SCOTTISH PLANT BREEDING STATION
PENTLANDFIELD
ROSLIN
MIDLOTHIAN.

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SCOTTISH PLANT BREEDING STATION
PENTLANDFIELD. ROSLIN. MIDLOTHIAN

REPORT

TO THE

ANNUAL GENERAL MEETING

OF

THE SCOTTISH SOCIETY FOR RESEARCH IN PLANT BREEDING

28th JULY 1966

BY THE

BOARD OF DIRECTORS

CONTENTS

DIRECTORS' REPORT

Introduction

An annual report of a Station such as this has two functions: one is to place certain administrative facts about the conduct of the Society and Station on formal record and the other is to inform both the Society and the public at large about the work of the Station. The first is relatively simple and the last four sections of this report cover the essential administrative facts. The second function is much harder to interpret: some review of the work of the year is necessary but too much detail makes for indigestibility; scientific results must be rigorously recorded but too much rigour makes difficulty for the lay reader; the report is necessarily annual but plant breeding is perennial, so that progress cannot easily be displayed in the long-term context. A workable solution of these problems seems to be as follows: first, to review very briefly the work of the preceding year in non-technical language; second, to discuss each year one chosen topic at greater length, with the aim of explaining to the non-scientific reader the broad context of one of our investigations; and, third, to report the purely scientific results of the Station in standard scientific journals in the usual way. In short this report is aimed at the layman, scientific papers at the scientist.

One implication of this conclusion is that the Record should cease to be issued. The Record has contained much valuable material—as an abundant flow of requests from abroad amply testified—but it has been a heavy expense and a source of much bibliographic difficulty to scientific colleagues elsewhere. The fact is that a " private " scientific journal such as the Record cannot attain the circulation of a standard journal, so that the work of the Station is not as widely known as it might have been. With these considerations in mind the Board of Directors have accepted that the Record should cease publication.

Following the principles outlined above, there follows a progress report for the year and then, as the chosen review topic, a discussion of the broad programme of the Station.

Progress 1965-6

Potato Investigations

The Merit Trials conducted by the Department of Agriculture and Fisheries for Scotland in 1965 contained 39 of the Station's seedlings, 29 in the 1st Year,

9 in the 2nd Year and 1 in the 3rd Year of trial. The Committee recommended that 12 of the 1st Year group and 3 of the 2nd Year group should be continued for further trial in 1966. The 3rd Year trial seedling 3033(5) did not attain the desired standard and was not commended. Although its total yield was satisfactory, the tubers were considered to be too small in the run and not up to standard for shape. Samples of those seedlings recommended for further trial in 1966 were forwarded to East Craigs together with a group of 30 new selections for inclusion in the 1st Year trials.

Although seedling 3033(5) did not receive commendation it possesses qualities of considerable importance in certain environments, particularly the tropics. It is resistant to blight, gangrene, dry-rot and virus Y. In addition it gave the highest yield in the N.I.A.B. Maincrop Potato Variety Trials at Terrington in 1965 where it proved to be of crisping quality. For these reasons it has been decided to test it more widely, particularly in Africa, as a special purpose variety suitable for areas where blight is a problem. It has accordingly been named Roslin Castle and application for Plant Breeders' Rights has been made. Trial samples have been forwarded to various countries overseas.

In addition to Roslin Castle, application for Rights in four other yet unnamed varieties was made and Rights were granted in respect of Pentland Falcon and Pentland Glory which are now launched in commercial production.

Trial and multiplication plots at Blythbank in 1965 covered about 11½ acres. Some 17,000 selections were represented in the various categories of plots which ranged in size from single plants of new seedlings to the maximum half-acre plot of the 3rd Year trial seedling 3033(5). Smaller multiplication plots of Roslin Eburu, R. Sasumua and R. Riviera were grown and the virus-tested collection of named varieties and seedlings was maintained.

The assessment of field resistance to blight can be made difficult by the occurrence of *R*-genes. Accordingly, a complex race (1,2,3,4,7,8) has been adopted as standard for testing and results obtained with it at Pentlandfield agreed well with field observations made on the same clones in Mexico. For this purpose 289 clones were grown at the Santa Helena Experimental Station in the Toluca valley in the standard test developed by the Rockefeller Foundation workers there. Many of the clones showed a high degree of field resistance and some combined this character with high yields. Two early maincrop selections from this group are included in the 1966 Merit Trials of the D.A.F.S., one each in the first and second years of test.

The difficulties inherent in assessing field resistance in the presence of *R*-genes was well illustrated during the year by the finding that one seedling was hypersensitive to race 1,2,3,4,7,8, and yet susceptible to another, less complex, isolate of blight; it must contain a new *R*-gene and the standard race becomes unsuitable for testing it. Though simple in principle, assessment of blight resistance presents many minor practical problems, including differences of response as

between tubers and foliage or between different parts of the leaf. Some interesting observations were made along these lines during the year.

Testing of advanced selections for resistance to scab and gangrene was continued. Methods are now fairly reliable though there are still some experimental problems to be solved in gangrene testing. Good agreement was obtained between scab reaction of clones grown at Archerfield, East Lothian, and a sample of the same (the Registration Trial seedlings) tested by Mr B. C. Knight of the National Agricultural Advisory Service at Wolverhampton.

The most damaging potato viruses are Y and leaf-roll while X can be regarded as at least a major nuisance. The potato breeder needs stocks having high resistance to these diseases and good agronomic qualities in other respects. This need is now well on the way to being met. Thirty-three seedlings, the survivors of 10,000 raised in 1959, have gone through a complete cycle of intense selection for resistance to the three viruses and are now being assessed for commercial and/or breeding value in the usual way. Resistance to X and Y can usually be assessed early so 10,000 new seedlings were screened; accordingly the survivors will enter field tests for leaf-roll resistance, a stage which 436 survivors from earlier years entered in 1965. The field exposure trials are carried out at Elvingston, East Lothian and at the Plant Breeding Institute, Cambridge.

The nature of genetic control of response to viruses is important information for the breeder. Genetic studies of reaction to X and Y in several wild species (*Solanum chacoense*, *S. sparsipilum*, *S. microdontum*, *S. stoloniferum*), and in material derived from the Andigena Group of cultivars were carried on. Resistances are undoubtedly present but genetic relations are complex. Investigations of the interrelations of the very numerous strains of viruses A and Y were also carried on.

