CRAIGS HOUSE, CORSTORPHINE.

SCOTTISH SOCIETY FOR RESEARCH IN PLANT-BREEDING.

REPORT.

Historical.

As this is the first Annual Report by the Directors to the Annual General Meeting, it may be well briefly to place on record the steps which led to the formation of the Society.

At a Conference held on 26th July 1918, convened by the Directors of the Highland and Agricultural Society, and at which were present representatives of that Society, and of the Scottish Chamber of Agriculture, the National Farmers' Union of Scotland, and the Scottish Seed Trade Association, it was unanimously resolved to approve a proposal to create in Scotland a Station for Research in Plant-Breeding, and to commend it to the support of the Board of Agriculture for Scotland and all interested in the industry of agriculture. The Conference was presided over by the Right Hon. Robert Munro, K.C., M.P., Secretary for Scotland, who, in commending the scheme to the meeting, stated that he proposed to sanction the expenditure from public funds towards the funds required for the station of pound for pound of the amount raised by voluntary effort up to a reasonable limit.

A Committee was thereafter formed to take the necessary steps towards the establishment of the proposed station, and to secure public support to the scheme. This Committee, of which Mr Charles Douglas, D.Sc., C.B., of Auchlochan, was appointed Chairman, comprised representatives not only of the bodies already mentioned, but of various other trade associations connected with agriculture.

By August 1920 the efforts of the Committee to raise funds had been so far successful that a sum approaching £21,000 had been raised.

At a meeting on 10th August a set of Rules and Constitution of a Society, to be known as the "Scottish Society for

Research in Plant-Breeding," was submitted and approved, and the first Board of Directors was nominated as therein provided.

The Directors of the new Society met for the first time on 6th September 1920; and the Society was registered as a specially authorised Society under the Friendly Societies Act, 1896, on 16th February 1921.

A list of first Directors and Office-bearers appears on page 10.

Object.

The aim of the Society is the establishment of a thoroughly equipped station for the improvement of agricultural plants. It is hoped that such improvement may be attained partly by selection and partly by the creation of new varieties possessing in the highest degree those qualities which will make them most profitable under Scottish conditions.

The Station.

An excellent site for the station was secured at East Craigs, Corstorphine. This consists of a commodious dwelling-house, known as Craigs House, with stable, coach-house, garden, two cottages, and grass park, covering an area of about 8¼ acres, and two fields of good arable land adjoining on the farm of East Craigs. The station is within 4½ miles of Edinburgh. Possession was obtained at Martinmas 1920, but through an arrangement with the tenant of East Craigs, the Committee secured possession of 3 acres of the land in the spring of 1920. This area was divided into plots, which were sown out with a comprehensive collection of oats, barley, and potatoes. The oats and barley comprised both home and foreign varieties, a large number of samples of the latter having been obtained, through the agency of the Board of Agriculture for Scotland, from Sweden, Denmark, Holland, France, and Canada. The valuable collection of potatoes belonging to the late Dr Wilson of St Andrews, which was handed over to the station by the Board of Agriculture, was also planted out at East Craigs.

In 1921 the whole of the ground was in possession of the Society, and utilised for the purposes of the station. Details of the work carried on will be found in the Report by the Director of Research—Mr Montagu Drummond, B.A., F.L.S.

Financial.

In the beginning of June 1921 the Society received from the Agriculture (Scotland) Fund, through the Board of Agriculture for Scotland, a sum of £22,363, being an amount equivalent to the sum raised from voluntary sources, as shown in the accounts of the Preliminary Fund, which were audited as at 16th February 1921, the date of registration of the Society.

After payment for the property, and meeting other initial expenses, it was found possible to invest a sum of approximately £33,450 in Government securities.

As a result of an application made to the Development Commissioners, through the Board of Agriculture for Scotland, a promise has been received of a grant from the Development Fund, not in any case exceeding £1100, which, when added to the interest derived from the grant made from the Agriculture (Scotland) Fund in aid of capital, will be equivalent to two-thirds of the maintenance expenditure of the Society during the year ending 31st March 1922.

Membership.

Donors of £20 or over (including donations to the Preliminary Fund) are 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.

The Directors have to report that, at the end of the first year, 31st March 1922, there were 176 members of the Society. Of these, 87 were life members, 31 were annual members paying an annual subscription of 10s., and 58 were annual members paying an annual subscription of £1.

The ultimate benefits which this station will ensure to the whole agricultural community of the country cannot be overrated. It is hoped, therefore, that all interested in agriculture, arboriculture, or horticulture, who have not already subscribed, may see their way to support this national institution by becoming members of the Society.

Obituary.

The Directors desire to place on record an expression of their deep regret at the death of Mr George A. Ferguson, Surradale, one of the first Board of Directors of the Society, and their sense of the loss which the Society has sustained through his death. Mr Ferguson took a keen interest in the affairs of the Society, and was a generous donor to the Preliminary Fund.

Election of Directors.

The term of office of the first Board of Directors, named in the Rules of the Society, expires in July 1922. It falls to the Annual Meeting to elect eighteen Directors, six of whom shall retire in July in each subsequent year. The Board of Directors recommends the re-election of the following :—

D. L. Bowe (Messrs J. H. Bowe & Sons), Dunbar.
Sir James Campbell, LL.D., 14 Douglas Crescent, Edinburgh.
William Cuthbertson, V.M.H. (Messrs Dobbie & Co.), Edinburgh.
J. Inglis Davidson, Saughton Mains, Corstorphine.
James W. Drummond (Messrs W. Drummond & Sons, Ltd.), Stirling.
David Ferrie of Parbroath, Cupar-Fife.
A. B. Fulton, 118 Queen Street, Glasgow.
James Gardner, South Hillington, Cardonald.
Sir Archibald Buchan Hepburn of Smeaton, Bart., Letham, Haddington.
J. H. Milne Home, Irvine House, Canonbie.
W. W. Hope, Linton Lodge, Prestonkirk.
John M'Caig of Belmont, Stranraer.
J. T. M'Laren, The Leuchold, Dalmeny.
A. T. M'Robert (Aberdeen Lime Co.), Aberdeen.
G. G. Mercer, Southfield, Dalkeith.
Principal W. G. R. Paterson, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow.
G. B. Shields, Dolphingstone, Tranent.
Sir David Wilson of Carbeth, Bart., Killearn.

Year 1921-22.

ANALYSIS OF MEMBERS.

Aberdeen	6	Midlothian	19
Argyll	3	Moray	2
Ayr	13	Nairn	..
Banff	1	Orkney	2
Berwick	10	Peebles	3
Caithness	..	Perth	14
Clackmannan	..	Renfrew	13
Dumbarton	2	Ross and Cromarty	5
Dumfries	10	Roxburgh	4
East Lothian	19	Selkirk	..
Fife	13	Shetland	..
Forfar	9	Stirling	2
Inverness	2	Sutherland	1
Kincardine	..	Wigtown	3
Kinross	2	England	1
Kirkcudbright	8		
Lanark	6		176
Linlithgow	3		

Life Members	87
Annual Members—	
£1 rate	58
10s. rate	31
	176

ABSTRACT OF

For the period from 16th February 1921

INCOME.

