

1946

SCOTTISH SOCIETY FOR RESEARCH IN
PLANT-BREEDING.

ABRIDGED
REPORT BY THE DIRECTORS.

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

At the present juncture the main problems confronting the Directors and to which they have been giving earnest consideration are: (1) the appropriate scale on which to expand the Society's investigational work so as to expedite the improvement of Scottish crop plants, and (2) the acquisition of the necessary additional ground and equipment for the plant-breeding experiments. For the former an enlarged programme of work has been prepared, discussed and approved, and the programme has been submitted for consideration by the Department of Agriculture for Scotland. The Directors are agreed that the work already on hand should be undertaken on a more extensive scale if the rate of progress in achieving the desired practical plant-breeding results is to be quickened. It is obvious there is now ample scope for more productive, disease-resistant crop plants of highest nutritive quality. In the years between the two wars the food produced was in excess of the effective demand and a world-wide problem then was the disposal of surplus food-stuffs, whereas the difficulty now is how to make good the deficiency. We are convinced that plant-breeders can make a worth-while contribution if they are given reasonably adequate facilities to pursue their work as effectively as possible.

The second problem—that of obtaining more land—presents difficulties. There is not much likelihood of land being available within easy reach of the Plant-Breeding Station, and the question of moving the Station to another site is under consideration. If it were decided to leave Corstorphine and to obtain land in another district the difficulty of erecting the necessary buildings on the new site would not be easily overcome under present conditions. It is generally agreed that the plant-breeding station should be within easy reach of Edinburgh, but it is also necessary, from the experimental point of view, that the land should not be readily accessible to trespassers.

The present position is that in view of plans for development of agricultural education and research by the Government it is advisable to delay meantime making any final or far-reaching decisions until more details are available regarding the Government schemes relating to agriculture.

It has, however, been possible to take some preliminary steps towards expanding the Society's research work. Experiments in grassland improvement have been started this year in Wester Ross, where 10 acres of land have been made available for the herbage work.

Staff.

In the financial year ended 31st March 1946 three new members were appointed to the Society's scientific staff: Miss T. M. R. M'Ghee, B.Sc. (in October 1945), who will work on potato virus disease problems; Mr Donald Cameron, B.Sc. (in March 1946), who will undertake work on cereals; and Dr J. C. Haigh (in March 1946), who will undertake work in connection with potato breeding at the Society's Sub-Station at Boghall. Mr Charles A. Lyall, B.Sc., who joined H.M. Forces in 1941 and has attained the rank of Squadron Leader,

has not yet been released, but it is expected that he will be demobilised this summer, and that he will resume his duties at the Plant-Breeding Station some time later. Dr William Black and Dr George Cockerham were again granted leave of absence in August to assist as temporary inspectors under the Department of Agriculture for Scotland scheme for the inspection of growing crops of potatoes.

Labour.

It is obvious that to carry out plant-breeding field experiments efficiently an adequate supply of labour at all periods of the year is essential. In the course of the last ten years or so it has become much more difficult to obtain a sufficient number of capable and reliable workmen, and this scarcity of labour has become a limiting factor in the amount of field work that can be undertaken satisfactorily. This difficulty in getting workmen is largely due to lack of suitable housing accommodation at or near the Plant-Breeding Station. Only two workmen's houses are available at the Station, and they are old and lack modern conveniences. In giving consideration to increasing the present programme of research work the question of providing housing accommodation for the Society's workmen is urgent, and will have to be taken into account.

Membership.

The Directors regret to report that in the past year eight members died, three members resigned, and the names of two members in arrear with their subscriptions were deleted from the roll. They are pleased to record, however, that twenty-three new members were elected during the year; five of these became life members. At 31st March 1946 the membership numbered 344, and consisted of 152 life members and 192 annual members (19 at the 5s. rate and 173 at the 10s. rate of

subscription). A list of members appears on pages 40 to 49 hereof.

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

**List of Varieties of Crop Plants raised or selected
by the Society and introduced into Commerce.**

<i>Oats</i> —		Date of Registration.
Elder	} Registered by the Department of Agriculture for Scotland as new varieties.	1930
Bell		1932
Early Miller		1934

Wheat—

Scottish Iron III.

Barley—

Craigs Triumph.

Potatoes—

The Alness	} Registered by the Department of Agriculture for Scotland as new varieties.	1934
Craigs Defiance		1939

Grasses—

"Scotia" Cocksfoot, Ref. No. *Cc* 196.

Timothy, Ref. No. *Cb* 224.

Perennial Ryegrass, Ref. No. *Ca* 448.

R E P O R T

BY

DIRECTOR OF RESEARCH

I. Research Programme.

GRAIN CROPS.

WILLIAM ROBB, *Director of Research.*

CHARLES A. LYALL, B.Sc., *Assistant.* (On Military Service.)

DONALD CAMERON, B.Sc., *Temporary Assistant.*
(Appointed 4th March 1946.)

Oats.

During the war years there were only limited facilities for having larger-scale field trials at the Plant Breeding Station or in other regions in Scotland. New oat selections which had shown certain promising characteristics in the small trial plots at the Station could not be adequately tested, but they were grown in small quantities in readiness for multiplication when conditions should become more opportune. In 1944 several new varieties were increased in quantity, and seed of those undernoted was available for some outside trials in 1945 :—

[TABLES

Ref. No. of Variety.	Parentage.	Crossed.	Remarks.
Aa 670	Orion × Yielder	1924	Straw of medium length, early-ripening ; grain white, large.
Aa 676	Castleton Potato × Yielder	1924	Straw short, resistant to lodging, early-ripening ; grain white, well-filled, rather under medium size.
Aa 705	Castleton Potato — Beseler's Prolific — Hybrid × Victory × Black Mesdag Hybrid × Hybrid × Hybrid × Marvellous Hybrid × Hybrid	1935	Straw of medium length, early-ripening ; grain white, large, well-filled.

