Reports of the Imperial

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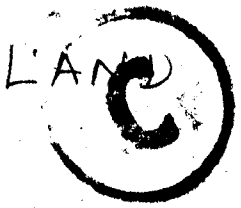
21st report

GRASS LAND SEEDS



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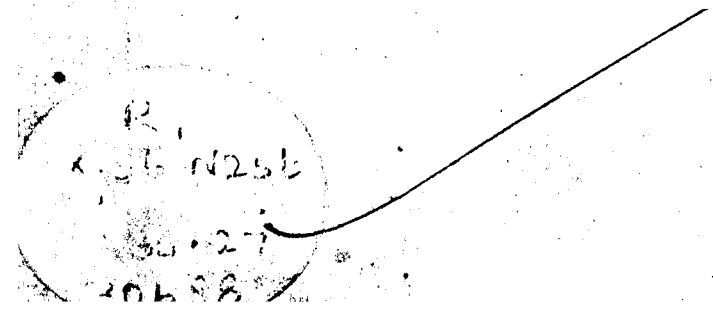

Reports of the Imperial Economic Committee

Twenty-Seventh Report

GRASSLAND SEEDS

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Twenty-Seventh Report: Grassland Seeds

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Secretary of State for India.

To the Right Honourable SIR PHILIP CUNLIFFE-LISTER, G.B.E M.C., M.P.,
Secretary of State for the Colonies.

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I. INTRODUCTION

1. We, the Imperial Economic Committee, appointed by the Governments of the United Kingdom, the Dominions, India and the Colonies and Protectorates, and acting in pursuance of a resolution of the Imperial Conference of 1930, beg leave to present to the Governments of the Empire this our twenty-seventh Report : *Grassland Seeds.*

2. We have examined a number of witnesses representing producing, marketing and consuming interests, and further have had the advantage of consultation with experienced Government officials and with men of scientific eminence. We thank them and all those who have appeared before us, or otherwise aided us in our enquiry, for their skilled assistance. In particular we desire to express our obligation to Sir William Lobjoit, O.B.E., J.P., and Mr. David Black, who as co-opted members helped us with their expert knowledge during the sub-committee stage of our enquiry.

II. THE IMPORTANCE OF THE GRASSLANDS OF THE EMPIRE

3. In the Committee's Report on Dairy Produce it was pointed out that the grassland crops of the Empire are no less important than the cereal crops. With the exception of pig and poultry products, nearly the whole of the primary produce of live-stock farming (such as beef, mutton, milk, butter, cheese, hides and skins, wool) is transmuted grass. An exact computation of the relative value of grass and cereal products is hardly possible, owing to the difficulty of calculating the factor of supplementary feed, and the following figures may therefore be interpreted as giving a general idea of the position.

4. The total value of imports of all descriptions into the United Kingdom in 1932 was £702 millions. Of this total, wheat, barley, oats, maize, rice and wheatmeal flour accounted for £58 millions, and grassland products (see Appendix D, Table 1) for £147 millions, of which £88 millions, or 60 per cent., came from Empire countries. Out of every £100 expended on imported merchandise, £20 18s. went on grassland products.

5. In the Census of Agricultural Production for England and Wales in 1925 (the latest issued) the estimated value of grassland products was £110·8 millions, or nearly 2½ times the value of the arable crops (£46 millions) and nearly half the estimated value of the total agricultural output (£225·3 millions).

6. The four principal countries in the Empire exporting grassland produce are Australia, New Zealand, the Irish Free State and South Africa. Figures for the aggregate values of the exports from these countries are given in Table 2 of Appendix D, from which it will be seen that in 1932 the proportion of the total represented by grassland products was over 43 per cent. in South Africa; 48 per cent. in the Irish Free State; over 54 per cent. in Australia; and over 90 per cent. in New Zealand. In the case of Canada, the values of cereals, metals and manufactured goods exported make the proportion of grassland produce in the total exports much smaller, i.e., less than 5 per cent.

III. THE RELATION BETWEEN THE MAIN FACTORS IN THE GRASSLAND PROBLEM

7. Grassland improvement involves a number of distinct but closely related factors, of which seeds, the subject of our enquiry, is only one. Apart from mechanical factors such as drainage and irrigation, these factors may be grouped under three main categories: soil fertility, pasture management, and herbage—i.e., the botanical constitution of the pasture itself. The degree in which grassland improvement as a whole is to be achieved, either by the scientific investigator or by the farmer, depends on the degree in which the connection between these factors is kept constantly in mind, although, while the variants in any one category are studied, it may be convenient to regard those of the other two as being, for the moment, constant.