	Period from 16th Feb. 1921 to 31st Mar. 1921.	Year to 31st Mar. 1922.	Total.
Subscriptions—			
Life	£ ...	£85 0 0	£85 0 0
Annual	...	73 10 0	73 10 0
	£ ...	£158 10 0	£158 10 0
Donations	116 4 6	311 14 6	427 19 0
Interests	2 7 3	1,312 6 5	1,314 13 8
Rents	58 14 8	20 0 0	78 14 8
Income Tax Recovered	...	84 16 7	84 16 7
Corn Subsidy	...	64 0 0	64 0 0
Sale of Produce and Stock in Hand	29 5 0	363 9 8	392 14 8
Discounts	...	16 7 11	16 7 11
Total Revenue Income	£206 11 5	£2,331 5 1	£2,537 16 6
Grant from Board of Agriculture	...	22,363 0 0	22,363 0 0
Tools received as a Donation	30 0 0	...	30 0 0
Investments realised £11,500 0 0	...	...	...
Total Capital Income	£30 0 0	£22,363 0 0	£22,393 0 0
Total Income	£236 11 5	£24,694 5 1	£24,930 16 6
Funds at 16th February 1921—			
House and Lands		£7,060 0 0	
Implements		56 5 9	
Laboratory Apparatus		15 16 6	
Sacks		37 0 0	
Corporation Loan		12,500 0 0	
Balance in Bank		1,748 13 11	
			21,417 16 2
			£46,348 12 8

ACCOUNTS.

(date of Registration) to 31st March 1922.

EXPENDITURE.

	Period from 16th Feb. 1921 to 31st Mar. 1921.	Year to 31st Mar. 1922.	Total.
Salaries—			
Officers	£198 0 0	£1195 9 2	£1,393 9 2
Secretary and Office	100 0 0	181 19 4	281 19 4
	£298 0 0	£1,377 8 6	£1,675 8 6
Labour	54 9 6	435 13 6	490 3 0
Seeds	...	92 17 8	92 17 8
Manures	...	97 7 3	97 7 3
Sacks	...	22 7 1	22 7 1
Other Working Expenses	2 2 3	90 13 8	92 15 11
Laboratory Expenses	2 10 3	3 15 10	6 6 1
Rates and Taxes	...	271 9 7	271 9 7
Insurances	7 8 6	19 5 6	26 14 0
National Health and Unemployment Insurances	0 10 10	2 18 6	3 9 4
Office Expenses	23 6 6	122 2 6	145 9 0
Advertising	2 18 4	13 5 6	16 3 10
Heating, Lighting, and Cleaning	...	50 0 0	50 0 0
Travelling	17 17 9	80 1 1	97 18 10
Legal Expenses	...	33 9 10	33 9 10
Investment Charges	...	112 0 0	112 0 0
Property Repairs	...	41 0 0	41 0 0
Depreciation on Implements, Tools, &c.	...	48 3 2	48 3 2
Total Revenue Expenditure	£409 3 11	£2,913 19 2	£3,323 3 1
Capital Expenditure—			
Implements and Tools		£409 18 7	
Laboratory Apparatus and Supplies		37 8 9	
Office Fittings		81 9 9	
Sacks		7 14 2	
Manures for Crop, 1922		112 13 3	
Books—Library		5 13 9	
Investments made	£33,450 12 6		
Total Capital Expenditure		£654 18 3	
Funds at 31st March 1922, per Balance-sheet			43,025 9 7
			£46,348 12 8

BALANCE

As at 31st

LIABILITIES.

I. Accounts Outstanding	£76 10 9	
II. Funds at 31st March 1922	43,025 9 7	
		£43,102 0 4

DR WILSON

Funds at 31st March 1922	£181 5 0
	£181 5 0

EDINBURGH, 11*th May* 1922.—I, the undersigned, having had access to all the Accounts, and verified the same with the Accounts and Vouchers relating thereto, now

45 QUEEN STREET.

SHEET.

March 1922.

ASSETS.

I. House and Lands		£7,060 0 0
II. Implements and Tools		459 0 2
III. Laboratory Apparatus and Supplies		48 8 6
IV. Office Fittings		75 7 6
V. Library—Books		5 13 9
VI. Stocks on Hand per Valuation		439 19 4
VII. Accounts Outstanding		19 16 11
VIII. Investments at Cost :—		

Value at 31st March 1922.			
£13,895 0 0	£14,000 5 per cent War Stock, 1929/47	£12,390 0 0	
11,865 0 0	£14,000 4 per cent Funding Loan, 1960/90	10,045 0 0	
9,990 0 0	£13,500 3½ per cent Conversion Loan	8,521 17 6	
2,590 12 6	£2500 5 per cent National War Bonds	2,493 15 0	
1,000 0 0	Corporation Loan	1,000 0 0	
			34,450 12 6
£39,340 12 6			

IX. Cash Balances—			
In Bank—			
On Deposit Receipt		£500 0 0	
On Current Account		29 16 11	
		£529 16 11	
On Hand		13 4 9	
			543 1 8
			£43,102 0 4

MEMORIAL FUND.

Value at 31st March 1922.			
£198 10 0	£200 5 per cent War Stock—valued at date of transfer		£176 5 0
	Interest for half-year		5 0 0
			£181 5 0

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

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

ESTABLISHMENT FOR 1921-22.

BOARD OF DIRECTORS.

Trustees.

THE RIGHT HON. ROBERT MUNRO, K.C., M.P., Secretary for Scotland.
CHARLES DOUGLAS, D.Sc., C.B., of Auchlochan, Lesmahagow.
JAMES ELDER, Athelstaneford Mains, Drem.
DAVID BELL, 15 Coburg Street, Leith.
JOHN FINLAYSON M'GILL, 69 Kyle Street, Ayr.

First Directors named in Rules of the Society.

D. L. BOWE (Messrs J. H. Bowe & Sons), Dunbar.
Sir JAMES CAMPBELL, LL.D., 14 Douglas Crescent, Edinburgh.
Sir ISAAC CONNELL, S.S.C., 18 Duke Street, Edinburgh.
WILLIAM CUTHBERTSON, V.M.H. (Messrs Dobbie & Co.), Edinburgh.
J. INGLIS DAVIDSON, Saughton Mains, Corstorphine.
JAMES W. DRUMMOND (Messrs W. Drummond & Sons, Ltd.), Stirling.
GEORGE A. FERGUSON, Surradale, Elgin. (*Deceased.*)
DAVID FERRIE of Parbroath, Cupar-Fife.
LORD FORTEVIOT, Dupplin Castle, Perth.
A. B. FULTON, 118 Queen Street, Glasgow.
JAMES GARDNER, South Hillington, Cardonald.
Sir ARCHIBALD BUCHAN HEPBURN of Smeaton, Bart., Letham, Haddington.
J. H. MILNE HOME, Irvine House, Canonbie.
W. W. HOPE, Linton Lodge, Prestonkirk.
JOHN M'CAIG of Belmont, Stranraer.
J. T. M'LAREN, The Leuchold, Dalmeny.
A. T. M'ROBERT (Aberdeen Lime Co.), Aberdeen.
G. G. MERCER, Southfield, Dalkeith.
Principal W. G. R. PATERSON, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow.
G. B. SHIELDS, Dolphingstone, Tranent.
Sir DAVID WILSON of Carbeth, Bart., Killearn.