Ref. No. of Variety.	Parentage.	Crossed.	Remarks.
Aa 707	Potato × Marvellous	1934	Straw of medium length, about the same as that of Victory, early-ripening; grain white, well-filled.
Aa 708	Castleton Potato × Yielder × Elder	1935	Straw short, highly resistant to lodging (see Fig. 1), early-ripening; grain white, well-filled.
Aa 710	Elder × Marvellous	1934	Straw medium length, rather soft when ripe, medium early-ripening; grain white, well-filled.
Aa 711	Victory × Black Mesdag └───┬───┘ Hybrid × Victory └───┬───┘ Hybrid × Elder └───┬───┘ Hybrid	1936	Straw short, resistant to lodging, early-ripening; grain white, medium size.

Undernoted are extracts from reports received regarding trials of several of the Society's varieties in 1945.

Trials in Shetland.—Four varieties—viz., *Aa 670*, *676*, *707*, and *708*—were included in the trials, which were conducted by Mr Andrew Howie, B.Sc., County Organiser, Lerwick. The four varieties were sown on 29th March. In his report Mr Howie states:—

“The following comments and comparisons can be made:—

Aa 670: Yield of grain and straw much inferior to the others (matured in 148 days).

Aa 676: Excellent yield both of grain and straw, regarded as easily the best variety on trial (matured in 151 days).

Aa 707: Good yield and early-ripening (matured in 147 days).

Aa 708: Good yield and early-ripening (matured in 147 days).

The oat variety in the field was *Yielder* (new seed obtained from Aberdeen). Due to freight delay *Yielder* unfortunately could not be sown until 11th April (13 days later than the others). It matured in 143 days. Only one variety—*Aa 676*—exceeded the *Yielder* plot in yield of grain and straw. Standing power of varieties could not be satisfactorily assessed this year since excellent weather conditions resulted during month of August. All varieties standing at cutting time.”

Trials at Craibstone, Aberdeen.—In the “Standing Power Trials” conducted by Mr W. M. Findlay, Superintendent of Experiments, there were eleven varieties, four of which were raised at the Scottish Plant-Breeding Station. The report received regarding the trials shows that—

Aa 708 was first in order of maturity. It showed no signs of lodging (see Fig. 1) and gave a yield of 24.4 cwt. of grain per acre.

Aa 711 was second in order of maturity. The crop did not lodge and the yield of grain was 28.6 cwt. per acre.

Aa 707 was third in order of maturity. This crop lodged; it was quite flat at harvest time. The yield of grain was 21.3 cwt. per acre.

Aa 710 was eighth in order of maturity. The crop lodged badly and was flat at harvest time. The yield of grain was 27.8 cwt. per acre.



FIG. 1.

Oat Plots in "Standing Power Trials," Craibstone, Aberdeen, 1945. Mr W. M. Findlay drawing attention to variety *Aa 708* which is standing. The other variety, on right, is badly lodged. (*Photograph reproduced by permission of Aberdeen Journals Ltd.*)

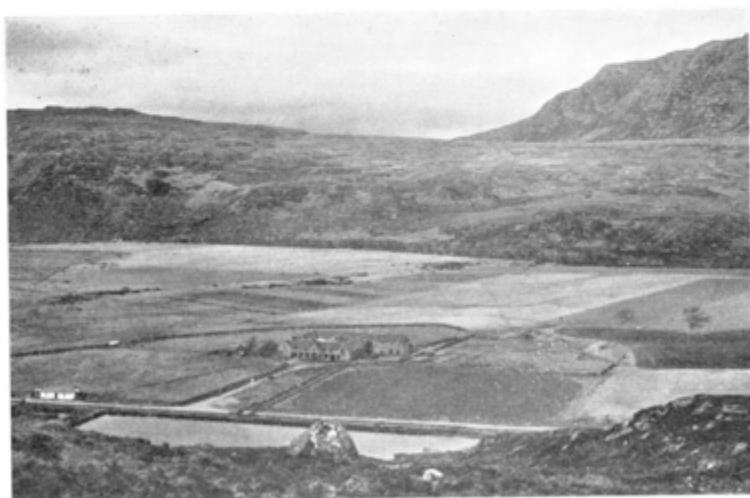


FIG. 2.

Complementary grazing at Black Muir, Dundonnell, Wester Ross. The trial area is seen immediately above the rock in the foreground. (April 1946.)



FIG. 3.
Crop of Bristle-pointed Oats (*Avena strigosa*), Tírce, 1945.



FIG. 4.
Rickles of new varieties of oats in early stages of multiplication, Plant-Breeding Station, Corstorphine. (September 1945.)

The variety Star was included in the trial. It was tenth in order of maturity and the crop lodged badly. The yield of grain was 27.7 cwt. per acre.

Trials arranged by the National Institute of Agricultural Botany, Cambridge.—By arrangement with the Director of the National Institute of Agricultural Botany four of the Society's new varieties of oats were included in observation trial plots in Yorkshire and Somerset. Had larger amounts of grain been available these varieties would probably have been included in larger replicated trials. The following extracts are taken from the Report received from the National Institute of Agricultural Botany :—

“ *Aa* 676 grown at Nafferton (320 feet) and Black Hedley (700 feet) only.

“ *Aa* 705 grown as *Aa* 676, and also at Cannington (30 feet) and West Somerset (950 feet).

“ *Aa* 707 grown at Cannington and West Somerset only.

“ *Aa* 708 grown at Nafferton and Black Hedley, and also at Cannington and West Somerset.

“ These oats were all grown adjoining Victory, which was used as a control.