The eelworm-resistance breeding work made good progress and seven varieties are now in trials: four in the first year and three in the second. All have specific resistances, four out of the seven derived from Andigena, one from *S. spegazzinii* and two that combine Andigena with *S. multidissectum* resistance. The resistance from *S. spegazzinii* has not yet been assessed on the national scale; probably it is rather similar to the Andigena resistance. Both should have uses where the corresponding eelworm is commonest—in Ayrshire, Lincolnshire, South and South-west England. These areas include the bulk of the first early acreage so it may be important that all the four Andigena resisters are first earlies. The combined Andigena-*multidissectum* resisters provide for an extension of control into the Midlands and North of England, areas in which, according to a recent N.A.A.S. survey, no more than 10 per cent of the eelworm biotypes should be pathogenic. In general the use of such potatoes carrying specific eelworm resistances will have to be guided by eelworm surveys and the very careful formulation of appropriate rotations.

By analogy with blight and other diseases we might expect a polygenic ("field") resistance to be more stable than specific resistances. Accordingly polygenic resistance from *Solanum vernei* is being explored in *vernei* × Tuberosum crosses, incorporating also the specific resistance genes H_1 and H_2. Populations are being screened against the corresponding eelworm race and then selected on tuber characters. Some resistance can certainly be got by this means but time alone will show whether the undesirable characters of *vernei* can be eliminated without impairing resistance.

As with any serious genetic-pathological study, understanding of the genetics of the pest as well as the host is needed. Progress has been made in constructing controlled matings of the eelworm and the way is now clear for an analysis of the genetic control of pathogenicity. In addition, some 485 inbred lines were isolated from 1,274 single-cyst samples taken from fields in East Lothian and Fife. Collectively, these studies should greatly aid the breeding programme and help in formulating farming plans for the utilisation of resistant varieties.

Forage Crops Investigations

Breeding work with oats was carried on during the year, selections from hybrid material being made at centres in Argyll, Inverness-shire and at Pentlandfield. Trials of fixed lines were also conducted in the same areas.

With the exception of Pentlandfield, where the extremely variable soil conditions gave erratic results, both hybrid and trial plots were satisfactory. All the above plots were protected by cages from damage by birds and in addition a number of selections which had already proved themselves in small scale trials were tested in larger plots in Inverness-shire, the highest yielding to be continued in the ensuing year.

At Pentlandfield some 2,500 selections resistant to oat stem eelworm were grown and rigorously selected on field attributes, the number being reduced in some 160 to be included in trial in 1966. During the winter months of 1965/66 the technique of testing for eelworm resistance by seedling inoculation has continued, the most resistant plants being selected and grown to maturity. Much of the material now in test is at the fourth backcross stage using high yielding *Avena sativa* varieties as the recurrent parents, the resistance derived from *Avena ludoviciana* being retained by selection in successive generations using the pad inoculation technique.

The malting barley programme in collaboration with the Plant Breeding Institute at Cambridge was continued. F_4 and F_5 material was included in a trial at Pentlandfield and a number of the most promising lines from earlier years were put in a replicated trial on the East of Scotland College farm at Boghall. As with oats, barley performance at Pentlandfield was extremely variable and arrangements have been made to repeat the whole of this trial

in 1966 on a farm near Dunbar. A further trial at Boghall has also been arranged.

The barley programme has hitherto been small and directed at malting quality. With an eye to the future and the quite different needs of a feeding-barley programme, a number of promising crosses was made in 1965 and F_1 plants raised in the glasshouse over the winter. Multiplication of the F_2 and an extensive crossing programme involving both hand pollination in the glasshouse and the use of male sterility in the field is planned for 1966 and the subsequent years.

Work on the Brassicas has continued along three main lines; root crops, kales and leafy allopolyploids. Of the root crops, material has been assembled for an extended swede breeding programme and for the production of tetraploid turnips. A possible swede variety (code CHO) was tested in collaboration with the National Institute of Agricultural Botany and the Scottish Colleges of Agriculture. It yielded poorly, though satisfactory in other respects, and appears to have little promise as an agricultural variety. However, it has some attractive features from a horticultural viewpoint and so its possible use as a culinary variety is being explored by the Scottish Horticultural Research Institute.

Within the kales attention was confined to the possibility of using the excellent hardiness and leafiness of the curly kales and to a preliminary exploration of the effects of tetraploidy. Two series of tetraploid crosses (wild kale × thousand-head and curly kale × thousand-head) both showed good winter hardiness and much the same yield as the control thousand-head variety, Canson. These results are quite promising since the stocks are still variable and the latter of the two crosses has a high lamina/petiole ratio which would imply a high protein content.

The programme to develop new allopolyploids was carried on during the year by a study of five fodder radish cultivars, coupled with extensive hybridization and colchicine treatment of diploid hybrids. Thus several thousand intergeneric crosses were performed involving fodder radish with fodder rape (*Brassica napus*), thousand-headed kale (*B. oleracea*) and a hardy, leafy *B. campestris* hybrid. Crosses of *B. oleracea* and *B. campestris* with radish were also made at the tetraploid level, with the object of producing directly amphidiploids combining the vigour and disease resistance of *Raphanus* with the winter-hardiness and biennial habit of *Brassica*. A few hybrids (genomic formula rac) between *B. napus* (aacc) and *R. sativus* (rr), *i.e.*, rape × fodder radish, were confirmed and treated with colchicine in the hope of producing true breeding hexaploids (rraacc).

New hybrid combinations of *B. napus* (aacc) with *B. campestris* (aa) were treated with colchicine in order to produce a greater range of leafy *B. napocampestris* (aaaacc) forms. Practically all worthwhile parents have now been combined

in these syntheses but much of the material is at an early stage of development. One hardy *B. napocampestris* involving fodder rape and an oriental salad vegetable (*B. campestris* ssp. *nipposinica*) has been multiplied on a moderate scale and seed distributed for trial in various parts of Scotland and England. It is too early to tell what future this new crop plant may have; it is certainly hardy, leafy and productive but its agricultural potential is yet unclear.

