shamrock, King Edward VII.  $\times$  39(15), Kerr's Pink  $\times$  966(b)(4), British Queen  $\times$  64(2), Up-to-Date  $\times$  98(23) (the latter parent is an Up-to-Date  $\times$  Majestic seedling), and Witchhill  $\times$  121(5). 121(5) is from a cross between Witchhill and an immune Ashleaf seedling.

In seven families of seedlings all the individual plants were grown. Each family consisted of at least fifty plants, and in one family 200 plants were grown. A comparative study was made of several botanical characters of each plant for the purpose of obtaining data regarding the inheritance of these characters. While a considerable proportion of the seedlings was obviously of no economic value, a part of the remainder showed distinct promise, and these have been retained for further trial and observation.

*Selfing.*—The experiments designed for the purpose of studying the effects of selfing potato plants through a series of generations were successfully continued. The method of procedure is the continued self-fertilisation of various types of seedlings until each breeds relatively true to type. In choosing plants for selfing, preference is given to those types which appear to be of economic value. Several seedlings

are now in the second selfed generation. None of these is as yet breeding true. This stage can scarcely be expected to be reached in two generations, when it is recognised that the genetic constitution of cultivated varieties of potato generally is complex. From the results observed no evidence has been obtained of reduction in vigour of selfed seedlings, and several plants possessing a high degree of self-fertility have been obtained. An increase in the number of self-fertile plants is in accordance with expectation and in agreement with the theory that by repeated selfing, self-sterility will be bred out. Among cultivated varieties there is not a wide range of types that can be utilised as male parents. This is an obstacle to progress in breeding, and makes it necessary to increase the number of suitable male parents.

*Crossing.*—Along with the investigations described above, a certain amount of breeding was carried out on a more or less empirical basis, mainly to find how certain pairs of varieties performed as parents for the production of varieties immune from wart disease and possessing characteristics of economic value. For this work over 750 seedlings were grown representing 17 different crosses. These seedlings were compared solely with reference to their probable commercial value, and any seedlings possessing undesirable characteristics were discarded; the remainder were retained for further trial. Each selection was divided into two groups, one group for trial at Corstorphine and the other for trial at the Sub-Station. From crosses between Great Scott and Bell, Kerr's Pink and Bell, Up-to-Date and Bell, and Bishop and No. 800(2), some promising plants were produced. Those that were immune from wart disease have been retained for further multiplication and trial. In 1928 about 650 selections (200 from "crosses" and 450 from "selfs") will be grown for observation and comparison.

*Virus Diseases.*—The reason for changing the locality in which the seedling potatoes are raised was to discover whether healthy stocks of seedlings could be maintained in a district where there was less risk of infection from virus diseases than was found to prevail at Corstorphine. So far as infection from virus diseases is concerned, there is reason to believe that much healthier stocks can be maintained at the Sub-Station than at Corstorphine. Young seedlings showing symptoms of virus diseases have appeared at the Sub-Station,

but so far there seems to have been very little, if any, spread of virus disease from plant to plant. In a family of seedlings in 1926 40 per cent of the plants were affected with leaf-roll, and the remaining 60 per cent were healthy. These healthy plants were grown again in 1927, but no symptom of virus disease appeared in any of the plants. In view of the possibility of virus disease being present in a latent condition in the plants, shoots from healthy "Arran Victory" plants were successfully grafted on a few of the seedlings, but no signs of virus diseases were thereby disclosed.

The progenies of the seedlings raised at the Sub-Station were again grown at the Plant-Breeding Station, Corstorphine, and these were almost all healthy and vigorous.

As in previous years, small and apparently "degenerate" plants occurred among the seedlings in the early stages of growth before any of the seedlings had been transferred from the greenhouse, which was kept free of greenfly by fumigation. These, and also a small proportion of degenerate seedlings that appeared later, were discarded when symptoms of virus disease became apparent.

*Wart Disease Immunity Trials.*—As in previous years, seedlings were submitted to the Board of Agriculture for Scotland for inclusion in these trials for immunity from wart disease. In certain families of seedlings a tuber from each plant was submitted for trial to obtain a count of the proportion of susceptible plants that occurred in each of the groups. In other families, tubers from only the most promising commercial plants were tested for the purpose of having the susceptible varieties discarded before they reached the field-trial stage.