“ The most striking feature of the plots was the big difference which occurred at certain centres in the time of maturing and length of straw. At Nafferton 676 and 705 were from 1 to 3 days earlier ripening and 708 about the same as Victory. Yet at Black Hedley all three varieties were 7 to 8 days earlier than Victory. At Cannington and West Somerset the differences noted were all smaller, and very little difference was noted between the two centres.

“ In straw length the differences were also very great. On the whole the straw was shorter than that of Victory, but while in places at Black Hedley a difference of 9 inches to a foot was noted, in West Somerset 705 and 707 were equally recorded as 3.5 inches taller than Victory.

“ The plots at Black Hedley were not on very fertile soil, and it is possible that the varieties react markedly to different growing conditions. Potato oat gives us rather similar variable behaviour in the southern half of England.

“ Very little lodging occurred except at West Somerset, and there 707 was considered to be rather weaker than the others or Victory.

"705 was considered to show rather more mildew and rust at Cannington and more mildew at West Somerset than the control.

"The yield of grain, judged solely on appearance, was not considered to be higher than Victory in any case except 708 at Cannington, where a slightly heavier yield was estimated."

There was some indication that *Aa* 676 and *Aa* 708 were the most promising for English conditions, and they have been included in further larger-scale yield trials in 1946.

Trials at Tiree.—Through the willing co-operation of Mr Alexander G. Malcolm, County Organiser, Oban, a small-scale preliminary trial of a few unfixed oat selections was made on alkaline soil in the Island of Tiree in 1945 to see how these oats responded to conditions there. The seed, however, could not be sown as early in the season as was intended, and although this was unfavourable for the success of the experiment the plants developed sufficiently well to allow of some being selected from the trial plot at the normal harvest time. It is hoped to continue the experiment on alkaline soil, where conditions should be advantageous for the development and selection of plants best adapted to the local soil and climatic conditions.

The customary-sized group of unfixed hybrid oats was grown at Corstorphine as spaced plants for selection of types characterised by good upstanding straw, early maturity, high productivity, and well-filled white grain. The selecting of crossed oats showing resistance to prompt germination at harvest time was continued. A few selections have given indications of breeding true for this desired character—*i.e.*, delayed germination at harvest time—and, if fixity of type in all the essential characters is shown, they will be multiplied in preparation for field trials. It may be mentioned that in testing for prompt germination at harvest time, grain from selected plants is sown in trays of moist sand in a greenhouse. In 1945 the grains from several selections, which in about eight weeks from the date of sowing had shown no germination or only a small percentage, were allowed to dry and kept in dry sand during the winter of 1945-46. The sand was again moistened in April 1946 and many of the grains germinated quite vigorously in a few days, thus showing that the unsprouted grain had not suffered in viability through being kept in moist sand for about two months in the previous autumn.

Wheat and Barley.

A comprehensive collection of named varieties of oats, wheat, and barley was grown for observation and reference, and also for demonstration to parties visiting the Plant-Breeding Station.

Small samples of several new varieties of wheat raised in France by M. Blondeau were forwarded to the Plant-Breeding Station by M. Blondeau through Captain Borthwick of Borthwick. Most of these wheats appear to be early-ripening, short-strawed types, but further observations will have to be made on them before their utility for Scottish agriculture can be assessed.

In view of the demand for seed of the Society's new varieties of cereals—viz., Early Miller and Bell oats and Craigs Triumph barley—elite stocks of these were again grown in 1945. Very satisfactory results are being obtained, particularly in the Morayshire area with Craigs Triumph barley. It was reported in the Press earlier in the year that grain of this variety was awarded first and second prizes in the class for barley at the Royal Northern Spring Show, Aberdeen, 1946.

Beans.

On account of the amount of natural intercrossing that has been occurring among field beans in previous years at the Station, attempts were made in 1945 to avoid cross-pollination in the experimental material by enclosing selected single plants, when in flower, in fabric bags. Cross-pollination is not obligatory in beans, and the plants which were enclosed set seed reasonably well. It is expected that by repeated "bagging" of selected plants pure-breeding stocks will ultimately be obtained.

Trials of Beans at Auchincruive, Ayrshire.—Three selections of beans raised at the Plant-Breeding Station were included in single-plot trials at Auchincruive in 1945. The varieties had grown satisfactorily in the trial, and in view of the fact that two of them ripen considerably earlier than the usual strains of beans, it is thought that the early-ripening types

will have a useful place in the West of Scotland. The under-
noted results were obtained in the trial:—

Varieties.	Yield per acre.
B.01 (S.S.R.P.B.)	2374 lb.
Carse	2157 lb.
B.02 (S.S.R.P.B.)	2571 lb.
Kilbride	1497 lb.
B.03 (S.S.R.P.B.)	2571 lb.

POTATOES.

(Breeding—Boghall Sub-Station.)

WILLIAM BLACK, B.Sc., Ph.D.

J. C. HAIGH, B.Sc., Ph.D., A.R.C.S. (Appointed 18th March 1946.)

In the past few years attention has been paid particularly to resistance to blight (*Phytophthora infestans*), field-immunity from viruses X and A, and resistance to leaf-roll. Recently the possibility of obtaining types field-immune from virus Y was visualised. A necrotic reaction to virus Y has been found in certain wild species from Mexico and Central America, and breeding work with them is now in progress. Additional material has also been obtained which may prove valuable in breeding Y-resistant varieties.

A collection of breeding material was obtained in Germany in August-September 1945. Among these potatoes are types which are claimed to have single and double resistance in respect of the blight fungus, true resistance to viruses X, Y, and leaf-roll, resistance to scab, and resistance to frost. The possibilities of this material seem worthy of investigation, and it is proposed to set up such experiments as facilities will permit.