Genecological investigations during the year included further studies of natural flush areas and of the artificial flush in the Pentlands. There is abundant evidence of genetic variability (for example, in morphology and mineral uptake) in the flush grasses (*e.g., Festuca rubra, F. ovina, Agrostis tenuis*) but as yet no decisive evidence that variability is spatially related to habitat factors—that, in fact, variation is ecologically adaptive. The artificially flushed area has given evidence of a higher degree of grazing but none of the change in species composition of the sward—which would hardly be expected yet. Another hill experiment was started with the preparation, by means of Dalapon, of a plot in the Pentlands for experimental planting. Trial material of *Agrostis tenuis, Festuca rubra* and Mediterranean type *Dactylis* was planted but suffered from much regrowth by indigenous *Poa pratensis*, a strongly rhizomatous species. Experiments on *Potentilla erecta* and *Plantago maritima* were also continued.

The uniformity trial with Italian ryegrass was concluded during the year and yielded useful practical results bearing on the question of experimental precision. The smallest plot (one square yard, 36 plants at $6'' \times 6''$) was always the most efficient in that it required the least ground to achieve a specified level of precision; but the two-unit plot size was as efficient if allowance were made for the use of a guard row. Since the larger plot permits the use of fewer replications it seems that the most economical size is two square yards. At any one plot size, coefficients of variation varied with plot shape, sometimes by as much as a factor of two. In general, long narrow plots were best.

The Long-term Programme

The aims of the Station are, as ever, twofold: to advance the scientific bases of plant breeding and to breed plants for use in Scottish agriculture. Though the aims are clear enough the means are debatable; indeed no two people charged with framing a long-term programme for a Station such as this would produce the same programme. But a choice has to be made and our successors will know whether we have chosen well or badly. In framing this programme I have consulted a great many people: colleagues on the Station, scientists in other Institutes or laboratories, and members of the Board of Directors (who represent collectively a great range of agricultural, com-

mercial and scientific experience). I am most grateful to them all—though no doubt I have sometimes rejected good advice.

All crops present problems of scientific interest the solution of which may—indeed often does—bear upon similar problems in other crops. Contrariwise, a general problem in the scientific methodology of plant breeding can often well be tackled by the use of any one of several different crops. Now, plant breeding and related scientific investigations go best hand-in-hand, when the two activities are closely intermingled. The practical conclusion from this is that it is best first to choose the crops which are to be bred and then to frame the related scientific studies in terms of these crops. It should thus be possible to achieve both integration of and the necessary balance between the fundamental and applied work.

One further principle is important and it is this. We aim to produce practical results in the form of new varieties but, as a state-aided Station, we are sufficiently free of economic pressure to be able to undertake some of the difficult, speculative, long-term breeding jobs that would generally be unattractive to commercial breeders; in short, we can, and indeed should, draw bows at ventures.

The first task, then, is to choose the crops and the breeding problems and this means trying to peer into the future in order to foresee trends in Scottish agriculture as a whole. Agricultural technology is changing rapidly and if plant breeding is to have real successes it must breed for the future rather than the present. As a guide, the following generalizations seem fairly secure: first, farming is becoming ever more technological and this will lead sometimes to completely new demands of the plant breeder, sometimes to changed or more stringent demands; second, Scotland is and will remain primarily a stock producing country, with an agriculture largely directed towards feeding animals; third, grass and barley will increase still further; but, fourth, oats and brassicas will probably stabilize in special places and for special purposes (for example, to provide breaks in rotations); and, fifth, the seed potato trade will remain important (because of Scotland's enormous natural advantages) but probably at a lower level of production—the need will be for smaller quantities of super-quality seed for export to England and, one hopes, elsewhere.

Where does this get us? Let us consider the last point first. Pentlandfield has long been well known for its potato breeding and allied researches on the crop. Several Scottish Plant Breeding Station varieties have had moderate success and several new ones now attaining commercial prominence promise extremely well—time will tell how good they really are. The Station has long been the leading potato breeding organisation in the country and we plan that the work should, of course, be retained and, indeed, expanded. It will be strengthened on the scientific side by the acquisition of the Commonwealth Potato Collection (C.P.C.) and the development, based on the Collection, of cytogenetic studies of the crop and its immediate relatives. The C.P.C. is

now, as it has been for several years, at the John Innes Institute and the idea of transferring it (and the associated researches) to Pentlandfield has had the enthusiastic approval of all the bodies officially concerned. We should thus be able to build a very strong potato research group having national (*i.e.*, United Kingdom) rather than strictly Scottish responsibilities.

If the right course of development for the potato programme is fairly clear the definition of activities in the other half of the Station, the Forage Section, presents harder problems. On the face of it, the first two choices are fairly clear—perennial ryegrass and barley—and with the second of these there can be no quarrel: barley has come to stay. Ryegrass presents us with a problem. It is the most widely grown crop in Scotland and yet, paradoxically, it is hardly a crop: it is a grass which is managed (usually in complicated mixtures) in as many ways as there are farmers; there are scores of varieties on the market and no rational way of assessing their worth. What is the point in breeding more? We have decided that there is none: if perennial ryegrass should come to be widely grown in pure stand and cut and conserved under a defined system of management then we should have to think again. The same sort of negative argument applies to Italian ryegrass: there are many varieties available and management varies. But we accept that defined management, and hence defined criteria of selection, may come sooner with the Italian than with the perennial form of the species. Again we shall have to watch the situation and perhaps change our minds.

Though we reject the ryegrasses there are, we think, two grass breeding projects that are worthwhile as more speculative, longer term ventures. One concerns cocksfoot, a grass that has many excellent qualities but which, as a species, is deficient in nutritive quality: in this respect, indeed, it hardly overlaps perennial ryegrass. Nevertheless, there are indications—in the relatively excellent quality of Scotia cocksfoot for example—that some advance in this important character should be possible by means of well judged selection on a wide genetic base. The other project is concerned with *Poa* and starts with the observation that the native *Poa pratensis* is a very hardy, persistent, rhizomatous perennial that responds well to fertilizers. Looking ahead to a time at which more intensive agricultural methods push out into hilly and marginal areas, improved Poas seem to us to be the sort of grasses that will be needed; under these circumstances a rhizomatous, almost couch-like habit could well be the reverse of a disadvantage. The native *Poa pratensis* itself is generally rather late-growing and unproductive but there is evidence that it will be possible to combine its hardy habits with the better growth of other *Poa* species, for example, the bunchy and early-growing *Poa ampla* from the U.S.A. There will be breeding problems in this work for many Poas are apomictic, producing what are in fact clonal progeny by seed rather than recombinants.