*Comparative Trials of Seedlings.*—As already indicated, these trials of the seedlings are made mainly at the Plant-Breeding Station, Corstorphine. While a seedling is being tested at Corstorphine, a small duplicate stock of the same selection is grown at the Sub-Station at Ainville to provide healthy seed, if required, for future trials.

Over four hundred selections were included in the trials. Comparisons of the seedlings were made with reference to habit of growth, yield, date of maturity, and disease resistance. The seedlings comprised a wide range of types, and included early-ripening and late-ripening varieties. It was gratifying to observe that the seedlings raised at Ainville in 1926 were

markedly free from virus diseases. The prospects of maintaining healthy stocks of potatoes by raising the seedlings at the Sub-Station, therefore, encourage the hope that fruitful results will follow. The propagation of healthy stocks will permit of the accumulation of more reliable data concerning the genetic differences of parent plants than was possible at Corstorphine alone.

Among the more important results of the trials, viewed from the economic standpoint, twenty-one selections appeared to compare favourably with the control varieties—Kerr's Pink, Great Scot, and British Queen. These promising seedlings have been retained for further trial in 1928, and they include one "second-early," eight "main-crops" and fifteen "lates." One of the heaviest cropping seedlings, from a cross between Kerr's Pink and Bell, produced on the average just over 4 lb. per plant, compared with 2½ lb. per plant from Great Scot. This new variety produced a large crop of white round tubers of satisfactory size, the proportion of "ware" tubers being 88 per cent.

Many of the varieties suffered in yield as a result of damage by blight early in the season. The severity of the attack varied with the variety. Fourteen varieties, however, were very little affected by the disease either in the haulm or in the tubers. Several of these apparently blight-resisting types have been retained for further experiment.

### C. HERBAGE PLANTS.

*Assistant in Charge*—J. W. GREGOR, Ph.D.

The purpose of the investigations which are being made regarding the herbage plants, perennial ryegrass, cocksfoot, and timothy, is mainly to obtain information that will lead to the construction of a sound system of breeding, and of comparing pasture types of the above-mentioned grasses. The investigations include studies of self-sterility in grasses, of the genetic differences of wild populations of perennial ryegrass, and of the effects of different environmental conditions on various species and strains of grasses. This work has been continued during the past year, and further progress has been made. The results obtained so far have indicated, on fairly

broad lines, methods of breeding that may tentatively be pursued.

*The Relationship between the Plant and its Environment.*—The fact that any new strain of pasture grass must ultimately compete with other plants under "pasture" conditions, renders it desirable to study plant populations collected from natural habitats. The survival of a plant in a pasture is dependent on the environmental conditions being suitable for its development—that is, the environment must suit the particular hereditary constitution of the plant. In a pasture the eliminating agents are not merely confined to the soil and climatic conditions, but include the activities of both animals and plants—the biotic factors of the environment. In nature there is in constant progress a struggle for existence among the various grass species, forms of the same species, and between grasses and other species of plants. The plants in several of the habitats from which specimens were obtained by Dr Gregor were severely grazed, and it has been assumed that the perennial ryegrass and cocksfoot plants, surviving in such habitats, are better adapted for grazing than plants which have been artificially selected mainly for other purposes. Through the study of different populations it may be possible to discover some of the factors which, under certain conditions, favour the survival of certain types and the elimination of others. The various types are probably different in their genetic constitution, and this probability has made it necessary to separate, if possible, types which are hereditarily different from one another. It is therefore important to discover the relationship between the various types of herbage plants and the particular environment to which they are adapted.

*Pedigree Cultures.*—It has been shown that there are several forms of perennial ryegrass ranging from the tall-growing erect form to the short, more or less prostrate, type. Each of the types has retained its distinctive characteristics throughout the years it has been grown at the Plant-Breeding Station, where the environmental conditions for all were more or less similar. Change of environmental conditions has not appreciably altered the types, thus indicating that the distinctive characters are hereditary. For the production of hay the tall form is no doubt to be preferred, but for grazing the low-growing form possesses characteristics that suggest its superiority for this purpose. When plants of perennial ryegrass

were collected from heavily grazed populations they were found to be mainly of the low-growing form. Many strains of these leafy low-growing forms have been selected for the breeding experiments. The frequent occurrence of a high degree of self-sterility in perennial ryegrass, cocksfoot, and timothy is an obstacle impeding progress towards pure-breeding strains. To circumvent this an attempt is being made to obtain strains breeding fairly true for certain characteristics, by interplanting cross-fertile plants of similar types. Plants possessing a relatively high degree of self-fertility probably exist, and it may be possible to isolate these, but until such are obtained, cross-fertilisation of strains nearly identical in type appears to be a practical method of obtaining, through the seed, a population of plants all more or less of the low-growing form.