8. Thus to the problem of soil fertility belongs the study of the ways in which a pasture of a given botanical constitution, and under a given system of management, may be improved by the choice and use of manures. In a study of pasture management, the botanical constitution and fertility of the pasture may for the moment be regarded as a constant, and the problem is that of effecting improvement by variation in the control of grazing and cropping. Among the numerous variables here are the quantity and nature of the live stock carried, the intensty of the grazing, the occurrence and duration of the intervals between grazings and between cuttings for hay or fodder, and generally the grazing rotation within a single season and, in the case of temporary leys, the occurrence of the ley in the scheme of crop rotation over a series of years. Finally, with soil fertility and pasture management taken as constants, there remains the herbage problem in a narrower sense: the problem of effecting improvement by choice and change in the botanical constitution of the sward. The bearing of grassland seeds and their supply on this special problem is the subject of our enquiry. The others lie outside it. The importance of this inter-relation can be shown from one or two examples. Very striking results have been obtained in the United Kingdom from the application of basic slag, particularly to pastures containing wild white clover. The action of the phosphatic manure, however, is not only to increase the growth of adult plants but also to assist seedlings to establish themselves. It has been found that where the pasture is poor or the undeveloped clover seedlings are scarce, the application of the manure itself is of little avail, but that if the land is ploughed, or even well scratched, and fresh wild white clover seed is sown, the result of applying the manure may then be something in the nature of a transformation.

9. Similarly, it has been found in Australia that although a top dressing of superphosphate may raise the carrying capacity of the native grasses in the summer rainfall region, the operation may not be economic, since the cost of the fertiliser may exceed the value of the increase obtained. If, however, the land is ploughed up and re-sown with a suitable seed mixture, there is a marked increase in carrying capacity which can be carried still further by the application of fertiliser. To get an economic return from the application of the fertiliser it is necessary that the pasture concerned should consist of herbage capable of responding adequately to the application.

10. What the grazing animal requires (and he is a selective feeder) is a nutritious and palatable herbage. It is the leafy and, *ceteris paribus*, the young and growing herbage that is most nutritious and palatable. In leafiness and rate of growth (and with that rate of growth the consequent duration of the palatable period) there are wide differences between one kind of herbage and another. Cocksfoot, for example, is highly palatable while growing but distinctly unpalatable as soon as growth stops, while it is one of the virtues of perennial rye-grass that it has a relatively long period of palatability; but whatever the herbage, the nutritive and palatable properties are best maintained when the pasture is sufficiently well grazed to prevent the plants reaching the stage where growth ceases and palatability declines. Here then the grazing animal (the "biotic factor") and control of his grazing, i.e., pasture management, become hardly less important than the herbage itself. But again: all defoliation is a tax on the vitality of the plant, and different kinds of herbage plants vary in their capacity to withstand the kind of grazing that will maintain a palatable and nutritive stage of growth in the pasture as a whole. Certain highly palatable species, such as timothy, suffer in consequence: It is therefore all the more important to include in the pasture other plants that are both palatable and able to withstand heavy grazing; and of these, wild white clover is an outstanding example.

There is thus a reciprocal relation between the management problem and the herbage problem. To maintain the pasture in a

nutritious and palatable condition calls for a certain type of pasture management, and this in turn requires a botanical constitution of the sward adapted to the type of management employed.

11. The herbage problem itself has two aspects. In countries where grassland farming has been long established, the main pasture species are already existing as a result of centuries of interplay between all the factors (including the biotic) involved, and the herbage problem is concerned with the choice and supply of suitable seed; but in countries where grassland farming is a result of comparatively recent migration from Europe the situation is very different, and in many cases the pasture has had to be created or profoundly modified by the introduction of other species. It follows that in those countries the establishment of species may remain for some time a problem no less important than the supply of seed.

IV. THE SEARCH FOR SPECIES

12. An epic struggle in clearing the land was only one of the many tasks of the early settler in Empire countries overseas. Native grasses, admirably adapted to the climate, and in equilibrium with the indigenous fauna, were often found inadequate to withstand the intensive grazing of the domesticated sheep and cattle which the settler brought with him from Europe. Hence an urgent need to obtain and establish herbage species adaptable not only to the climate but also to the demands made upon them by civilised man and his grazing animals. Although at first much damage (and, as some think, irreparable harm) was done, yet the two countries in which the need was particularly urgent are examples of the success that attends determined endeavour. Until the advent of the white man, Australia, which now carries 110,000,000 sheep and 12,000,000 cattle, knew only the light browsing of marsupials such as the Kangaroo and the Wallaby, while New Zealand, which in proportion of area devoted to grassland farming may now be regarded as probably the finest pastoral country in the world, was absolutely devoid of grazing animals.