We saw above that feeding barley must certainly be an important breeding

objective. In the past ten years barley has risen from about one-fifth of the Scottish cereal crop to about two-thirds, a phenomenal rise which has not yet come to an end. Oats have declined correspondingly and there is little doubt that the swing is permanent, at least for the drier and more fertile parts of the country. The leading current barley variety is Ymer, an old (1942) Swedish variety which can produce fair malting quality; nevertheless, malting is a minor use and the great need is for heavy-yielding feeding barleys that are responsive to fertilizers and can be combined. These we are going to try to breed. Oats still have their place, especially on the more acid lands and in wet areas—and Scotland has plenty of both; and there would be a place for oats in the drier and more fertile areas, alongside barley, if heavy-yielding, fertilizer-tolerant and combinable strains were available; but they would have to produce grain yields comparable with or even rather better than barley under these conditions. Two groups of oat varieties are therefore wanted: one adapted to marginal conditions (in effect a continuation of the past oat breeding programme) and one adapted to high farming. In both, as well as in the barleys, the emphasis must be on sheer yield of nutritious grain; straw is now unimportant and, within limits, the less of it the better. We propose to use some unorthodox methods to attack these breeding problems and may, we believe, finish up with some pretty unorthodox varieties—why not six-row barleys, for example, since the evidence is that they out-yield two-row types? They are not very pretty but would the cow mind that?

Brassica work at Pentlandfield has had a long history, having a recent promising issue in the swede Pentland Harvester which has given outstanding yields in trials in Britain and abroad (but may be too " early " to be generally acceptable); it is excellently adapted to mechanical harvesting and we assume that this technique, together with precision seeding, will ensure a place for swedes in Scottish agriculture for years to come. Accordingly we are going to breed swedes and since turnips (*i.e.*, true turnips, *Brassica campestris*) are locally important in Scotland we are also going to give them some attention in the form of an attempt to develop tetraploid lines; turnips are diploid and auto-tetraploid strains produced by colchicine have been found in Sweden to be extraordinarily productive. The project is a simple and relatively short-term one but could be valuable. On kales we do not plan any extensive work but are exploring some crosses of the traditional Scottish curly kale (which has excellent hardiness and leafiness) coupled with studies of the effect of tetraploidy —which might be guessed to be favourable, as in the turnips.

The main straight breeding effort in Brassicas, then, is to be the swedes, aiming at " late " varieties which can be managed by machines; as a long-term more speculative venture there are some extraordinarily interesting possibilities among *Brassica* and *Raphano-Brassica* allopolyploids. Some of these crosses have been known to geneticists for many years—indeed Karpechenko's amphi-

diploid *Raphano-Brassica* is a classic example cited in all the text books. But the possibilities were never seriously explored from a breeding viewpoint until the production at Pentlandfield of the hexaploid *napocampestris* stocks mentioned in the last Annual Report. These are, in effect, a new crop and we shall face some curious problems in developing them to the commercial level. When to sow and when to harvest? How to feed? What to compare them with in trials? Many *Brassica* crosses are difficult (and these with *Raphanus* often more difficult still) so many genetical and experimental tricks will be required to exploit the potentialities of this material. For example, we are planning breeding schemes that will produce much variability in the primary allopolyploids so as to avoid having to repeat very difficult matings. This is a highly speculative venture but in the long term a rather promising one. We don't even know whether the best chances lie in producing leafy forages (such as the current *napocampestris* types) or in new synthetic root crops, although one might guess the former.

These then are to be the main breeding programmes of the Forage group: barleys, oats and root Brassicas as the immediate tasks with cocksfoot, *Poa* and *Brassica* hybrids as longer term projects. All these studies present fundamental cytogenetic problems some of which we are going to attack concurrently with the breeding programmes themselves. Thus cereal breeding is intimately connected with fundamental problems of population structure and productivity in inbreeders, for example: how important is heterosis in such plants? How important are interactions between different strains or genotypes in mixture? Could we use mixtures commercially if there were any advantage to them? Why do we usually use pure-line cereals anyway? Similarly grass breeding prompts some quite general questions about the best means of utilizing variability in outbreeders (such as cocksfoot) and about how to overcome apomixis (as in *Poa*). And the Brassicas pose innumerable problems of cytogenetic relationship between species, means of surmounting interspecific mating barriers and so forth. These are the sorts of studies we are going to develop alongside the breeding programmes, aiming at a reasonable balance between the two kinds of activity, the applied and the fundamental—kinds of activity which are, in fact, much more interlocked and complementary and less contrasted than is commonly allowed.

DR J. W. GREGOR

After a lifetime in the service of the Society, Dr J. W. Gregor retired on 30th September 1965. He joined the staff in 1924 as Chief Assistant. With an agricultural background and a Ph.D. taken in 1925, he was well equipped to tackle some of the agricultural problems which the Society, founded only a few years earlier, had set itself to solve.

From the beginning Dr Gregor's interests lay in pasture improvement. Although in the early years his work was contemporaneous with Stapledon's, it was typical of Dr Gregor that he should adopt a different approach. His plant breeding researches led him to studies of the genetic structure of natural populations and so to the concept of genecology, a field in which he became a recognised world authority. Edinburgh University awarded him a D.Sc. in 1939.

In 1950 he was appointed Director of the Scottish Plant Breeding Station. Shortly afterwards the establishment of a new Station at Pentlandfield called for planning vision and a clear concept of the functions of a modern agricultural research station. Dr Gregor had both and set about transmuting them into laboratories, greenhouses and administrative offices with the positiveness which all his decisions revealed. In 1961 he became a C.B.E.

Behind a shrewd, analytical mind was a sensitive nature. In Dr Gregor his staff found a resolute defender of their freedom to think, to explore and to discover new knowledge for themselves, a sympathetic listener to their problems, a man generous by impulse. Not without relish did he assault bureaucracy wherever he found it interfering with progress or human dignity; to him regulations were largely *impedimenta*.

Dr Gregor's friendly disposition and wide knowledge of Scottish agriculture ensured a harmonious relationship with the Board of Directors. Confronting both was the permanent and perplexing task of striking a balance between the solution of practical agricultural problems and pursuing fundamental research, a task that engendered both mutual respect and close co-operation.

The Board of Directors and the Pentlandfield staff wish Dr and Mrs Gregor many happy years of retirement.