The investigations concerning the economic potentialities of the collection of Mexican and South American potatoes and the mode of inheritance of several characters such as morphological features, sterility and incompatibility, and resistance to blight have been continued. Many problems arise in the selfing and inter-crossing of certain varieties and species, and some aspects of potato breeding are being pursued in co-

operation with the John Innes Horticultural Institute. This co-operation has also been extended to investigations on the origin of bolting in potatoes.

During 1945 over 8000 seedlings were raised. They were bred from parents which possessed one or more of the following characteristics: resistance to blight, field-immunity from viruses A, X and Y, and resistance to leaf-roll. Tests for reactions to the A strain of blight were carried out on 3800 seedlings and to the B strain on 3000 seedlings. Seedlings which were susceptible in these tests were eliminated.

About 4000 seedlings of the original 8000 were planted out and grown to maturity. Selections made when harvested resulted in the retention of 659 varieties for further trial as possible economic types. Among them was a substantial number of varieties immune from both the A and B strains of blight. The C strain of blight was not utilised during 1945 on account of the lack of facilities for keeping it isolated from the A and B strains.

Second-year seedlings, which numbered over 500, were grown in small plots. The majority of them were immune from all three strains of blight, and many of them were bred from parents which possessed field-immunity from viruses X and A and resistance to leaf-roll. Field-immunity from viruses X and A was derived from varieties such as Craigs Defiance, Epicure, Ninetyfold, Southesk, and certain seedlings, while Shamrock, Southesk, and Imperia represented the sources of resistance to leaf-roll. These plots contained several interesting heavy-yielding varieties. 85 types were selected for more extensive trial.

Older seedlings, numbering over 150, were grown in trial plots. Some of them have proved immune from all three strains of blight and also field-immune from viruses X and A. In others blight immunity is limited to the A and C strains. Certain selections, 15 in number, were grown in multiplication plots, the largest of which was one-third of an acre.

Selections from this material were grown in trial-plots at Craigs House, and a number of them were included in the Registration Trials at East Craigs and in the Ministry's trials at the Midland Agricultural College, Loughborough. Trials were also carried out by Mr W. M. Findlay at Craibstone, Aberdeen, and by Mr J. K. Thompson at the Harper Adams College, Salop.

Selections of seedlings have again been forwarded for inclusion in various trials to be carried out in 1946.

In response to requests for blight-resistant and other types, samples of seedlings were sent to various countries, including South Africa, Kenya, Tanganyika, Australia, Canada, India, Bolivia, and Holland. Reports received of trial samples sent in previous years have generally been favourable. For example, Dr J. E. van der Plank, Chief of the Division of Botany and Plant Pathology, South Africa, writes: "Out of hundreds of new varieties—named and unnamed—from Britain and the United States which I have watched during the past few years, your No. 914a(12) is the most promising for our conditions." It is apparent from the reports that single varieties may differ greatly in their response to different environmental conditions.

Three seedlings were included in the Lord Derby Gold Medal Trials in 1945, and in respect of one of them, No. 655(43), the Committee unanimously agreed to award a Certificate of the Gold Medal Award which replaces the pre-war medal. No. 655(43) has been described by the Committee as follows: "Ample foliage, strong haulms, broad open leaflets. Very even in the drills. Very healthy—no disease. Tubers long white, slightly inclined to be pear-shaped, but throughout of uniform shape. There was no inclination to roughness, and it was a fine bold sample of potato, giving promise of being a good marketing proposition. *Cooking*—Fairly white texture with pleasant flavour." No. 655(43) is a maincrop variety and was bred from the blight-resistant wild species, *Solanum demissum*. Under test it has proved immune from blight strains A and C, but susceptible to strain B. It is field-immune from viruses A and C.

Arrangements have been made for the multiplication of No. 655(43) in Aberdeenshire through the kind offices of Major James Keith, Pitmedden, Udny.

A few notes regarding the seedlings which were multiplied at Boghall are given in the following table:—

TABLE I.

Ref. No.	Percentage	Maturity	Immune from blight strains	Field Immune from Viruses	TRIALS.				
					L.D.G.M.	M.O.A.F. Completed	2nd-Year M.O.A.F. 1945	1st-Year M.O.A.F. 1945	1st-Year D.O.A.S. 1945
653c(35)	967c(38) × Katahdin	E.M.	A, C.	A, B.	×	×	×	×	×
655(43)	967c(38) × 70(13)	M.	A, C.	A, C.	×	×	×	×	×
835a(4)	Craigs Defiance × 800(2)	M.	A, C.	X, A, B, C.	×	×	×	×	×
593a(9)	151(80) × 317a(46)	1st E.	—	B.	×	×	×	×	×
593a(22)	Do.	1st E.	—	A.	×	×	×	×	×
759d(24)	967c(38) × Alness	E.M.	—	A.	×	×	×	×	×
764c(11)	967c(38) × 121(2)	E.M.	A, C.	C.	×	×	×	×	×
831(113)	Craigs Defiance × Gladstone	2nd E.	—	X, A.		×			×
833b(98)	Craigs Defiance × 800(2)	E.M.	A, C.	X, A, B, C.					×

Key to Contractions—See next page.

TABLE I.—continued.

Ref. No.	Percentage	Maturity	Immune from blight strains	Field Immune from Viruses	TRIALS				
					L.D.G.M.	M.O.A.F. Completed	2nd-Year M.O.A.F. 1945	1st-Year M.O.A.F. 1945	1st-Year D.O.A.S. 1945
914(52)	Craigs Defiance × 764(15)	M.	A. C.	X, A. C.	×			×	×
593(3)	151(80) × 317(46)	E.M.	—	A. C.			×	×	×
829(96)	Craigs Defiance × Arran Bard	1st E.	—	A.				×	×
834(29)	Craigs Defiance × 800(2)	2nd E.	A. C.	C.				×	×
931(5)	655(34) × Alness	1st E.	A. C.	A.				×	×
1088(1)	653(97) × M233(13)	M.	A. C.	A. C.				×	×

Key to contractions:—

M = Maincrop.