Directors nominated by the Board of Agriculture.

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

Chairman of Directors—CHARLES DOUGLAS, D.Sc., C.B., of Auchlochan, Lesmahagow.

Vice-Chairman—JAMES ELDER, Athelstaneford Mains, Drem.

Director of Research—MONTAGU DRUMMOND, B.A., F.L.S., Craigs House, Corstorphine.

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

Assistant Director and Assistant Secretary—WILLIAM ROBB, N.D.A., Craigs House, Corstorphine.

COMMITTEES.

1921-22.

RESEARCH.

G. Bertram Shields, *Convener.*
T. Anderson.
William Cuthbertson, V.M.H.
J. W. Drummond.
James Gardner.
Sir Robert B. Greig.
Sir Archibald Buchan Hepburn, Bart.
J. F. M'Gill.
A. T. M'Robert.
Principal W. G. R. Paterson.
Sir David Wilson, Bart., D.Sc.
Charles Douglas, D.Sc., C.B., *Chairman, ex officio.*
James Elder, *Vice-Chairman, ex officio.*

MANAGEMENT.

David Bell, *Convener.*
D. L. Bowe.
J. Inglis Davidson.
David Ferrie.
W. W. Hope.
J. T. M'Laren.
G. G. Mercer.
James Wood.
G. Bertram Shields.
J. H. Milne Home.
Charles Douglas, D.Sc., C.B., *Chairman, ex officio.*
James Elder, *Vice-Chairman, ex officio.*

FINANCE.

J. H. Milne Home, *Convener.*
David Bell.
Sir James Campbell, LL.D.
Sir Isaac Connell, S.S.C.
Lord Forteviot.
A. B. Fulton.
John M'Caig.
Alex. M'Callum, M.A., LL.B.
G. Bertram Shields.
Charles Douglas, D.Sc., C.B., *Chairman, ex officio.*
James Elder, *Vice-Chairman, ex officio.*

REPORT

BY

DIRECTOR OF RESEARCH.

I. Research Programme—General Outline.

In the first Annual Report of a newly-established Plant-Breeding Station the research policy can only be sketched in outline. The scope of the programme will necessarily be limited to begin with, and the various lines of specialisation must to a great extent be allowed to develop gradually by a process of evolution and adjustment. It is, however, possible, and indeed imperative, at the outset to define the objects to be kept in view, therefrom to deduce guiding principles of research policy, and finally to select appropriate methods of work. The object of the Scottish Society for Research in Plant-Breeding being to promote the discovery and creation of such new and improved races of the leading crop plants as are best suited to Scottish conditions, it follows that the research work of the Station will be directed strictly towards practical ends. It should be noted at once, however, that a certain amount of attention must inevitably be given to problems not in themselves of immediate economic importance. A concrete instance may help to make this point clear. Of twelve new experimental varieties of potato classed as promising by the Society's Potatoes Sub-Committee in 1921, eight have already proved susceptible to wart disease. A similar heavy casualty list—and a commensurate waste of time and energy expended in raising potato varieties otherwise satisfactory but doomed through susceptibility to wart—may be anticipated each year, until an exact understanding of the inheritance of wart immunity has been attained. The study of immunity inheritance is thus seen to be an

urgent problem for the practical plant-breeder ; prominence is accordingly given to this question in the potato programme for the coming year (see below, p. 28). Similar problems complicate the task of amelioration in the case of most crops, and technical difficulties (such as the self-sterility of many clovers) may also entail protracted study before they can be brought sufficiently under control for advance along practical lines to proceed without constant risk of unforeseen checks or unsuspected digressions.

In the main, nevertheless, the methods to be employed at a Station of the " plant-factory " type will be such as

tend to the immediate improvement of seed and crop. Chief among these are :—

Collection and classification of suitable living material.
Isolation of pedigree strains (pure lines).
Comparative trials of varieties, pedigree strains, &c.
Hybridisation (crossing) of pedigree strains, varieties, and species.

1. Collection and Classification.

The collection of living material from which to breed must form the foundation of every breeding programme. It is the simplest of the breeder's tasks, and activity in this direction is limited only by the ground available for reception, the facilities for raising of seedlings, and the number and enthusiasm of contributors of samples. Before

any use can be made of the material taken into the collection, the laborious but essential task of classification has to be performed. A close study of botanical characters is required to ensure certainty of identification and for the detection of synonyms. The "physiological" characters of each variety or strain (such as time of maturity, hardiness, disease resistance) must also be determined, and assessed with reference to standard types. The ordinary botanist, when confronted with a similar task in regard to species growing in a state of nature, is able, as a rule, to enlist the help of the excellent "Floras" which have been compiled for most parts of the world, and also to consult the admirable representative collections of dried plants preserved for the purpose at Kew and other centres of systematic botany. At present the plant-breeder has few external aids of this sort at his disposal, and is therefore forced to expend much time and trouble on the preliminary work of framing a working classification of his plants based on his personal observation. Professor Vavilov of Petrograd, writing in the current number of the 'Journal of Genetics' (April 1922), expresses the opinion that it will require a century of collective work to elaborate a generally accepted classification of the varieties and races with which breeders are mainly concerned. It is to be hoped that this estimate is unduly pessimistic, but the fact that it is put forward in all seriousness by a plant-breeder may serve to emphasise the undoubted magnitude of the problem of classification.

2. Pedigree Culture.

Pedigree culture, that is, the isolation of pedigree strains—or pure lines, as they are also termed—is likewise a simple matter in theory. The method of procedure is implied in the definition of a pure line as "a number of individuals, derived through seed from a single original parent, which do not differ among themselves—even after propagation through an indefinite number of selfed generations—to a greater extent than do separate fragments of the original parent." If the plant in question is capable of perpetual self-fertilisation, and the original parent is not a hybrid, a pure line is obtained in the first generation, and can be

perpetuated indefinitely. Assuming the ordinary precautions against casual cross-fertilisation or admixture to be observed, the only disturbance of the pure line so obtained that can occur is the appearance of a sport (mutation), which will at once be detected by the experienced observer, and may be eliminated or isolated for further study according to its apparent merits. Plants which are normally cross-fertilised (*e.g.*, the majority of rootcrops), or which are more or less self-sterile (as many leguminous crops), are less amenable to pedigree culture. In some instances, indeed, it is hard to see how genuine pure lines can be isolated at all, although strains sufficiently pure for practical purposes can probably be obtained in most cases by interbreeding individuals as nearly as possible alike. Fortunately for the plant-breeder, the important British cereal crops are all normally self-fertilised, and accidental crosses are of rare occurrence among them. Turnips and mangolds are normally cross-fertilised, but, so far as is known, offer no obstacle to selfing. The potato presents special difficulties, not only owing to the complicated and obscure ancestry of most varieties now in cultivation, but also from secondary causes, such as the partial or complete sterility of many types. A fuller knowledge of the factors determining successful fertilisation in the potato is greatly to be desired, and an exhaustive study of this problem would provide a very suitable field of inquiry for one or more research students. With regard to forage-grasses little is at present known in this connection, and the possibilities of pedigree breeding of ryegrasses, Timothy and Cocksfoot, will have to be explored at the Scottish Station in the immediate future. Clovers being apparently more or less completely self-sterile, do not lend themselves to pedigree culture in the strict sense, and most probably will have to be dealt with by other methods.