VARIETIES BRED BY THE STATION

Distribution of elite stocks of Scottish Plant Breeding Station products is in the hands of the following:—

Oats	BELL	Messrs Macfarlan, Shearer & Co., Greenock.
Grasses	SCOTIA COCKSFOOT SCOTIA TIMOTHY SCOTIA PERENNIAL RYEGRASS	National Institute of Agricultural Botany, Cambridge.
Swede	PENTLAND HARVESTER	National Institute of Agricultural Botany, Cambridge.

Other Scottish Plant Breeding Station products on the market are:—

Oats	CRAIGS AFTERLEA	EARLY MILLER
	ALBYN DONSIDE	ALBYN BARD
	ALBYN EMPRESS	SHEARER
Barley	CRAIGS TRIUMPH	
Bean	ALBYN TICK	
Potatoes	CRAIGS DEFIANCE	CRAIGS ROYAL
	CRAIGS ALLIANCE	PENTLAND ACE
	PENTLAND BEAUTY	PENTLAND CROWN
	PENTLAND DELL	PENTLAND ENVOY
	PENTLAND FALCON *	PENTLAND GLORY *

Plant Breeders' Rights have been granted in these varieties * and licences to reproduce and sell stocks have been issued to growers and merchants.

Applications for Plant Breeders' Rights have been made in respect of the following potato variety and seedlings:—

Roslin Castle
Seedling 3641a(1)
,, 3074ab(3)
,, 3358ab(3)
,, 2591aj(16)

Stocks of the following potato varieties bred by the Station are maintained for local use (mostly abroad and at present mostly in Kenya):

Roslin Sasumua
Roslin Eburu
Roslin Elementeita
Roslin Mt Kenya
Roslin Riviera

Applications for licences to grow and sell protected varieties of plants bred by the Society should be sent to the Secretary, Scottish Plant Breeding Station, Pentlandfield, Roslin, Midlothian.

Growers wishing to raise virus-tested stocks of potatoes bred by the Society should make application to the Secretary for virus-tested units. The Department will continue to distribute the Society's stocks of new varieties of potatoes; applications should be sent to the Director, Scientific Services, East Craigs, Edinburgh, 12.

EXPERIMENTAL CENTRES

In addition to Pentlandfield, the following experimental centres are in use:—

Potatoes:—

Animal Breeding Research Organisation Farm, Blythbank, Peeblesshire. Centre for potato seedling selection and multiplication of virus-free stocks.
Plant Breeding Institute, Cambridge. Centre for virus resistance trials.
Elvingston, East Lothian. Centre for leaf-roll resistance trials.
Archerfield, East Lothian. Trial centre for resistance to common scab.

Oats:—

Lairgandour, Daviot, Inverness-shire. Trial centre.
Tullochgorum, Boat of Garten, Inverness-shire. Environmental selection centre.
South Ledaig, Benderloch, Argyll. Environmental selection centre.
Archerfield, East Lothian. Centre for selection for resistance to manganese deficiency.
Hedderwick Hill, Dunbar. Environmental selection centre.

Barley:—

Hedderwick Hill, Dunbar. Trial centre.

The Society is indebted to officers of the three Agricultural Colleges, respectively at Aberdeen, Glasgow and Edinburgh, for assistance in connection with the testing of plant material; to the Animal Breeding Research Organisation, Edinburgh, and the Plant Breeding Institute, Cambridge, for facilities at respectively Blythbank and Cambridge; to the National Institute of Agricultural Botany, the National Agricultural Advisory Service and the Scientific Services of the Department of Agriculture and Fisheries for Scotland; and to the many farmers and land-owners who have co-operated in the work of the Station.

STAFF LIST

Director: J. W. Gregor, C.B.E., Ph.D., D.Sc., F.R.S.E. (retired 30.9.65).
N. W. Simmonds, Sc.D., A.I.C.T.A., F.I.Biol. (from 1.10.65).

Chief Assistant: W. Black, Ph.D., D.Sc., F.R.S.E.

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J. M. Dunnett, B.Sc., Ph.D.
D. A. Govier, B.Sc., Ph.D.
Miss J. F. Malcolmson, B.Sc., Ph.D.

T. M. W. Davidson, B.Sc., Ph.D., N.D.A.
A. W. Macarthur, B.Sc.

Graduate Student: A. Bedi, M.Sc.

Technical Assistants: Miss C. Brydon
A. McFarlane
Miss J. McMillan

Administration

Secretary: R. J. L. Gallie, F.C.C.S.
Assistant Secretary: Miss A. Malcolm
Clerical Officer: Miss A. G. Dunnett
Clerical Assistant: Miss A. M. Niven
Shorthand Typist: Miss R. Jackson

BOARD OF DIRECTORS 1965-6

Trustees

H.M. SECRETARY OF STATE FOR SCOTLAND, Scottish Office, St Andrew's House, Edinburgh.
DAVID BELL, 15 Coburg Street, Leith, Edinburgh.
Sir JAMES DENBY ROBERTS, Bt., O.B.E., M.A., J.P., Strathallan Castle, Auchterarder.
ROBERT L. SCARLETT, C.B.E., C.D.A., S.H.M., V.M.H., Sweethope, Musselburgh.

Chairman of Directors

Sir JAMES DENBY ROBERTS, Bt., O.B.E., M.A., J.P., Strathallan Castle, Auchterarder.

Vice-Chairman

ROBERT L. SCARLETT, C.B.E., C.D.A., S.H.M., V.M.H., Sweethope, Musselburgh.

Ordinary Directors

1963

ROBERT ALLISON, Turnhouse Farm, Corstorphine, Edinburgh 12.
R. L. FORREST, Mersington, Greenlaw.
W. H. M. GILL, Rosskeen, Invergordon.
G. B. R. GRAY, Smeaton, East Linton.
JOHN MARSHALL, C.B.E., Dalreoch, Dunning.
A. GORDON PORTER, Scryne, Carnoustie.

1964

W. A. BUCKPITT, B.Sc., The Rowans, Duns.
H. F. D. ELDER (Messrs William Dods & Son), Haddington.
A. HOWIE, B.Sc.(Agric.), N.D.A., N.D.D. (North of Scotland College of Agriculture), 41½ Union Street, Aberdeen.
PETER MACDUFF (Messrs Macfarlan, Shearer & Co.), Greenock.
A. D. C. MAIN, O.B.E., B.Sc., J.P., Windyedge, Perth.
R. H. WATHERSTON, C.B.E., Crichton Mains, Ford.