E.M. = Early maincrop.

1st E. = 1st Early.

2nd E. = 2nd Early.

L.D.G.M. = Lord Derby Gold Medal Trials.

M.O.A.F. = Ministry of Agriculture and Fisheries Trials.

D.O.A.S. = Department of Agriculture for Scotland Trials.

× = Included in Trials.

Information has been received to the effect that several hundred tons of seed potatoes were imported from the United Kingdom and planted in Lebanon in 1944. These included Craigs Defiance and a number of well-known other British varieties. The valley in which they were planted stands 3000 feet above sea-level. In the main the soil there is a rich red loam. Irrigation was necessary, but that was the only difference from the methods of cultivation employed at home. Of all the varieties in the experiment Craigs Defiance was reported as being *absolutely* outstanding, with the result that the farmers there have been endeavouring to get further seed ever since.

Virus Diseases—Craigs House.

GEORGE COCKERHAM, B.Sc., Ph.D.

T. M. R. M'GHEE, B.Sc. (Appointed 8th October 1945.)

Work with potato viruses at Craigs House has included (1) the testing of 195 seedlings submitted by the Potato Breeding Section for field-immunity from one or more of the viruses X, B, A, and C; (2) the further testing of exotic forms of the potato, some of them newly obtained, for characters of resistance value as judged by their reactions to individual viruses; (3) genetic studies relating to the inheritance of field-immunity; and (4) field studies on the inheritance of resistance to leaf-roll, on the spread of virus X, and on the relationship between aphid populations and the spread of leaf-roll and virus Y.

A good deal of attention has been concentrated on the problem of resistance to virus Y and on the conjoint project, with the Potato Breeding Section, of combining blight resistance and field-immunity from viruses X and A with resistance to leaf-roll.

The hypersensitive reactions of E.P.C. 4 (a variety of *Solanum demissum*) and *S. simplicifolium* towards virus Y have been studied both in these two species and in their seedling progenies. Tests have shown that the character has most probably the value of field-immunity, at least in older plants, though in young, newly emerged plants a number of systemic infections resulting in death follow the feeding of infective aphides. The progeny tests gave indication that the character is hereditary, though the actual mode of inheritance is not yet clear.

A second line of investigation has been directed towards a study of the effect of virus Y on the seedling progenies of potato varieties which show leaf-drop streak when infected with this virus and which are killed, and are therefore field-immune, when infected with the C strain of virus Y. The results indicate that the two reactions are probably related, and that by replication of the gene conditioning field-immunity from virus C it might be possible to obtain field-immunity from virus Y by selective breeding within the range of cultivated varieties.

Progress with the attempt to combine virus resistance with blight resistance has been made both in successful breeding operations and in the raising and testing for blight and virus reactions of further seedling progenies required for the establishment of a sib-producing programme.

Herbage Plants.

J. W. GREGOR, Ph.D., D.Sc., F.L.S.

The greater part of the work in this section at present deals with grassland improvement, and in accordance with the suggestion of the Herbage Sub-Committee the results obtained so far at Dalmahoy and Whelpside, near Balerno, and in the Dundonnell area in Wester Ross, have been summarised for inclusion in this Report.

Broadly speaking, the investigations aim at finding a method of grassland farming whereby specialised cultivated pastures could be employed as the nutritional complements of adjacent rough grazings with the object of utilising to the full the potentialities of both. The work is being carried out under two heads: (1) the breeding of specialised races and the search for suitable ecotypes of grassland plants, and (2) the assessment of their value under a system of complementary grassland utilisation. These two aspects are so intimately related that they are being treated as parts of the same problem—a problem which is being studied both at Craigs House and at field centres in “marginal” districts.

Dalmahoy Centre.—Briefly, the results to date suggest that when vegetations of widely contrasting type—e.g., highly cultivated and natural—are grazed as complementary pairs

the utilisation of the paired vegetations is more efficient than when either is grazed separately; and secondly, the cultivated member of the pair can, in the circumstances, be relatively small and botanically simple. So far only the productive capacities and competitive relationships of different maturity races of perennial ryegrass have been examined, but a start has now been made to deal with the chemical aspects of the problem.

The trial area has been grazed as the complement of a much larger area of rough pasture. The grazing season extended from April to October, both months inclusive, but the actual grazing time was divided into periods of three weeks, each period being separated by rest intervals of a week. At the start of each rest period the herbage of the sample areas was again cut, and this time weighed. Thus the figures obtained relate to production and not to the amount of herbage consumed by the animals.

The data showed that in respect of the total seasonal production the difference between the highest yielding races of the contrasting maturity types is negligible. On the other hand, there is positive evidence that the different maturity types when grown in pure culture can be used to spread production more evenly over the grazing season, though the spread is largely negated when distinctive types compete with each other in a mixture. In fact, by the third year under the prevailing system of management, mixtures comprising extreme maturity types exhibited production cycles not very different from those of their early constituents growing in pure culture. On examination of the racial composition of one of these mixtures which in the first year contained 56 per cent early variates and 44 per cent late, it was found that by the third year the percentage of early variates had risen to 74. However, judging by the rapid change towards a homogeneous ryegrass—wild white clover sward of a control species mixture—it would seem that inter-racial competition among ryegrass types is somewhat less intense than is inter-specific—*e.g.*, that between ryegrass and cocksfoot.

There is no doubt that if specialised systems of grass farming are to find a place in upland agriculture, the relative values, in terms of production spread, of species and racial mixtures, and of races in pure culture, deserve to be critically examined.