*Relative Hardiness of Grasses.*—An attempt is being made to compare the relative hardiness of different species and strains of grasses. For this purpose forms of several species were collected from exposed situations, and have been grown at the Plant-Breeding Station, Corstorphine, under environmental conditions which were as nearly as possible the same for all the plants. Other forms of the species from other habitats were used for comparison. It was found that the majority of the "hardy" types were very liable to "winter burn." Not much is known regarding this condition, but it is possible that it may be a physiological characteristic of "hardy" types which enables them better to withstand adverse conditions.

With a view to obtaining a strain of timothy hardier than the ordinary cultivated strains, Common timothy has been crossed with Alpine timothy. The first generation plants of this hybrid were grown in 1927. These plants were more or less intermediate in form between the two parent types. They showed decided promise as pasture types, but unfortunately the male organs were completely sterile and the female organs almost all sterile also, thus preventing a second ( $F_2$ ) generation of plants from being obtained. From a possible number of three or four hundred thousand florets the seed obtained produced only seven seedlings. As the first generation hybrids were of promising types, this cross has been repeated. Other forms of the two species were used as parents in order to discover whether less sterile plants may be secured.

*Experiments with species of Plantain.*—In recent years trouble has occasionally been experienced by farmers through their stock "scouring" when grazed on pastures containing a large amount of wild white clover. We understand that a small quantity of rib grass, *Plantago lanceolata*, a species believed to possess astringent properties, is sometimes included in grass-seed mixtures to help in preventing "scouring." From field observations Dr Gregor concluded that rib-grass, *P. lanceolata*, was comparatively little eaten by sheep. Moreover, its broad flat leaves and its habit of growth are not desirable characteristics for a "pasture" plant. There is, however, another species of plantain, the sea plantain (*P. maritima*), the leaves of which are succulent and almost grass-like. When grown in "wild" pastures it seems that the leaves of this plant are readily eaten by grazing animals. Plants of sea plantain have been collected from coastal and inland habitats, and the characteristics of their progenies are being compared. The object of the experiment with sea plantain is to discover whether it has any possibilities as a pasture plant.

*Multiplication and Trial of New Strains of Grasses.*—A start was made in 1927 to multiply by seeding a strain of late-flowering perennial ryegrass in distance isolation. It is expected that a sufficient quantity of seed will be obtained in 1928 to permit of the trial, on a small scale, of this strain in a pasture. While the trial is proceeding the stock of seed will also be increased.

The plants of a pasture strain of timothy have been divided for multiplication vegetatively. These will be seeded in 1928 to provide seed for the initial multiplication by seed in 1929.

A soft broad-leaved type of cocksfoot has also reached the same stage as the above-mentioned strain of timothy, and is also being multiplied vegetatively.

#### D. "ROOT" CROPS.

(*Swedens and Turnips.*)

*Assistant in Charge*—V. E. M'M. DAVEY, B.Sc.

The chief problems that are being investigated were selected mainly for the purpose of obtaining information which will lead to improved methods of breeding being devised. Before

these problems can be solved several generations of plants must be examined, and the types of plants in each generation compared. The swede is a biennial plant, and this characteristic renders progress in analysing the hereditary characters slower than it generally is in annual plants, such as cereals.

The experiments started in previous years have been continued satisfactorily despite the unfavourable season in 1927.

*Analysis of Hereditary Characters.*—The investigations started a few years ago to discover the mode of inheritance of shape of bulb, colour of bulb, type of foliage, dry-matter content, resistance to finger-and-toe disease, and tendency to "bolt" or run to seed, have been advanced a stage further. Preliminary observations have been made with a view to discovering the heredity of the type known as a "bulbless bolter," an aberrant type of plant that occasionally appears in crops of swedes. None of the above-mentioned investigations has reached the stage at which definite conclusions can be drawn, but further data have been accumulated. The solution of these problems will greatly assist in establishing principles on which to base future breeding methods.

*Controlled Seeding.*—In connection with the investigations already referred to, about one hundred and forty swedes and ten turnips were seeded, each one being individually isolated. Abundant self-fertilised swede seed was obtained. About sixty hybridisations were made within or between swede or turnip species, a few flowers in each case being emasculated and hand-pollinated. The majority of the pollinated flowers set seed. Many of these hybridisations are back crosses, made mainly for the purpose of elucidating the heredity of certain botanical characters.