1965

JOHN ARBUCKLE, Logie, Newburgh.
W. ANDREW BIGGAR, M.C., B.Sc., Magdalene Hall, St Boswells.
GEORGE CLAPPERTON, Sheriffhall Mains, Dalkeith.
J. W. GRANT, B.Sc. (North of Scotland College of Agriculture), Drummondhill, Stratherrick Road, Inverness.
F. R. HORNE, C.B.E., M.A., N.D.A., N.D.D., Hill Farm, Lolworth, Cambridge.
IAN JENNINGS, Shiel, New Galloway, Castle Douglas.

Directors Co-opted

JAMES GRAY, M.B.E., T.D. (James Gray & Co. (Stirling) Ltd.), Stirling.
G. A. STORRAR, M.C., B.Sc.(Agric.), J.P., Rossie, Auchtermuchty.
D. THOMSON, Cessford, Kelso.

Directors nominated by the Secretary of State for Scotland

D. W. WILLIAMS, M.Sc., Ph.D., Scientific Services, East Craigs, Corstorphine, Edinburgh.
ALEXANDER NELSON, Ph.D., D.Sc., N.D.A., F.R.S.E., 86 Great King Street, Edinburgh.
M. A. H. TINCKER, M.A., D.Sc., F.L.S., F.R.S.E., Arbeadie House, 44 Station Road, Banchory.
C. M. YONGE, C.B.E., Ph.D., D.Sc., F.R.S., 13 Cumin Place, Edinburgh, 9.

Standing Committee—Finance

Sir JAMES DENBY ROBERTS, Bt., *Convener.*
R. ALLISON.
G. B. R. GRAY.
A. D. C. MAIN.
ALEXANDER NELSON.
ROBERT L. SCARLETT.
M. A. H. TINCKER.
D. THOMSON.

Research Committees

Potatoes

R. L. SCARLETT, *Convener.*
R. ALLISON.
J. ARBUCKLE.
W. H. M. GILL.
A. D. C. MAIN.
J. MARSHALL.
A. G. PORTER.
G. A. STORRAR.
D. W. WILLIAMS.
Sir JAMES DENBY ROBERTS, Bt. (*ex officio*).

Forage Crops

H. F. D. ELDER, *Convener.*
W. ANDREW BIGGAR.
W. A. BUCKPITT.
G. CLAPPERTON.
R. L. FORREST.
G. B. R. GRAY.
JAMES GRAY.
J. W. GRANT.
D. THOMSON.
F. R. HORNE.
A. HOWIE.
I. JENNINGS.
P. MACDUFF.
R. L. SCARLETT (*ex officio*).
R. H. WATHERSTON.
Sir JAMES DENBY ROBERTS, Bt. (*ex officio*).

ELECTION OF DIRECTORS

In accordance with the rules of the Society the following Directors retire from the Board at this time:—

ROBERT ALLISON, Turnhouse Farm, Corstorphine, Edinburgh, 12.
R. L. FORREST, Mersington, Greenlaw.
W. H. M. GILL, Rosskeen, Invergordon.
G. B. R. GRAY, Smeaton, East Linton.
JOHN MARSHALL, C.B.E., Dalreoch, Dunning.
A. GORDON PORTER, Scryne, Carnoustie.

To fill the aforementioned vacancies the Board of of Directors recommend the election of the following:—

A. MANTON BAXTER (Baxter & Guion Ltd.), Museum Buildings, Priestgate, Peterborough.
J. LESLIE DAWSON, B.Sc. (S.A.I. Ltd.), West Mains of Ingliston, Newbridge, Midlothian.
J. F. FALGATE, Pinkerton, Dunbar.
JAMES GRAY, M.B.E., T.D. (James Gray & Co. (Stirling) Ltd.), Stirling.
G. A. STORRAR, M.C., B.Sc., J.P., Rossie, Auchtermuchty.
D. THOMSON, Cessford, Kelso.

MEETINGS

The Board of Directors met four times, on: 29th July 1965; 25th November 1965; 7th April 1966; 2nd June 1966.

The Finance Committee met on 2nd June 1966.

Research Committee Meetings were held as follows: Potatoes on 26th August 1965, and 19th January 1966; Forage Crops on 3rd February 1966.

ADMINISTRATION

Finance

The abstract of the audited accounts set out on pages 30–36 reveals the Society's financial position at 31st March 1966. Maintenance expenditure for the year amounted to £91,311, 11s. 5d. against which the Department of Agriculture and Fisheries for Scotland provided a grant of £91,000 while income from other sources was £926, 15s. 11d. As a result, £615, 4s. 6d. was added to unexpended balances of grants held on behalf of the Department bringing these to £5,064, 13s. 4d.

The Department also met the capital cost of additional drying shed facilities and improvement to the rabbit house. These amounted to £417, 10s. 5d.

The Directors thank the Department of Agriculture and Fisheries for Scotland for grants received during the year and firms, organisations and individuals who contributed to the funds of the Society.

Membership

At 31st March 1966, the total membership was 353, comprising 170 life members and 183 annual members. Four new members were elected during the year while 12 members died or resigned.

Distribution of Membership as at 31st March 1966

Aberdeen	10	Fife	21	Renfrew	2
Angus	24	Inverness	4	Ross and Cromarty	9
Argyll	3	Kincardine	2	Roxburgh	10
Ayr	11	Kinross	1	Selkirk	3
Banff	1	Kirkcudbright	3	Stirling	5
Berwick	22	Lanark	22	Sutherland	..
Bute	..	Midlothian	65	West Lothian	7
Caithness	4	Moray	6	Wigtown	3
Clackmannan	1	Nairn	1	England	25
Dumfries	6	Orkney	3	Ireland	1
Dunbarton	4	Peebles	1	Wales	..
East Lothian	49	Perth	19	Abroad	5

Board of Directors

Mr Ian Jennings, Shiel, New Galloway, Castle Douglas, was welcomed on his election for the first time to the Board of Directors.

Staff

As reported above, Dr Gregor retired from the post of Director of the Scottish Plant Breeding Station on 30th September 1965.

Dr Simmonds, whose appointment was announced in the 1965 Report, took up his duties on 1st October 1965.

The following resignations from the staff took place:—

Miss S. Cameron, Cytology.
Mr A. Currie, Herbage Plants and Genecology.
Mrs R. Hutson, H.N.C., Cytology.
Miss A. M. Niven, Administration.