The practical value of pedigree culture can scarcely be exaggerated. It is the only method of procedure that ensures uniformity and—apart from eventual mutation—constancy in the breeding stock. It is significant that the most outstanding achievements of the Scandinavian plant-breeders have been attained with those crops which are peculiarly suited to pedigree culture—viz., the self-fertilised cereals.

3. Comparative Trials.

Hardly less important than pedigree cultures are the comparative trials between different varieties and strains which bulk so largely in the programmes of most agricultural stations. These provide a basis for assessing the relative values of different strains, and thus for deciding which should be multiplied for further trial on a larger scale, and which may be rejected altogether as worthless, or at most retained in minimum quantities for eventual hybridisation. Such comparative trials should be carried out for every phase of the work of amelioration. Methodical observation of the small " breeding plots " (see below, p. 19) provides data which even at this early stage often suffice for detection of the most promising types. Next follow definite strain- or variety-trials between selected types ; the scale on which these are to be planned depends on various circumstances, but primarily on the quantity of seed in hand and the amount of space available. For cereals they will range in general from $\frac{1}{100}$th-acre to $\frac{1}{10}$th-acre plots. It is scarcely feasible, nor would it be profitable, to attempt much larger trials at the Plant-Breeding Station itself. Full-scale field-trials should be arranged for, when required, outside the Station, though under the supervision of the Station staff, at various centres in different parts of the country, with seed supplied from the central stock of the Station. This system has been carried out for many years in Denmark with excellent results ; its value as a means of deciding whether a new or improved strain is of more than local utility is sufficiently obvious.

4. Hybridisation.

Hybridisation is commonly regarded as the most fruitful source of new varieties. Certainly many remarkable results have been achieved in the past by crossings apparently carried out at random, but in reality more often based on exceptional knowledge of the plants concerned, or guided by that instinct for choosing the right parents that the most successful breeders seem to possess. Of late, hybridisation has become more of an organised science. The rules of " Mendelian " inheritance theoretically enable the breeder

to effect any desired combination of the characteristics possessed, visibly or in a latent state, by the parents chosen for crossing, subject to the following conditions: the parents must be mutually fertile in a high degree; the hybrid offspring must be self-fertile; and the progeny of the cross must be grown on at least to the third generation in sufficient numbers to ensure the appearance of all the theoretically possible combinations. Of these conditions it is the last that offers the most serious difficulties in practice. The simultaneous carrying out of quite a moderate number of Mendelian experiments is a task which, through sheer expansion of material, will rapidly absorb the energies of a large number of workers. Where the staff is occupied with other equally pressing lines of work, the only feasible plan is to select a few specially urgent or promising problems for Mendelian treatment, such as the case of wart-disease immunity already referred to (p. 12). For similar reasons a certain amount of " haphazard " crossing may justifiably be carried on by the practical breeder as a side-line, although there can be no doubt that, in the long-run, more will be accomplished by the slower and immensely more laborious Mendelian method.

It remains to point out two limitations to which Mendelism is subject, quite apart from the practical difficulties indicated above. In the first place, the Mendelian rules do not apply to all types of hybrids, though they do seem to hold good generally for crosses between closely-related pure lines and varieties—*i.e.*, for precisely those cases which are of primary interest in agriculture. Further, the novel types resulting from Mendelian crosses never possess any really new features, but merely constitute fresh combinations of characteristics already represented in the ancestry of the original parents. For purely practical purposes this second point may be of no great moment; it seems advisable, nevertheless, to deprecate at the outset any tendency to regard the Mendelian breeder as a sort of wizard who can " create " new varieties at will.

The possibilities of intercrossing distinct species, long familiar to the horticulturalist, have hardly been exploited in relation to field crops. Some few experiments in this direction have indeed been carried out—*e.g.*, crossing of potato with wild species of *Solanum* with a view to intro-

ducing increased blight resistance—but without such conclusive results as might be obtained from investigations on a more extended scale. Mr Burbank, one of the most successful of the "empirical" hybridisers, relies very largely on inter-specific crossing, and makes it a point to accumulate all obtainable species related to the plants which he desires to improve, quite irrespective of whether the former have any obvious useful properties or not. It is probable that a similar policy might be pursued with great advantage in the case of forage plants, especially clovers, vetches, and other members of the Leguminosæ, a family which in any case is rich in species of potential herbage value.

5. Mutations.

Mutations or "sports" provide the only source of genuine novelties—*i.e.*, races exhibiting characters not possessed by the immediate parent or any of its known ancestors. It is therefore of the utmost importance that any mutations that may be encountered should be promptly isolated and their potentialities investigated. Unfortunately the conditions provided by a Plant-Breeding Station are not the most favourable for the frequent appearance of sports. Mutation in general seems to be a rare occurrence, and is more likely to be met with where few varieties or species are cultivated in bulk than where numerous strains are grown in small quantities. For this reason all interested in the work of the Station are earnestly requested to mark down any sports that may come under their notice, and if possible to secure living specimens for the Station. It is not essential that the sport should possess features of practical value; sporting is a sign of a constitutional disturbance, and a worthless and apparently solitary sport may be a member of a whole group of mutations, among which some may be of value.

6. Manuring, Cultivation, and General Treatment of Crops.

At first sight it might appear that a plant-breeding station should be conducted on the lines of a model farm, high cultivation, heavy manuring, and all the other re-

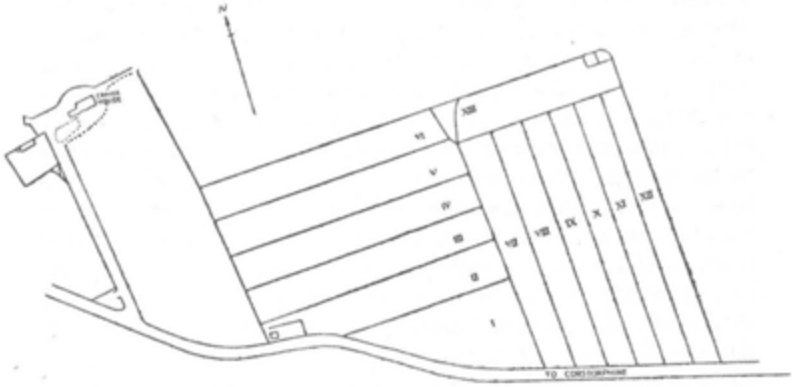
sources of scientific agriculture being applied so as to secure the best possible crops. Such a policy would, however, be entirely mistaken. The object is not only to produce new varieties, but also to test their value as compared with the best varieties already on the market. The ideal procedure would then rather be to subject the new races to tests exceeding in severity any that they are likely to experience under general cultivation. In practice, however, such drastic treatment cannot very well be attempted at the Breeding Station itself, if only because of the constant loss of valuable material which would certainly result from its general application. The safest plan is to follow a middle course by treating the experimental crops with average care, adhering as closely as circumstances permit to the modes of cultivation customary in the neighbourhood. For similar reasons the ordinary six-course rotation is carried out on the experimental fields as far as is feasible. Scarce or specially valuable material may naturally require more careful treatment, and operations which are unnecessary or impracticable on the farm may have to be resorted to in order to ensure the perpetuation of a strain represented by a few individuals, or even by a single plant or a solitary seed. Sowing in boxes or pans of partially sterilised soil, forcing under glass, multiplication by cuttings, and other devices proper to gardening rather than to agriculture, are indispensable adjuncts for the practical plant-breeder, though, owing to the additional labour, time, and outlay involved, he will use them as sparingly as possible.