13. A complete account of this search for species would show an almost infinite variety of conditions and corresponding grades of difficulty in the search, ranging from areas of temperate climate where, as in New Zealand, the establishment of European species has been comparatively easy and rapid, to areas where conditions of frost, heat, and drought render the task more difficult, and areas where, as in many parts of Australia, success depends on the introduction of non-European species. There is likewise a wide range of difference between the suitability of local species. Moreover, in three out of the four chief countries concerned, range of climate and even the mere extent of territory involved, not only

multiply the problems with which the authorities have to deal, but add to the expense of organised research in labour, money, and time.

14. In temperate areas, particularly in New Zealand and parts of Australia, the introductions have been legion; nor have they always been deliberate, for in the days before official regulations the seeds of many species which have since flourished were introduced as impurities in imported seed, or in fodder and in or on the bodies of animals fed on such fodder during the voyage. Thus some mattresses brought ashore from a ship wrecked near King Island contained seeds which are said to be the origin of the " King Island " melilot now established both on the island and in many parts of the Australian mainland. Fodder brought ashore from another disabled vessel was the means of introducing " Chilian rats' tail " into New Zealand. In most cases the occasion of these accidental or " stowaway " introductions is of course unknown, but while a few have been destructive, others, especially some of the annual clovers, have proved hardly less valuable than the species deliberately introduced.

15. In view of the ill-omened examples of the blackberry among plants and the rabbit among animals, it is not surprising that stringent precautions are now taken, especially in " new " countries, against the introduction of such " undesirable aliens ", but only the event can show how the exotic plant will behave in its new home. What is a comparatively harmless weed in one country may prove a serious pest in another, and it is also true that what is harmful or useless in one country may, in a different environment, be harmless or even useful. Alsike in Canada usually contains a quantity of trefoil which in Canada is condemned as a weed, but which assists the export of Canadian alsike to the United Kingdom, where in many localities the trefoil is regarded as advantageous; and similarly, several European annuals, which are regarded as weeds in the United Kingdom, have proved useful additions to the less densely populated swards in some districts in Australia.

16. The general result of these introductions, deliberate and accidental, is that over immense areas in the more temperate regions the herbage population is now comparable with that found in Britain. It has been observed that in New Zealand, and in some temperate areas in Australia, there are pastures which, except for a difference in the relative prevalence of particular species or for the presence of one or two non-European species in the sward, might almost have been transplanted from England. Moreover, some species have been so well established in their new home as to become " secondarily indigenous " or even wild, and thus an actual or potential source of seed supply not only for the country of their adoption but also for their country of origin.

17. Reference has been made to the destructive effect on the native herbage of the introduction of European sheep and cattle by the early settlers in New Zealand and Australia. Their no less powerful influence in effecting creative change must also be recognised. In all the temperate areas the grazing animal does much to create the pasture on which he feeds. His grazing, destructive as it may be where the equilibrium between beast and pasture is disturbed, nevertheless helps to maintain the herbage in a nutritious and palatable condition. His droppings manure the soil, and as he moves from pasture to pasture he acts as a distributor for the herbage seeds he carries in and on his body (and in the case of clover, for the nodule organisms he carries in the mud on his feet), while by his treading and trampling he assists the young seedlings to establish themselves. Just as in England the sheep, as they are moved from the meadow pastures to the Downs, carry with them a variety of herbage seeds, so in the South Island of New Zealand, for example, it can be observed that where the sheep and cattle are moved from temporary leys to the tussock grasslands, they carry with them and establish in their tussock grazing grounds white clover, crested dogstail, and other species, of which not a seed has been sown by man.

18. Such in outline is the picture of the relatively simple task of plant introduction in temperate areas. The more difficult situation created by climatic range and territorial extent is well exemplified by Australia. With an area of approximately three million square miles, and a rainfall ranging from less than 10 up to 160 inches, the Australian continent comprises at least five major climatic regions, each presenting important problems of its own.