A new appointment was made as follows:—

Miss J. Hartridge, B.Sc.

Dr Jean F. Malcolmson presented a paper entitled " Assessment of resistance to *Phytophthora infestans* (Mont.) de Bary in potatoes " to the European Association of Potato Research, Pathology Section meeting, held at Wageningen, The Netherlands, from 9th to 11th June 1965.

Dr Govier attended a conference on Plant Viruses held at Wageningen, The Netherlands, from 5th to 9th July 1965.

Dr Dunnett attended the VIIIth International Symposium of the Society of European Nematologists at Juan les Pins, Antibes, from 7th to 11th September 1965.

By invitation from the Potato Association of America and The Rockefeller Foundation Dr W. Black attended the 49th Annual Meeting of the Potato Association of America in Mexico City, 27th to 31st July 1965. He gave two papers, namely:—

(*a*) " New races of *Phytophthora infestans* (Mont.) de Bary and their Complementary *R*-genes in *Solanum demissum* Lindl."
(*b*) " Observations on the Nature and Inheritance of Field Resistance to *Phytophthora infestans* in potatoes."

Dr Black made several local journeys and visits in Mexico and, on return, spent ten days in Canada where he saw the potato investigations of the Depart-

ment of Agriculture Research Branch at Fredericton, New Brunswick, and at Alma on the Bay of Fundy. He also paid a visit to the University of Maine Experimental Farm at Presque Isle to see the potato trials of the United States Department of Agriculture.

Miss Bennett visited under invitation the United Nations Crop Research Introduction Centre at Izmir, Turkey, in July 1965.

Dr Ratcliffe read a paper on *Arabidopsis* ecology and physiology at a Symposium arranged by the University of Göttingen, West Germany, from 21st to 25th April 1965.

Dr Simmonds attended the annual meeting of the British West Indies Sugar Association Technical Committee in Barbados in December. He was in Barbados from the 6th to 14th of the month as Consultant to the B.W.I. Central Sugar Cane Breeding Station. On the way out he visited the University of North Carolina at Raleigh, U.S.A., gave a seminar, and had many useful talks with the numerous geneticists and plant breeders on the campus.

ABSTRACT OF ACCOUNTS

For year ended 31st March, 1966

INCOME

1964-65				
£200		Interest received	£241 4 10	
117		Recoverable Income Tax	154 2 9	
—	£317			£395 7 7
541		Sales of Produce and Stock on Hand		414 6 4
50		Sale of Equipment		3 0 0
95		Subscriptions—Annual		85 10 0
		Note.—Annual Subscriptions amounting to £9 are in arrear.		
29		Rent of Cottage		28 12 0
	£1,032	*Total Ordinary Income*		£926 15 11
		Grants received from the Department of Agriculture and Fisheries for Scotland:—		
£84,700		Maintenance for year 1965-66	£91,000 0 0	
2,400		Capital	417 10 5	
—	87,100			91,417 10 5
	£88,132	*Total Income*		£92,344 6 4
		Balances at 1st April 1965:—		
£160,638		Funds	£163,037 13 7	
6,308		Department of Agriculture and Fisheries for Scotland—Maintenance Grant	4,449 8 10	
—	166,946			167,487 2 5
	£255,078			£259,831 8 9

EXPENDITURE

1964-65			
	Salaries:—		
£47,767	Scientific and Technical Staff .	£50,552 9 2	
5,314	Administrative and Clerical Staff.	5,445 15 8	
602	Pension Supplementation . .	725 7 0	
£53,683			£56,723 11 10
5,081	Superannuation Contribution		5,268 2 0
9,927	Wages		10,688 10 7
1,871	National Insurance and Graduated Contributions .		2,343 16 11
2,145	Sundry Working Expenses		2,894 17 11
679	New Vehicle		711 11 9
561	Maintenance of Vehicles		781 19 10
4,858	New Equipment and Renewals of Implements and Tools		2,016 19 3
82	Furniture		135 15 8
419	Library Expenses		382 19 3
965	Rates, Taxes and Insurances		1,238 11 1
132	Audit Fee and Legal Expenses		160 15 0
895	Printing		1,366 18 0
764	Stationery, Postages, Telephone and Office Expenses .		835 5 6
2,827	Power, Light and Heat		3,189 6 3
962	Travelling and Subsistence Expenses		907 19 5
474	Property Repairs and Upkeep		697 11 8
45	Regional Trials		40 0 0
360	Advertising Vacancies		79 12 0
861	Edinburgh Centre of Rural Economy—Contribution towards upkeep		847 7 6
£87,591	*Total Ordinary Expenditure* . .		£91,311 11 5
	Capital Expenditure £417 10 5		
	Balances at 31st March 1966:—		
£163,038	Funds, per Balance Sheet . .	£163,455 4 0	
4,449	Department of Agriculture and Fisheries—Maintenance Grant .	5,064 13 4	
167,487			168,519 17 4
£255,078			£259,831 8 9

BALANCE SHEET

as at 31st March, 1966

I Funds at 31st March 1966		£163,455 4 0
II Current Liabilities:—		
Accounts outstanding due by Society . .	£920 0 7	
Subscriptions paid in advance. . . .	2 0 0	
Department of Agriculture and Fisheries for Scotland Maintenance Grant . . .	5,064 13 4	
		5,986 13 11
		£169,441 17 11

Edinburgh, *12th May 1966.*—The undersigned, having had access to all the Books and Accounts of the Society, and having examined the foregoing Statement of Accounts and verified the same with the Accounts and Vouchers relating thereto, now sign the same as found to be correct, duly vouched, and in accordance with law.