In order to determine whether the conventional manurial treatment applied so far is actually suited to the soil at Craigs House, arrangements have been made for a soil analysis of the experimental fields to be carried out by the chemical staff of the Edinburgh and East of Scotland College of Agriculture (through the kindness of Dr A. Lauder). A number of samples were taken for this purpose early in 1922, and the results of analysis will be communicated in due course.

7. Experimental Plots and "Commercial" Crops.

The smallest plot employed in experimental work is the breeding plot, which may contain a single plant or as

many as 500, according to circumstances. It is utilised in the production of pedigree strains, in sorting out the various types of progeny resulting from a cross, and for propagating new material on a small scale for preliminary study. Desirable types which prove to be "fixed" after several years' trial in breeding plots are next grown in larger multiplying plots with a view to increasing the stock of seed. Comparative tests are carried out either with small plots (up to $\frac{1}{100}$th-acre) in replicate, or with single plots of larger area ($\frac{1}{10}$th-acre and upwards). The system of replicate small plots is in many respects the more reliable,



PLAN
SCOTTISH PLANT BREEDING STATION.
1922

but entails much additional labour and involves increased risk of mixing of varieties. In practice the size and number of the trial plots will be largely determined by the amount of seed available and the number of varieties to be compared. The above description applies more particularly to cereals, but the arrangements for other crops differ only in minor details.

While as great an area as possible is naturally devoted to experimental work, a variety of considerations make it necessary to fill a certain number of divisions each year

with "commercial" crops. The desirability of carrying out the normal rotation has already been mentioned. Further, if a division were to be split up into numerous small plots year after year, there would be a serious risk of disturbing its uniformity—a danger which is avoided by cropping the whole division with one variety of oat, &c., now and again. Apart from such considerations, it is highly inadvisable to locate experimental plots of a particular crop on the same ground in successive years, owing to the certainty of "ground-keeping" seeds or tubers appearing as impurities in the current crop. The same objection applies to the employment of a permanent protective cage. Movable cages, if more troublesome to handle, are much safer from the point of view of maintaining pure stocks, a matter of prime importance. Their use will therefore be continued for general purposes, though fixed wire cages will be required for special material when this attains dimensions sufficient to warrant the expense of erecting a permanent protection.

II. Research Programme—Detail for 1921 and Forecast for 1922.

A. Cereals.

Oats, 1921.—Area, 21½ acres. Divisions II., V., VI., and the whole of Field B (Divisions VII.-XIII.)

Artificial manures (whole area)—

Superphosphates . . .	2 cwts per acre.
Kainit	2 „ „
Sulphate of Ammonia . .	¾ „ „

Experimental Plots. Division II. 2½ *acres.*

Pure Lines.—The work of selecting pedigree strains from the representative collection of named varieties started by the late Dr Wilson was continued. Some of these pure lines may prove valuable, and they are required in any

case to serve as standards with which to compare new varieties bred at the Station.

Crossed Oats.—Selections were taken from the previous year's stock; about 16,000 grains were sown singly. The age of the hybrids ranged from the first generation from the cross (F_1) to the fourth generation (F_4). F_1 and F_2 hybrids were caged. The grain suffered considerable damage from the wet weather at harvest time, so that the natural colour of the grain and some other characters could not be determined. This difficulty will be largely overcome when a shelter for drying and storing small samples has been erected. Selections were made from the various hybrids and the selected plants critically examined. The aim of most of the crossing was to obtain improved varieties of oats of the Potato, Sandy, and Tam Finlay types, and the results have been sufficiently promising to encourage further efforts in this direction. Some of the F_5 hybrids were approaching fixity of type, and it is hoped that in 1922 these will prove to be fixed and thus be ready for multiplication.

Multiplication plots ranged from 2 sq. yds. to $\frac{1}{10}$th acre. All varieties but one had been multiplied from small samples. The $\frac{1}{10}$th acre (12) and the $\frac{1}{100}$th acre (12) plots were sown by the seed-drill at the rate of 2,700,000 grains per acre. Besides supplying comparative data (see Table I.), these plots also revealed some of the difficulties encountered in maintaining purity of stocks, a matter which is of greatest consequence in the early stages of multiplication. In spite of every precaution, a small percentage of rogues were found to recur in a number of varieties. One unexpected cause of admixture met with in 1921 (and again in 1922) was the storing of seed in small "granaries" by rats and mice; these pests were found to steal seed from sown plots and carry it to adjacent plots (unsown at the time), where it was easily overlooked, as it had been carefully buried by the thieves.

The results of trials of named varieties grown in 1921 are set forth in Tables I. and II.

Table I.—Oats, 1921.

Name or Reference No.	Source.	Days to mature.	Grain per acre.	Straw per acre.
			Bushels	Tons.
Mansholts No. 1	Dr Mansholt, 1920	129	57·1	1·35
Mansholts No. 2	,, ,,	126	57·1	1·25
Mansholts No. 2a	,, ,,	125	57·1	1·25
Mansholts No. 2b	,, ,,	125	59·5	1·3
Mansholts No. 3	,, ,,	127	57·1	1·25
Garris	St Andrews, 1920	135	59·5	1·15
Glebe	,, ,,	128	57·7	1·05
Kinness	,, ,,	131	52·3	1·15
1 F. (c) B.	,, ,,	135	47·6	·95
Joanette	,, ,,	131	38·09	·95
3 (C) 3	,, ,,	123	50·	1·15
3 D. 4	,, ,,	126	47·6	1·
Bjarn	Svalöf, 1920	123	33·1	·85
Crown	,,	128	43·3	1·15
Early Siberian	Vilmorin, 1920	122	46·4	·85
Giant Yellow	,,	134	39·5	·7
Golden Rain	Svalöf, 1920	122	53·3	1·25
Klock III.	,,	123	53·5	·95
Ligowo	,,	123	61·2	1·05
O. A. C. No. 72	Canada, 1920	121	49·04	1·25
O. A. C. No. 3	,,	121	24·5	·55
Orion	Svalöf, 1920	111	31·2	1·15
Trifoliums	Trifolium Co., 1920	122	51·4	1·5
Victory	Svalöf, 1920	122	53·35	1·2

Table II.—Analysis of Straw of Oat Varieties, 1921.