19. In some areas with climatic conditions differing widely from those in Europe, certain European species have, none the less, proved successful. Among those of outstanding economic importance, a typical example is subterranean clover, which was not deliberately introduced but reached Australia as a " stowaway ". It is found in South Europe and Great Britain as a roadside plant, but in those climates it was formerly not considered worth cultivation. In its new home, however, conditions were so favourable that it has thriven greatly, and has proved a boon to considerable areas of relatively poor country in South Australia and to the light, sandy lands in Western Australia. The annual rye-grass found in the Wimmera district of Victoria, and now extensively cultivated in Australia, was also a " stowaway " introduction. It has proved of exceptional value in the wheat belt, in conditions of rainfall ranging as low as 15 up to 25 inches. Another European species, phalaris tuberosa, has proved of great value in the region of winter rainfall and summer drought.

20. On the other hand, the most important of the alien species established in the sub-tropical region on the eastern coast is

paspalum, which was introduced from South America some 40 years ago, and is said to have had a very large share in the great extension of the dairying industry in Queensland and New South Wales. Other valuable introductions into this region are Sudan grass, Para grass (from Uruguay) and Rhodes grass and Kikuyu grass, from Africa, whence also comes a more recent introduction " woolly-finger grass " (digitaria eriantha) which promises to be suitable for the sub-tropical areas.

21. In the Union of South Africa the importance of grassland improvement is assuming a new significance, owing to the efforts that are being made to develop an export trade in meat. The main grassland country lies in the East and North-East of the Union. In summer the high veld affords ample grazing and produces abundance of hay, but owing to early frosts the growing season is short and winter food deficient. The surrounding middle veld, with a lower elevation, has a longer growing season, and in spite of uncertain rainfall and a tendency to phosphorous deficiency in the soil, is regarded as potentially an important cattle raising area. In the low veld the growth is luxuriant in districts approaching the coast, but the grazing is poor, while further inland the rainfall in the low country is either very restricted or very concentrated, giving either poor grazing or good grazing for a very limited period.

22. Of the numerous native species two stand out as, at present, the main support of the stock-raiser; rooi grass and Kweek grass. Rooi grass is closely allied to the " Kangaroo " grass indigenous in the southern area of Australia. In South Africa, it grows in abundance, is readily grazed, and yields palatable hay, but it will not stand heavy grazing, it tends to disappear with annual burning, and its nutritive value is rather poor. Kweek grass, on the other hand, besides being very palatable, is of high feeding value. It is, moreover, a good " coloniser " in bare ground. It exists in a large number of varieties, which are widespread in the country, and it is possible that, under selection, it may yield strains of special value for differing local conditions.

23. It has however been recognised for some time that the grasses of which the " natural " veld at present consists are inadequate for the requirements of modern farming. Serious deterioration has already taken place in consequence of overstocking, overgrazing, and soil erosion, as well as from veld burning and errors in management. The search for species was at first directed towards the introduction of exotic grasses and fodder crops. Alien pasture grasses have not proved suitable to veld conditions, though some of them, e.g., canary grass, cocksfoot, New Zealand tall fescue, rye-grass, and especially paspalum, have been found useful in moist or irrigated areas. Since 1913, attentior has therefore been directed mainly to a careful examination of indigenous grasses.

in the hope of discovering species or types which would lengthen the grazing period and increase the feeding value of the grass-veld area.

24. Experiments have been made with a large number of such species, and it has been found that several promise to be of high value for South African conditions. Three outstanding instances have already been mentioned on account of their usefulness when introduced into Australia—i.e., Kikuyu grass, Rhodes grass, and digitaria eriantha, or " woolly-finger " grass. Authorities in South Africa have recently concentrated their attention on " woolly-finger " grass, of which they have formed a very favourable opinion. It is rich in protein and mineral contents, it is very palatable, and stands grazing well. Though it rarely sets seed, it is stoloniferous, which is an advantage in a dry country.

The Future of Pasture Plant Introduction and Establishment

25. It is clearly desirable that this search for herbage species, which has already been of great economic importance to the Empire, should be vigorously continued. In Australia the plants, species, and strains that have already been introduced are numbered in thousands, and it is considered that even if one per cent. of them ultimately prove of economic value, the trouble and expense of introducing and testing them will have been repaid. That the future may yet have something in store may be seen from the fact that although Southern Europe has been well searched, a specialist on a visit to Morocco was able to obtain a " new " variety of cocksfoot which may prove useful for Australian conditions.