Certain pedigree strains which in 1926 showed a high degree of uniformity in appearance, and considerable promise as economic types, were seeded each in distance isolation, and sufficient seed obtained for a progeny trial on a field-scale.

*Comparisons of Pedigree Cultures.*—Fourteen strains in the second hybrid ( $F_2$ ) generation—crosses between Purple- and Green-top swedes—were grown, and the individual plants classified as regards bulb-colour and neck-colour to obtain information concerning the inheritance of these characters.

About forty-five pedigree strains of swedes were sown in duplicate small plots for observation and comparison. An exceptionally severe attack of finger-and-toe disease in this



plot resulted in stunted crops on which it was futile to attempt making comparisons. It was possible, however, to obtain healthy bulbs from a number of the strains for seeding. This is the first season in which the swede crop at the Station has been seriously injured by this disease. Swedes are grown only once in six years on the same plot, and as a preventive against finger-and-toe quicklime was applied to the root crop at the rate of one ton per acre a few months before the swedes were sown. The attack of finger-and-toe disease was also severe in the isolated and purposely infected plot, where certain varieties and strains were being tested for resistance to the disease. Only three plants appeared to be free from finger-and-toe at the end of the season, and they have been retained for seeding. Their progenies will again be grown in the plot highly infected with the finger-and-toe organism to test their capacity for resisting the disease.

Three pedigree lines which showed promise in 1925 were sown in small replicated plots and compared with a mass-multiplied line. The results of this trial (summarised in Table I.) indicate that two of the three self-fertilised strains compare favourably with the less inbred control in total yield per acre, and in yields per acre of dry-matter and sugar. The differences in these characteristics between the control and the other self-fertilised strain are insignificant. It will also be seen from the Table that the bulbs in all three strains were rather larger in size than those of the control. Apparently no loss of vigour has resulted from three generations of selfing.

[TABLE I.

TABLE I.

## YIELD TRIAL, 1927.

*Material.*—Three pedigree strains, self-fertilised and selected for three generations—

Da 281, Soft-flesh, purple-top swede (5 plots).

Da 289, Firm-flesh, purple-top swede (4 plots).

Da 304, Firm-flesh, bronze-top swede (4 plots).

*Control.*—A pedigree strain that was mass-multiplied to obtain a quantity of seed, and was included in 1926 trials—

Da 86, Fairly firm-flesh, purple-top (10 plots).

| Control Da 86 Average Yields.           | If the yields of the control be expressed as 100, the corresponding yields of the other varieties proportionally are:— |         |         |
|---|--|---------|---------|
|   | Da 281.  | Da 289. | Da 304. |
| Yield per acre . . . . . 21 tons        | 119  | 100     | 118     |
| Dry-matter content . . . . . 11.4%      | 97   | 100     | 102     |
| Dry-matter per acre . . . . . 48 cwt.   | 116  | 105     | 121     |
| Sugar content . . . . . 7.1%            | 93   | 98      | 100     |
| Sugar per acre . . . . . 30 cwt.        | 110  | 98      | 116     |
| Average weight of bulb . . . . . 2½ lb. | 113  | 109     | 113     |

*Selfing.*—Self-fertilisation of swedes has been largely practised in studying the heredity of various characters. Note has been taken of the relative vigour of selfed strains, and the results obtained so far have been referred to in a paper written by Mr Davey on "Breeding of Swedes and Turnips," in which it is reported that in the swede no lack of vigour as a result of self-fertilisation has yet been observed, and that although only a limited amount of material has been handled in the flowering stage, it was believed decrease in fertility seldom occurred.

*Chemical Analysis.*—The determination of the dry-matter in single cores from a large number of individual roots was

made in order to confirm previous results which had indicated that high dry-matter content was a hereditary characteristic.