	Mansholts. No. 1.	Mansholts. No. 2.	Mansholts, No. 3.	Joanette.	3 D. (4).	Glebe.	Garris.	I. F. c. B.	Kinness.
Water		calculated to 12 per cent at 100° C.							
Laevulose	0·00	0·13	0·66	0·00	0·00	0·00	0·00	0·00	0·00
Cane Sugar	·05	·08	·10	·09	·10	·20	·05	·11	·18
Other Sugars	·55	·56	·23	·51	·78	·92	·49	·66	1·55
Total Sugar	·6	·77	·99	·60	·88	1·12	·54	·77	1·73
Albuminoids	3·17	2·98	2·57	2·45	2·81	5·04	3·06	2·82	3·44
Ash	6·01	5·58	5·88	4·85	4·85	6·38	5·28	5·06	5·39

The analysis figures of straw of certain varieties (Table II.) were kindly supplied by Mr S. H. Collins, The Armstrong College, Newcastle-on-Tyne, to whom samples were forwarded at his request. The relatively high quality of "Glebe" straw is noteworthy. The exceptionally dry

season adversely affected the yields of grain and straw, which are probably below average for all varieties. Definite conclusions cannot be drawn from a single year's trial, but the early ripening of Orion, which came to maturity in 111 days from date of sowing, is striking, and confirms previous observations on small plots of this variety.

Commercial Crops. 18½ *acres.*

Field B (13½ acres) was sown with Crown oats purchased from Svalöf, at the rate of 6 bushels per acre, by seed-drill, 3 bushels being drilled parallel to and 3 bushels across the furrows. The oats brairded well, but the protracted drought affected the yield adversely. Bad weather was experienced at harvest time, and it was not possible to cut the crop as soon as it was ripe. Some grain was thus lost in handling, but on the other hand there was no sprouting or discolouration as in most of the other oats. The crop was stacked in the field and later thrashed with the "Homestead" thrasher, precautions being taken to prevent any admixture of other varieties. Total yield, 105 qrs., equal to about 62 bushels per acre.

Divisions V. and VI. (together 5 acres) were cropped with Hamilton, Crown (once grown), and Victory oats, Division VI. being afterwards sown out for one-year ley.

Yields :

Hamilton	59	bushels per acre.
Crown	72	„ „
Victory	76	„ „

As there are no facilities for cleaning or storing grain at the Station, all the commercial samples (except for 3½ qrs. of Svalöf Crown oats retained for seed) were handed over after thrashing to Messrs David Bell, Ltd., of Leith, for disposal.

1922 (*Forecast*).—*Experimental Plots.* 2½ *acres. Division I.*

The pure line and hybrid selections work is being continued on the same lines as before. Other experiments include: investigation of inheritance of ear-type; com-

parative trials of a number of varieties raised from small samples; multiplication of pure lines of Potato, Tam Finlay, Sandy, and Hamilton in the breeding plots. About 18,000 grains have been sown by hand, representing 88 selections from named varieties and close on 200 from hybrids.

The experimental material on hand has thus grown to such dimensions that few or no fresh crosses can profitably be undertaken for the present.

Commercial Crops. (*7 acres approximately.*)
Divisions V., X., XI., and XII.

Division V. Victory, 1 acre (rest of Division multiplication plots of three varieties).
Division X. Crown, 2 acres.
Division XI. Crown, 2 acres (see p. 24).
Division XII. Crown, 2 acres, sown out (see p. 24).

Wheat, 1921.—The only wheat cultures were two small multiplying plots of the spring wheats Huron and Marquis, and a small breeding plot of Victor. The samples were late in arriving, and the yields were not so high as might have been obtained with earlier sowing. (See Table III.)

1922 (*Forecast*).—The collection of wheats now amounts to about fifty varieties and species. These are being grown in small breeding plots ($\frac{1}{100}$th-acre plots, or less according to seed available) for preliminary study and classification. Larger quantities ($\frac{1}{10}$th-acre plots) have been sown of Huron and Marquis.

Barley.—Comparative trials of a few named varieties were carried out in $\frac{1}{100}$th-acre and $\frac{1}{10}$th-acre plots; the seed, with two exceptions, was obtained by multiplication from small samples received in 1920. All plots of barley (and wheat) received artificial manures on the following scale:—

Superphosphates . . .	2 cwt. per acre.
Kainit	2 „ „
Sulphate of Ammonia . .	$\frac{1}{2}$ „ „

Rate of seeding, 1,500,000 grains per acre. The results are set forth in Table IV.

1922 (*Forecast*).—$\frac{1}{10}$th-acre plots have been sown for comparative trial from the following varieties: Plumage, Plumage Archer, Spratt Archer, Golden Pheasant, Duckbill, Smooth Goldthorpe 21, Brewing Chevalier A., Primus and Alida.

TABLE III.—WHEAT, 1921.

Name or Reference No.	Source.	Days to mature.	Grain per acre.	Straw per acre.
			Bushels.	Tons.
Marquis . . .	Canada (Murray), 1920	133	25	1·4
Huron . . .	,, ,,	133	25	1·25

TABLE IV.—BARLEY, 1921.

Name or Reference No.	Source.	Days to mature.	Grain per acre.	Straw per acre.
			Bushels.	Tons.
Duckbill . . .	Canada (Murray), 1920	113	23·2	1·25
Smooth Goldthorpe (50)	Dr Smith, 1920 . .	120	26·7	1·25
,, ,, (21)	,, . .	120	37·5	1·6
Peacock . . .	,, . .	115	26·7	1·55
Clara . . .	Holland, 1920 . .	113	35·6	1·5
Brewing . . .	Dr Smith, 1920 . .	117	46·4	1·9
Chevalier A. . .	,, . .	116	42·6	1·8
Alida . . .	Holland, 1920 . .	112	35·6	1·3
Stein . . .	,, . .	112	33·9	1·35
Louise . . .	,, . .	113	28·5	1·5
Golden Pheasant .	M'Gill & Smith, 1921 .	114	26·7	1·25
Princess . . .	Svalöf, 1920 . .	118	30·5	1·
Gold . . .	,, . .	111	37·2	1·05
Prentice . . .	Tystofte, 1920 . .	117	38·1	1·15
Moravie . . .	Vilmorin, 1920 . .	114	35·1	·65
Svanhals . . .	Svalöf, 1920 . .	106	30·	·7
Primus . . .	,, . .	106	27·9	·65

Disease in Cereals.—Very little disease of any kind was encountered. The only case of interest was the appearance of Leaf-Stripe (Helminthosporium) on certain oat varieties, the breeding plots of Aurora and Albion (seed from U.S.A.), and one Sandy × Giant Yellow Hybrid being severely attacked while adjoining plots of other varieties were quite untouched.