Under a system of complementary grazing the cultivated

complement will inevitably lie adjacent to an inferior grazing, and since many a rough grazing, Dalmahoy not excepted, is a breeding ground of the crane-fly (*Tipula paludosa*), the question of leather-jacket control becomes a very important one. Leather-jacket damage to the cultivated area at Dalmahoy is almost entirely confined to patches on the early ryegrass plots, where the grazing had been least efficient. The matter was referred to Dr Cameron of the Department of Entomology, Edinburgh University, and as a result the area has been examined by his assistant, Mr West, who records the following leather-jacket counts: *cultivated area*—bare patches 2,000,000 per acre, remainder 700,000; *adjoining rough pasture*—1,000,000 per acre.

Whelpside Centre.—In May 1945 races of perennial ryegrass, cocksfoot, and timothy were sown as pure cultures and as mixtures under various grazing nurse-crops. Eight hundred pasture samples were analysed botanically in April of this year. The results show no difference in pasture density between plots seeded under cereals and those which lacked a nurse-crop. However, the effect of a series of Brassica nurse-crops was to reduce the density by 31 per cent. While the effect of the Brassicas (turnip, rape, marrow-stem kale, and thousand-headed kale seeded respectively at 6, 7, 8 and 8 lb. per acre) was to lower the establishment value and give a relatively open and tufted type of pasture, these nurse-crops nevertheless allowed cocksfoot to compete successfully with perennial ryegrass. For instance, in the Brassica series perennial ryegrass contributed 57 per cent to the total population originating from equal quantities of viable seeds of the two species, whereas in the cereal and no nurse-crop series perennial ryegrass contributed 81 per cent.

Italian ryegrass employed as a nurse-crop and sown at the rate of 10 lb. per acre also had a markedly adverse effect on cocksfoot establishment, though it had little or no effect on the establishment of the early races of perennial ryegrass. With heavy autumn and light winter grazing, however, the establishment value of cocksfoot was only 16 per cent less than when under a cereal nurse-crop, but when lightly grazed in autumn and not at all in winter, this percentage rose to 62.

Under the conditions of the present trial the cereals were ready to graze seven weeks after sowing, or seventeen days sooner than the Brassicas. Oats and barley gave equally early returns, but the latter made a relatively poor recovery

after an initial grazing period. Winter rye, like Italian ryegrass, though less productive than either oats or barley during the first grazing period, added a greater amount of autumn herbage, while the Brassicas, though reaching their optimum grazing stage considerably later than the other nurse-crops, outyielded them all in bulk of produce. Nevertheless, for complementary pastures where quick establishment and a short interval between seeding and grazing are desired, and moreover where a floristically simple vegetation is no disadvantage, oats (cleaned seconds sown at the rate of 3 bushels per acre) are likely to meet average requirements.

Dundonnell Centre.—While arrangements were being made for establishing the Dundonnell Home Farm Centre a start was made on another farm in order to obtain advance information as to grassland conditions obtaining in the district. For this purpose Mr A. S. MacLean kindly put a $1\frac{1}{2}$ -acre grass field on the farm of Black Muir at the Society's disposal (see Fig. 2).

This field is part of the arable acreage, but from the point of view of cereal cultivation must be regarded as sub-marginal, for the yield of oats in 1935 did not exceed the 6 bushels sown. On 3rd May 1945 it was re-seeded with a grazing nurse-crop of Bell oats and winter rye, and a ryegrass strain of Cornish origin raised from seed collected by Mr F. R. Horne, Director of the National Institute of Agricultural Botany.

The re-seeded area was for part of the season used as the complement of moorland vegetation, and, during the remainder of the season, of a 5-acre field of poor grass. With the exception of a two weeks' rest in early October the area was grazed continuously from 21st June 1945 to 16th January 1946.

Mr MacLean's records can be summarised as follows:—

Stocking.

Cows.	Calves.	Stirks.	Hoggs.	Grazing days of approx. $3\frac{1}{2}$ hours each.
2	2	—	—	13
5	5	2	—	103
—	—	—	30	93
				209

The effects of the complementary diet were reflected by an increase in the general quality of the animals concerned. Based on the performances of previous years the yields of the two cows which were milked rose by 20 per cent and the hogg weights by approximately 5-6 lb. per head, while the calves were very much superior. No increase in the normal stocking of the farm was required to ensure full utilisation of the re-seeded herbage, and it is probable that even if the area were to be doubled it would still be no more than sufficient to correct the marked signs of malnutrition occasioned by the poverty of the rough grazings.

At the Home Farm Centre, thanks to the active co-operation of the Farm Manager, Mr MacLeod, the maturity-type trials of perennial ryegrass and cocksfoot were sown on 11th May 1946. These particular trials cover an area of 8 acres. Other special purpose trials will be laid down in due course.

Multiplication of Strains.—15 acres of Scotia cocksfoot were seeded in Essex in 1945. The seed was cleaned for the Society by Messrs David Bell, Ltd., and approximately 39 cwt. were sold to members of the Society.

About 5 acres of perennial ryegrass, Ref. No. Ca 434 (late), were sown in 1945 in Hants. Seed should be available in 1946.

ROOT CROPS.

V. M'M. DAVEY, B.Sc., Ph.D.

Swedes and Kales.