An extended investigation into the relation between the composition of swedes and their nutritive value has been carried out recently by a Committee appointed by the Board of Agriculture for Scotland (see Scottish 'Journal of Agriculture.' Vol. IX. (1926), page 160; Vol. X. (1927), page 428). As the result of these investigations, it appears probable that the two constituents of most importance are the dry-matter and the soluble solids present in the root. The Committee has worked out methods for the determination of these constituents, and the methods are now being used in the laboratory; it has also been arranged to carry on the analytical work in collaboration with the Chemistry Department of the Edinburgh and East of Scotland College of Agriculture in Edinburgh, which will mean that a greatly increased number of roots can be analysed each season. A beginning was made with this joint investigation last season, and 160 bulbs of certain varieties, grown at the Plant-Breeding Station in soil free from finger-and-toe disease, have been examined by the College and an equal number by the Station Assistant. A specially constructed and approved type of press for expressing the juice from single cores was obtained for this work at the Station. Many bulbs have been selected on the basis of the analyses for seeding. These bulbs will be self-fertilised at the Plant-Breeding Station, and later their progenies as a whole will be compared. In the course of the analyses it became evident that the method recommended for the analysis of bulk samples is in need of slight modification for single core analysis. It will not be possible to estimate the value of this method of selection before 1929, when the progenies of the selected roots will be grown.

*Living Museum.*—Over sixty commercial varieties of swedes and turnips were sown in small plots for reference. Eighteen of these were sown on a larger scale mainly for observation of their botanical characters. The arrangements for tillage rendered necessary the sowing of the latter rather early in the season. In the autumn it was noted that "neckiness" and "bolting" were more pronounced in some varieties than in others. There was also a considerable amount of variation in these characteristics within some of the varieties. From those varieties, which, as a whole, were distinctly "necky,"

typical "long-necked" and "short-necked" plants were selected for seeding with the object of discovering whether these contrasting characters might be hereditary.

## II. Publications and Lectures by Staff.

### PUBLICATIONS (P) AND LECTURES (L).

Director of Research :—

- "Standing Power of Oats," Chirnside Agricultural Discussion Society, February 1928. (L)
- "Heredity and Environment," Royal Caledonian Horticultural Society, March 1928. (L)
- "The Scottish Plant-Breeding Station: Its Work and Objects." (P)

Chief Assistant J. W. Gregor, Ph.D. :—

- "Experiments on the Pollination of *Lolium perenne* and *Lolium italicum*," Royal Society of Edinburgh, November 1927. (L)
- "Observations on *Phleum pratense*, *P. alpinum* and their hybrid (*P. pratense* × *P. alpinum*)," Botanical Society of Edinburgh, February 1928. (L)

Assistant V. E. M'M. Davey, B.Sc. :—

- "Breeding of Swedes and Turnips," 'Scottish Journal of Agriculture,' Volume XI., No. 1, 1928. (P)

## III. Demonstrations.

Demonstrations regarding the work at the Station were given by members of the staff to various groups of agriculturists and other interested parties who visited the Plant-Breeding Station throughout the year.

Special arrangements were made to show visitors round the experimental plots at the Plant-Breeding Station during the week in which the "Highland Show" was being held in Edinburgh in 1927.

#### IV. Acknowledgments.

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

Professor Aldous, Manhattan, Kansas.

Mrs N. L. Alcock, Royal Botanic Garden, Edinburgh.

Messrs Alex. Cross & Son, 19 Hope Street, Glasgow  
(per Thomas Hogg, Esq.).

Messrs David Bell, Ltd., 15 Coburg Street, Leith.

Messrs Wm. Dods & Son, Seedsmen, Haddington.

Messrs Gartons, Ltd., Warrington, England (per G. P.  
Milne, Esq.).

J. A. More, Esq., The University, Edinburgh.

Messrs M'Gill & Smith, Ltd., Seedsmen, Ayr.

J. T. M'Laren, Esq., The Leuchold, Dalmeny.

Fredrik Nilsson, Esq., Landskrona, Sweden.

Professor John Percival, M.A., Sc.D., Department of  
Agricultural Botany, The University, Reading.

Scott Agricultural Laboratories, Kenya Colony.

G. Bertram Shields, Esq., Rosebery Farm, Gorebridge.

C. Smith, Esq., Corstorphine.

Otto Walle, Esq., Plant-Breeding Station, Tammisto,  
Malmi, Finland.

WILLIAM ROBB,

*Director of Research.*

## LIST OF MEMBERS as at 4th July 1928.

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 M'Nab, J. B., Newtonmill, Brechin.  
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 Marshall, H. B., Rachan, Broughton.  
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 Miller, Robert, Ferrygate, Dirleton.  
 Montgomerie, A. W., Lessnessock, Ochiltree.  
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 Morrison, J. A., West Fenton, Drem.  
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 Munro, James, Crook, Bilbster, Wick.  
 Murdoch, Alex., East Hallside, Hallside, Glasgow.  
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