B. POTATOES.

1921.—The experiments with potatoes have so far consisted mainly in propagating and selecting from the 200

or more varieties and strains which had been raised in the St Andrews experiments by the late Dr J. H. Wilson. A large proportion of these consist of unnamed varieties of various ages from the seed. The oldest strains were raised about 1912, and the newest in 1919. The selections made in the 1920 experiments were propagated in 1921, and occupied an area of over two acres (Division III.). The most promising samples amongst the older varieties were grown in moderate quantities; of some, over 1000 tubers were planted.

As very few of the unnamed varieties had been tested for immunity from wart disease, samples of all the untested varieties were sent to the Wart Immunity Trials carried out by the Board of Agriculture for Scotland at Philpstoun. Of 176 varieties or selections submitted, 76, or over 40 per cent, proved susceptible on first trial. Only one tuber from each of the 1919 seedlings was sent to the trials, and as the season was not favourable to the development of wart disease, it is possible that when the progeny of the 1919 seedlings are tested on a larger scale this year, a further number may prove susceptible. Acting on the instructions of the Potatoes Sub-Committee, many of the non-immune varieties have been discarded; some of the more promising have been retained in small quantities, as they may be useful as parents for crossing.

Prior to the harvesting of the experimental crop in 1921, the Potatoes Sub-Committee inspected the experiments, and examined samples which had been lifted from what were held to be the most promising selections in some of the older strains, a number of named varieties being dug at the same time for comparison with the unnamed varieties. It was decided that twelve varieties should be multiplied, if found to be immune from wart disease. In view of the modifications in the regulations regarding the planting of non-immune varieties in certain districts, some of the non-immune varieties are now also being multiplied. The chief characteristics taken into account in selecting in the early stages have been—yield, shape and colour (external and internal) of the tubers, period of ripening and resistance to blight.

Diseases.—Very little blight was observed, the exceptionally dry season being unfavourable for the development

of the disease. The virus diseases "Leaf-Roll" and "Mosaic" are prevalent in some strains. A few varieties were markedly affected with what is termed "Rust." It was suggested by an eminent plant pathologist who visited the Station in summer that development of this condition may be due to lack of potash in the soil. It is expected that the soil analysis now in progress will throw light on this point.

Seedling Potatoes.—A small quantity of the potato seeds received from Dr Wilson's representatives was sown in addition to the seeds from two crosses secured in 1920. Lack of facilities for growing potato seedlings last year allowed of only a restricted amount of this work being carried out. Three hundred and eighty-six seedlings were raised under glass and ultimately planted out. Fifty seedlings were raised from a "Templar" × "Bishop" cross. There were many promising plants amongst them, and samples from all the surviving plants (42) have been retained and sent to be tested in the Wart Disease Trials this season, the object in sending samples for *all* the plants being to obtain information regarding the inheritance of immunity from that disease. Fifty-four samples from a "Templar" × "Flourball" cross have also been sent to the Wart Disease Trials with the same object in view. In all, 128 single tuber samples have been sent for inclusion in this year's Wart Trials.

1922 (*Forecast*).—*Area,* 4⅓ *acres. Divisions II. and VII.*

The larger multiplication plots occupy about three acres, the remainder of the area being occupied by small trial plots. A selection of named varieties is being grown in replicate for comparison with experimental strains. The small trial plots are laid out in five standard sizes—(1) 5-tuber tests of about 132 selections from seedlings raised in 1921; (2) 12-tuber tests of 39 selections; (3) 25-tuber tests of 11 selections; (4) 50-tuber tests of 16 selections; (5) 100-tuber tests of 9 selections. The 50-tuber tests have been put in in duplicates of 25, the 100-tuber tests in quadruplicates of 25.

A collection of named varieties is being formed. Twenty-seven samples have been obtained from Craibstone Experi-

mental Farm, Aberdeen, and a similar number from the Fredericton Experiment Station, New Brunswick.

Potato Seedlings.—Over 6700 potato seeds have been sown this season, a large proportion being chosen from the late Dr Wilson's stock of potato seeds which the Society received last year. The whole of the progeny of some of the resulting seedlings will be retained for inclusion in next season's Wart Disease Trials (1923).

It is intended to carry out a certain amount of crossing this season, and also to try repeated selfing of "Templar," "Bishop," &c., in the hope of producing strains that will breed true in respect of immunity.

The main objects to be kept in view in the potato experiments are immunity from wart disease, high cropping capacity, coupled with a high standard of table quality and early maturity.

C. Herbage Plants.

The work on herbage plants, which it is intended to develop into one of the main lines of research, is still in the preliminary phase of collection of material. No field area was available for this purpose in 1921, but in the current year 1½ acres (Division XIII.) are being fallowed and cleaned for the reception of herbage plots. In order to reduce interference with the rotation in the main portion of Field "B" to a minimum, the herbage area is placed athwart the arable Divisions (VII.-XII.), and can thus be extended southwards as occasion demands. During the latter portion of 1921 about sixty small plots (each 4 yds. × 2 yds.) were cut on the east side of the drive to provide temporary accommodation for grasses and clovers. Two-thirds of these beds are already occupied, and the samples in hand are more than sufficient to fill up the rest. The permanent rôle of these beds will be to act as small plots for potentiality trials of untested novelties.

The untouched field of research among herbage plants is so vast that it was of great importance to make a definite choice of the most urgent problems at the earliest opportunity. The undernoted provisional scheme was approved by the Board of Directors in January 1922 :—

(*a*) Grasses and clovers to be improved by selection and hybridisation in the following order of importance :

Perennial Ryegrass, Timothy, Cocksfoot, and Wild White Clover, other grasses and clovers.

(*b*) Research on Fescues and other turf-forming grasses to be prosecuted as opportunities permit.

(*c*) The possibilities of Lucerne to be investigated.

Work on all these problems has been started with the samples in hand, among which Wild White Clovers (plants, chiefly from the North of Scotland) and commercial strains (seed) of the principal herbage crops are best represented. Material is required of plants and seeds of indigenous grasses — especially Perennial Ryegrass, Timothy, and Cocksfoot—and of plants of Red Clovers. Contributions of these, and indeed of any promising herbage plants, will be welcomed from members and others at any time, but preferably in spring or autumn.

The herbage work is not sufficiently advanced to warrant detailed discussion. A few points of interest may be referred to in passing. The material sown or planted so far, though limited in extent, comprises many distinct strains of Wild White Clover and several of Wild Red Clover and Perennial Ryegrass. If the collection continues to expand at the present rate, it will soon be possible to start with methodical classification of the various races and isolation of pedigree strains. Studies on the technique of selfing and crossing will be carried out throughout the flowering season. Among the species acquired for small-scale potentiality trials may be mentioned Subterranean Clover, several foreign clovers, including one (*Trifolium Johnstoni*), apparently of the Wild White type, Japan Clover, Siberian Vetch, and Western Ryegrass (*Agropyron tenerum*). Observation of a small number of Lucerne plants (Grimm's Alfalfa) grown in pots suggests that absence of the proper nodule-bacterium may be a factor adversely affecting the establishment of this crop in our soil. Cultures of nodule-bacteria have been obtained from Denmark, and small-scale trials between infected and non-infected plots are now being carried out. The Lucerne plants raised in 1921 were all of the "non-fibrous" type (*i.e.*, with a single main root), and those which were planted out in autumn and survived the winter suffered from the "heaving" action of alternate frosts

and thaws in the manner characteristic of this type, as shown by Professor Southworth of the Manitoba Agricultural College. This point is probably of importance in relation to the winter hardiness of Lucerne, and is receiving further attention.