Seed-propagated crops fall into two classes: those like oats, wheat, and barley which are naturally self-fertilising and can be bred as highly uniform varieties, and those like the majority of root crops which are cross-fertilising and require the stimulus of crossing to maintain their yield and vigour. Constant selection keeps varieties of the second class approximately true to type, but strict uniformity may not be obtained, and any attempt to diminish the variability by inbreeding may result in a serious decline in vigour in the next generation. Between these classes lies the swede, which is fully self-fertile, but crosses to a considerable extent when plants are seeded together. In general practice, to obtain adequate supplies of

seed, swede varieties must be seeded in mass, so that crossing between plants will occur then, but in the early stages of producing a variety, lines can be bred from single plants by self-fertilisation in isolation. It has been one of the main objects of the work of the Station to investigate this method, and so far it would appear that there is no great difference between the yield of a good self-fertilised line and that of a commercial variety. Nevertheless the diverse nature of the hereditary constitution of the variety causes it to benefit by such crossing as occurs naturally between the parent plants, and it seems probable that a self-fertilised line, whose hereditary variability has been much reduced by inbreeding, could not benefit to the same extent when it passes to the mass-propagated stage. Consequently if line breeding is employed to obtain uniformity of type, it might be desirable to breed a number of lines of similar appearance but different hereditary constitution, which, when thrown together might give a variety capable of benefiting by natural crossing. In the present stage of the work strains derived from crosses between swedes of different types are being examined. A few generations of self-fertilisation has reduced these from highly variable assemblages to fairly distinct types, without as yet causing them to be highly uniform either in appearance or hereditary constitution.

Swede Propagation.—About 200 plants were self-fertilised in pollen-proof bags, some hand-crosses were made, and five strains were seeded in groups of thirty or forty plants in outlying isolation plots. The season was not favourable, but small quantities of seed were obtained from most of the parent plants.

Swede Observation Trials.—The strains were represented by single plots, as the area available was still restricted. The material under observation included some old pedigree lines, originally selected from commercial crops and being now maintained chiefly to obtain highly uniform hereditary constitutions. Most of the strains, however, were derived from crosses between varieties, and were under examination for possible uses. There were also some lines derived from swede \times turnip hybrids, and others in which curled leaf shape was combined with bulb formation.

Clubroot Resistance.—Seedling tests in trays of soil, and field tests on an infected plot, were carried out, and apparently resistant plants were kept for propagation.

Kales.—Derivatives of a cross between Curly Kale \times Perpetual Kale were under examination to see whether a highly curled leaf could be obtained on a form which would propagate vegetatively. Hybrids between Thousand-headed kale and broccoli were also bred and observed for the selection of leafy types. The Station strain of Thousand-headed kale, T1, was continued for observation.

1945-46 *Swede Trial.*—The second of a series of small-scale trials was carried out to estimate losses of plants and the causes, and to compare the behaviour of Station strains of various types. Eight strains were sown in four plots each, and half plots were examined in November, while the other halves were left growing till March. The total area under each strain would contain 400 plants at 10-inch spacing, and the figures below are calculated for a 100-plant area—*i.e.*, they are percentages of a full stand. There was little or no damage from drought or the "flea" beetle, and in July, after singling, the plant numbers ranged from 105 to 94 for the area. By November 5½ per cent of the plants had been lost, cabbage root-fly being the probable cause, and by March another 4 per cent had disappeared. In November 91 per cent of the plants were alive, but 11 of these were classed as unusable because of serious damage to the bulb by soft-rot or brown "canker," hollows or transversed splitting. Of the 80 remaining plants classed as usable, 46 were undamaged, the rest had clubroot and/or *Phorbia* maggot damage, and 1 or 2 had early stages of dry-rot. There were 93 plants left standing in March (the July numbers being greater in these half plots), of which 44 had dead necks and most had decay at the roots. When topped and tailed 33 bulbs seemed sound, 30 had sound and rotten areas, and 30 were completely rotten. The bulbs were large and the dry-matter percentage exceptionally low. This summarises the condition of the crops as a whole, and the behaviour of the strains will now be briefly mentioned in the undernoted table:—

TABLE II.

	NOVEMBER.			MARCH.		
	Usable bulbs.	Average weight in lb.	Dry-matter %-age.	Sound bulbs.	Partly-sound bulbs.	Rotten bulbs.
Victory	89	2.8	8.7	14	41	32
Champion	81	2.3	9.6	31	31	20
Aberdeenshire	79	1.8	9.5	62	14	20
Strain ABJ	65	3.2	8.5	20	27	46
" ADC	84	2.5	9.9	37	39	19
" AFR	93	2.8	8.3	5	38	52
" AFS	74	2.3	9.2	32	28	36
" AFT	86	2.7	9.7	60	21	14
Mean	80	2.5	9.2	33	30	30

A strain known as AFT gave the best performance, yielding 22 lb. of dry matter in November, due to high dry-matter percentage combined with good bulb weight. In March it had 60 sound bulbs, which was only equalled by the Aberdeenshire variety. AFT was derived from Buffalo \times Stirling Castle, and has been in disfavour because of a tendency to develop long necks. Yielding 21 lb. of dry matter were the control variety Victory and a strain AFR of similar type but bronze-skinned, which was derived from crossing Victory with Caledonian. Both had a good stand of large roots in November, but succumbed to the frosts later. Fourth, with 20 lb. of dry matter was ADC, a strain of average bulb weight and dry-matter percentage, which was slightly above average for frost resistance. ADC was from Stirling Castle \times Magnificent and had a long bulb shape. The strain ABJ yielded 18 lb. of dry matter, which was below the average of the trial. Its bulb weight, 3.2 lb., was definitely the highest, and even with the low percentage of dry matter it should have outyielded the rest in November, but 22 plants had to be disqualified because of a brown rot or "canker," and the condition of the crop was also poor in March. ABJ is a short globe with dark purple skins and looks a harder type than the results disclose. Strain AFS, a purple globe from Caledonian \times Buffalo had low weight and only average percentage of dry matter. It was also low in number of plants in November, but showed

and harvested separately. Their progenies will be examined in trials next year with a view to improving the strain. After the 1944-45 trials plants of Station strains which had carried the best curds were chosen, and the stumps were lifted and sheughed. Some of these produced side-shoots which survived the winter, and they are now being grown in pots for seeding.