16 Alva Street.

R. L. MACDONALD, *Approved Auditor.*

J. D. ROBERTS, *Convener, Finance Committee.*

	Cost	*Amounts charged to Revenue*	*Net*
I Fixed Assets:—			
Heritable Property . .	£156,921 4 10	...	£156,921 4 10
Implements and Tools . .	9,202 5 0	£9,202 5 0	...
Vehicles	2,498 16 6	2,498 16 6	...
Laboratory Apparatus . .	10,960 15 3	10,960 15 3	...
Furniture and Fittings . .	4,687 3 0	4,687 3 0	...
Library Books . . .	3,784 0 0	3,784 0 0	...
	£188,054 4 7	£31,132 19 9	£156,921 4 10

II Current Assets:—		
Stocks on Hand as valued by Directors . .	£23 10 0	
Accounts Outstanding, due to Society . .	702 16 9	
Income Tax Recoverable	154 2 9	
Investments (see Appendix), at cost . .	5,961 4 4	
Cash and Bank Balances.	5,678 19 3	
		12,520 13 1
		£169,441 17 11

LIFE MEMBERSHIP SUBSCRIPTIONS AND DONATIONS ACCOUNT

Interest received	£253	17	1
Recoverable Income Tax	117	7	9
	£371	4	10
Life Subscription	10	0	0
Donation	5	0	0
Balance at 1st April 1965	6,741	0	7
	£7,127	5	5

W. J. REID AND JAMES MUNRO BEQUESTS

Interest received	£77	15	11
Recoverable Income Tax	2	18	11
	£80	14	10
Balance at 1st April 1965	1,761	18	11
	£1,842	13	9

DR. WILSON MEMORIAL FUND

Interest received	£17	7	8
Recoverable Income Tax	2	16	9
	£20	4	5
Balance at 1st April 1965	428	10	10
	£448	15	3

Travel Grant				£50 0 0
Grant towards retiral gift				31 19 10
Balance at 31st March 1966, consisting of:—				
Investments (see Appendix), at cost	£6,249 13 5			
Recoverable Income Tax	117 7 9			
Sum in Bank of Scotland Savings Account	548 2 8			
Sum in Bank of Scotland Current Account	125 1 9			
Sum in Hand	5 0 0			
				7,045 5 7
				£7,127 5 5

Travel Grant				£50 0 0
Balance at 31st March 1966, consisting of:—				
Investments (see Appendix), at cost	£1,564 7 1			
Recoverable Income Tax	2 18 11			
Sum in Bank of Scotland Savings Account	15 15 11			
Sum in Bank of Scotland Current Account	209 11 10			
				1,792 13 9
				£1,842 13 9

Balance at 31st March 1966, consisting of:—				
Investments (see Appendix), at cost	£362 11 6			
Recoverable Income Tax	2 16 9			
Sum in Bank of Scotland Savings Account	47 13 6			
Sum in Bank of Scotland Current Account	35 13 6			
				£448 15 3
				£448 15 3

APPENDIX

LIST OF INVESTMENTS

General Account

Nominal Value				*Market Value at 31/3/66*
£3,064	9	7	Funding 4 per cent Stock 1960-1990	£2,812
375	0	0	Courage, Barclay & Simonds 750 Ordinary 10s. Shares	750
225	0	0	National Commercial Bank of Scotland 450 Ordinary 10s. Shares	647
160	0	0	Royal Exchange Assurance Co. Capital £1 Stock	558
525	0	0	Imperial Chemical Industries Ordinary £1 Stock Units	1,122
325	0	0	Electric & Musical Industries 650 Ordinary 10s. Stock Units	1,002
£4,674	9	7		£6,891

Life Membership Subscriptions and Donations Fund

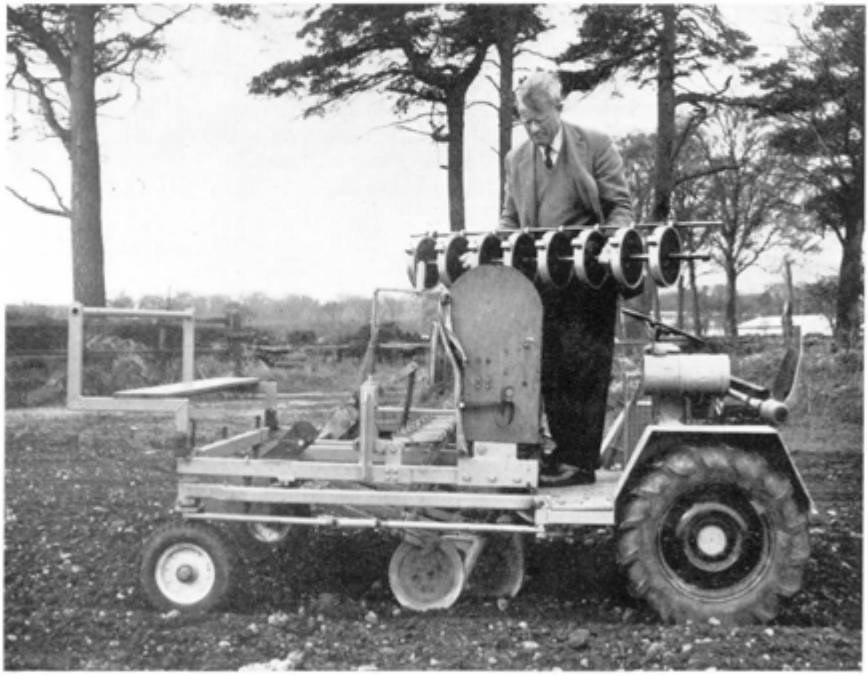
£2,135	11	0	Funding 4 per cent Stock 1960-1990	£1,959
360	0	0	City of Birmingham 6¼ per cent Redeemable Stock 1972-1973	346
247	10	0	National Commercial Bank of Scotland 495 Ordinary 10s. Shares	712
120	0	0	Royal Exchange Assurance Co. Capital £1 Stock	419
240	0	0	Courage, Barclay & Simonds 480 Ordinary 10s. Shares	480
345	0	0	Imperial Chemical Industries Ordinary £1 Stock Units	737
220	0	0	Electric & Musical Industries 440 Ordinary 10s. Stock Units	678
400	0	0	Defence 5 per cent Bonds, 1st Issue	400
500	0	0	Defence 5 per cent Bonds, 2nd Issue	500
£4,568	1	0		£6,231

W. J. Reid and James Munro Bequests

£67	0	0	Imperial Chemical Industries Ordinary £1 Stock Units	£143
1,295	0	0	Defence 5 per cent Bonds, 1st Issue	1,295
150	0	0	Defence 5 per cent Bonds, 2nd Issue	150
£1,512	0	0		£1,588

Dr Wilson Memorial Fund

£30	0	0	Royal Exchange Assurance Co. Capital £1 Stock	£104
210	0	0	Defence 5 per cent Bonds, 1st Issue	210
£240	0	0		£314



THE SCOTTISH PLOT SEEDER

Above—The machine in operation, showing landwheel, coulters and magazine cover.

Below—The magazine detached showing the eight drums each holding fifteen charges of seed.