D. Roots.

Swedes and Turnips, 1921.—Area, 2½ acres. Division I., being earmarked for roots in the rotation scheme, was divided among thirteen named varieties of Swedes for a rough comparative test. The results were not sufficiently conclusive for publication, but the experiment was useful inasmuch as it led to the working out of a system of sampling for yield, based on a unit of sixteen lineal yards of drill, which proved satisfactory, and will be adhered to for the present. Twenty further varieties of Swedes and turnips were grown in small quantities in garden beds for botanical study; all came through the winter without protection other than ridging up, and are being carried on for study of second-year characters and practice in the technique of selfing and crossing. Several plants of one Swede variety (and a single plant of another variety) showed the interesting phenomenon of root-budding. The shoots developed from the root-buds differ strikingly in appearance from the main shoot, resembling Kale rather than Swede. The production of bud-sports from roots seems to be a novel feature in the Swede. The process is of great theoretical interest, as shown by the work of Dr Bateson and his collaborators at the John Innes Horticultural Institution on Pelargoniums, &c.; whether it has any practical importance in the case of Swedes remains to be seen, but as a possible method of obtaining new varieties it is receiving careful attention.

1922 (*Forecast*).—The principal feature is a large trial (8 acres) of representative Swede and turnip varieties. More than eighty of these will be grown in small replicate plots, three plots of each variety being located on Divisions VIII. and IX., and three on the Plant Registration Station. The main purpose of the trial is preliminary study and classification of the varieties and determination of yield, dry-matter content, hardiness, and other characters of prac-

tical value. It has been arranged for six of the varieties to be grown simultaneously from the same seed at the Craibstone Experimental Farm and for feeding tests to be carried out with these by the Rowett Institute of Animal Nutrition. Comparison of the actual food-values of several varieties, as determined by feeding tests, with the values indicated by dry-matter estimation, will, it is believed, be of great assistance in the devising of a reliable method of assessing "quality," at present a somewhat elusive character in all crops, but eminently so in the case of Swedes and turnips. This trial forms the first phase of a methodical programme of research on Swedes and turnips to be carried out jointly by the Scottish Registration and Plant-Breeding Stations, with the co-operation of the North of Scotland College of Agriculture, the Rowett Institute, and such other institutions as may eventually become associated with the scheme.

Seed of a number of Swedes bred by the late Dr Wilson on a basis of chemical selection of individual plants is in the Society's possession, and is being sown in 1922 for further investigation. It is unlikely, however, that much progress can be made along these lines until the Society's staff is augmented by the addition of an expert biochemist.

Commercial Crops. 2 acres. Division IV. (See Section E.)

Mangolds and Beets.—None were grown in 1921. A few representative varieties will be grown in 1922 in small quantities for preliminary study.

E. Miscellaneous Crops.

Sunflower.—A small plot was grown in 1921 with a view to testing the suitability of this crop for Scotland. The yield worked out at 16·7 tons per acre (fresh weight); but this includes a high proportion of fibre, and the general appearance of the plants was not encouraging, even the exceptionally fine summer of 1921 not having been sufficiently "Continental" in character to produce a heavy crop.

Green Manures.—Sweet Clovers (species of *Melilotus*) are considered useful green manure crops in North America, notably the biennial species (*M. officinalis* and *M. alba*). The newly introduced Annual White or "Huban" Sweet Clover (*M. alba annua*) is said to be the least valuable for this purpose, an unfortunate circumstance, as its annual character would otherwise render it specially suitable as a green manure for potato growers. Strains of various Sweet Clovers have been obtained for trial in 1922.

Shallow and Deep Sowing.—Some controversy has arisen about this subject during recent years in England, where exponents of shallow sowing of cereals are pressing their views energetically. A small experiment with wheat on these lines is in progress at the Station, and a larger area sown with barley (Division III., 1 acre) for rotation purposes has been divided into shallow and deep (normal depth) sown sections.

Rotation Crops (1922).

Division IV.	Swedes.
Division VI.	Hay.
Division V.	Sown out for 1-year ley under Oats.
Divisions X. and XI.	Oats.
Division XII.	Sown out for ley under Oats; clover mixture the same throughout, with six different strains of Italian ryegrass laid out in strips across the Division.

III. Publications, Lectures, and Official Visits by Staff.

PUBLICATIONS.

W. Robb, Assistant-Director: "Potatoes, Their Breeding, Selection, and Development" (paper read to the International Potato Conference, London, November 1921).

VISITS.

Director :—

Welsh Plant-Breeding Station, Aberystwyth, June 1921 ; [1] Plant-Breeding and Agricultural Experiment Stations in Denmark and Sweden, October 1921.[1]

Assistant-Director :—

Craibstone Experimental Farm, September 1921; International Potato Conference, London, November 1921 (as delegate).

IV. Demonstrations and Exhibits.

DEMONSTRATIONS TO PARTIES VISITING THE PLANT-BREEDING STATION.

Scottish Chamber of Agriculture, August 1921.

Agricultural Education Society, September 1921.

British Association for the Advancement of Science, Section M (Agriculture), September 1921.

EXHIBITS.

Highland and Agricultural Society's Show, Stirling: exhibit of photographs and literature.

International Potato Conference, London: exhibit of potato varieties.

V. Buildings and Equipment.

The alterations and additions to Craigs House, comprising provision of a separate entrance to the office, with cloak-room accommodation, and the conversion of an outhouse into a provisional laboratory, were begun on 31st January 1922, and are nearing completion.

The principal items of equipment purchased since the establishment of the Station are as follows :—

42" "Homestead" thrasher, with special fittings for ease and certainty of cleaning.

[1] Separate Reports already submitted to the Board of Directors.

Rotary grader (hand-drive).
Haveller (hand-drive).
Steelyard (3 cwt.)

Also, a complete set of card-index files and ledgers for systematic registering of material and recording of data. The nucleus of a library has been acquired by purchase of the principal handbooks and subscription to the leading scientific periodicals devoted to the subject of plant-breeding.

VI. Acknowledgments.

Grateful acknowledgment is made to the undernoted departments, institutions, firms, and individuals for gifts of samples (up to 31st March 1922).

David Bell, Esq., J.P. (Messrs David Bell, Ltd., Leith).
The Board of Agriculture for Scotland.
J. Cadzow, Esq., Broxburn.
Central Experimental Farm, Ottawa.
Capt. Clayton (Messrs Edw. Webb & Sons, Ltd., Stourbridge).
Wm. Cuthbertson, Esq., V.M.H. (Messrs Dobbie & Co., Ltd., Edinburgh).
Director, Royal Botanic Gardens, Kew.
Director, Welsh Plant-Breeding Station, Aberystwyth.
Messrs John Donaldson & Co., Edinburgh.
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Kansas Agricultural College, Manhattan.
Manitoba Agricultural College, Winnipeg.
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