II. Publications and Lectures by Staff for the Year ended 31st March 1946.

Publications (P) and Lectures (L).

W. Black, B.Sc., Ph.D.

"Inheritance of Resistance to Blight (*Phytophthora infestans*) in Potatoes: Unbalanced Segregations." Proc. Roy. Soc. Edinb. Section B. Vol. LXII., Part II. (No. 20), 1945. (P.)

"Inheritance of resistance to blight in potatoes." Ann. appl. Biol., Vol. 32, No. 3, pp. 279, 280, 1045. (P.)

"Breeding Crop Plants." West of Fife Young Farmers' Club. (L.)

"Evolution of potato varieties." Auchterderran Farmers' Discussion Club. (L.)

G. Cockerham, B.Sc., Ph.D.

"Some Genetical Aspects of Resistance to Potato Viruses." Ann. appl. Biol., Vol. 32, No. 3, 1945. (P.)

J. W. Gregor, Ph.D., D.Sc., F.L.S.

"Reseeded land as a complement to rough grazing." Notes for Farmers, Vol. VII., No. 3, 1945. (P.)

"Re seeding on upland farms." Lauder Farmers' Club. (L.)

"Complementary vegetations and their significance." Hill Farm Research Committee Conference. (L.)

III. Visits.

Director of Research :—

Craibstone Experimental Farm, Aberdeen.
Auchincruive Experimental Farm, Ayrshire.

William Black, B.Sc., Ph.D.

Lord Derby Gold Medal Trials, Hutton Farm Institute,
Preston.
Various German Plant-Breeding Stations.

V. M'M. Davey, B.Sc., Ph.D.

Sugar-Beet Demonstration near Cupar, Fife.

J. W. Gregor, Ph.D., D.Sc., F.L.S.

Ministry of Agriculture's Grassland Improvement Station,
Dodwell, Stratford-on-Avon.
Hannah Dairy Research Institute, Kirkhill, Ayr.

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- M'Arthur, J., Middleton, Tiree.
- M'Leod, D. J., Division of Botany and Plant Pathology, Department of Agriculture, Canada.
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 Forbes, Colonel Robert, D.S.O., M.C., Balglassie, Forfar.
 Forrest, Robert Jack, Whitemire, Edrom.
 Fraser, Samuel (Alex. Cross Seed Co., Ltd.), 21 Hope Street,
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 Gebbie, Alexander (Scottish Co-operative Wholesale Society,
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 Garve.
 Gibb, John, Fliskmillan, Newburgh.
 Gibb, William G., Pitteuchar, Markinch.
 Gibson, James G., Toll House, Finavon, Forfar.
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- Hamilton, Robert (John Donaldson & Co., Ltd.), 24 St Giles Street, Edinburgh.
- Hamilton, Robert C., Kilnknowe, Galashiels.
- Hamilton, W. H., Cairns, Kirknewton.
- Hannah, George A., Drem Farm, Drem.
- Hannah, John J. M., Girvan Mains, Girvan.
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- Harper, Thomas, Charlotte Street, Stranraer.
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- Henderson, John, Townhill Farm, Hamilton.
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- Hogg, Thomas (A. Cross Seed Co., Ltd.), 21 Hope Street, Glasgow.
- Hogg, William, Meikle, Clovenfords.
- Home, The Earl of, The Hirsell, Coldstream.
- Home, Captain John Gavin Milne, Irvine House, Canonbie.
- Home, Sir John H. Milne, Irvine House, Canonbie.
- Hope, Sir Harry, Kinnettles, Forfar.
- Hope, William W., Braehead, St Boswells.
- Houldsworth, Lieut.-Colonel W. T. R., of Kirkbride, Maybole.
- Howie, Alex., Ardgaith, Glencarse.
- Howie, John (Storrar & Howie), Newton, Wormit, Fife.
- Howie, John C., Ballinbreich, Newburgh, Fife.
- Howie, Robert, Drumfork Farm, Helensburgh.
- Howie, Robert, B.Sc., Grange, Kirkcaldy.
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- Johnston, W. L., Oxnam Neuk, Jedburgh.

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- Kirkwood, John, B.Sc., Scorrieholm, Lesmahagow.
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- Lang, James, Mount Top Farm, Paisley.
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- M'Gill, J. Becket (M'Gill & Smith, Ltd.), Ayr.
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- MacGillivray, Finlay, Greenhead, Pencaitland.
- MacGregor, James (James MacGregor, Ltd.), Garrion Grain Mills, Wishaw.
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 Miller, Hugh, West Fortune, Drem.
 Miller, James B., Dolphingstone, Tranent.
 Miller, Robert, Ferrygate, North Berwick.
 Mills, Fred (Roughead & Park, Ltd.), Haddington.
 Miln, David L., F.L.S., Mollington Banastre, near Chester.
 Miln, Thomas Edward (Gartons, Ltd.), Warrington.
 Milne, Frank G., Southesk Granaries, Montrose.
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 Mitchell, Matthew, Chesterhall, Wiston, Biggar.
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 Montgomery, Andrew Mitchell, Netherhall, Castle-Douglas.
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 Morrison, John A., West Fenton, Drem.
 Moss, Edward C., Fountainside, Gorebridge.
 Motherwell, Andrew (A. Motherwell, Ltd.), Gorbals, Glasgow.
 Muir, Sir A. Kay, Bart., of Blair Drummond, Perthshire.
 Murdie, T. Laurie, Baggerton, Forfar.
 Murdoch, Alexander, East Hallside, Cambuslang.
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 Murray, James C. (Lothian Coal Co., Ltd.), Newbattle Collieries, Newtongrange.
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- Wilson, Philip, Corn Factor, Duns.
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