26. The detail of future plant introduction either from one Empire country to another, or from foreign countries, is necessarily a matter of experiment. Certain possibilities have been brought to our notice in the course of our enquiry, but detailed local knowledge is needed to assess their application. Our attention has been drawn by more than one authority to the importance of developing the introduction of leguminous plants into the warmer climates of the Empire. It is now well known that a mixture of grasses and clovers (or clover-like plants) is essential to the formation of high-grade permanent pastures, but while there are a number of grasses available for warm or tropical climates, the number of suitable legumes is comparatively small. In the opinion of some authorities, the key to the establishment of permanent pastures in tropical rain forest zones is to be found in the discovery of a suitable pasture legume. Similarly, there is need for a legume suitable for arid tropics and other arid areas, which in all probability would be different from the type suitable for humid areas. There is also, we have been informed, some ground for the belief that the South African pasture problem has hitherto been considered somewhat too much from the standpoint of grasses, and that the discovery or introduction of suitable clovers, not only in South Africa but also in other countries of the Empire where large areas of undeveloped land exist, would be of great economic importance, as has already been the case in Australia

27. Of more general interest is the view that the introduction and establishment of pasture plants would be facilitated by ecological surveys of the major pasture regions, with the object of determining the " plant associations " in each district. The argument is that an ecological survey would ultimately prevent waste of time and energy. Within any one country it would enable research workers to judge how far the results of their experiments might apply to other regions of similar character. Further, it would enable the authorities or specialists to classify the kinds of plants that are either suitable or required for each district, as a guide both in selecting plants for experiments and in selecting districts in which to test them. Under existing conditions, little difficulty is felt in securing seeds for trial from investigators in other countries. What is lacking, however, in the case of many introduced species, is precise information as to their natural range of habitat.

28. The conduct of an ecological survey necessarily takes a long time, especially in countries covering vast areas and possessing a wide range of soil and climate. In such countries it would naturally be confined at first to the areas of principal economic importance. So far, most progress has been made in New Zealand, but a beginning has already been made by the Plant Industry Division of Australia, systematic work in the direction of " zoning " the valuable indigenous plants has been carried on in Alberta and Saskatchewan, and authoritative opinion in Canada takes the view that the valleys of the interior of British Columbia, with their great diversity of soil and climate, should also offer opportunity for the ecological study of a wide range of herbage species.

29. Not only is it desirable that such ecological surveys should be undertaken wherever possible, but it is also desirable that those conducting them in different parts of the Empire should work in consultation, and particularly that the terms used should have a uniform and recognised significance. In surveys of this character it is almost impossible to avoid the use of qualitative epithets such as persistent, leafy, hardy and the like, some of which do not always mean the same thing. In Australia, for example, a hardy strain means a strain capable of resisting extremes of heat. In Canada, on the other hand, the term denotes a strain capable of resisting extremes of cold. In both countries it connotes drought resistance. In respect of temperature, however, the term is used with two opposite meanings. Again, in Canada, winter-hardiness means ability to resist dry cold, or snow. In the United Kingdom it

means ability to resist wet cold. Strains that are " winter-hardy " in the United Kingdom will not necessarily be " winter-hardy " in Canada. On the other hand a red clover that resists the Canadian or Russian winter by drawing the crown under the soil to keep it warm may, in so doing under United Kingdom conditions, fail to survive the wet winter against which the native species keeps the crown above ground.

The difficulties of standardising descriptive terms are formidable. Yet no one is likely to deny the need for some standard method of description and classification in order that the experimental introduction of pasture plants from one region in the Empire to another may rest on a reliable basis and yield the quickest practical results.

V. THE SIGNIFICANCE OF STRAIN

30. Within each herbage species there exist, as would be expected, a number of varieties which have resulted from adaptation to environment. A crop of English wild white clover would be sufficiently unlike a crop of commercial Dutch white clover for the difference between the two crops, as wholes, to be noticeable even to the untrained eye. Single plants in each crop might be alike, but the generality of the plant population would be markedly different. Within each crop, however, the members of the population, though generally bearing a strong family likeness, would on further examination be found to differ from one another in several respects. Further, what is equally important is that if two crops are grown from English wild white clover seed harvested from different districts, the informed observer would discover both resemblances and differences, and in some cases such differences, e.g., in size of leaf, density of growth, rate of spreading, ability to root at the nodes, and productiveness, would have important agricultural significance.

31. The fundamental fact is that not only the species, but the local varieties, or " strains " as they are called, must be regarded as a complex of related but not altogether similar individuals, and the character of the complex, both in the species and the strain, may depend not so much on the presence or absence of certain typical plant forms as in the numerical proportion of such forms or groups of forms in the population as a whole.

32. Being thus complex in its composition, any herbage species will be all the more strongly affected by the influence which soil, climate, and management exert upon it in any particular environment. The effect may appear at first through variations in the proportion in which the types composing the complex are found in any one locality. The selective influence is, however, cumulative, and in time the character of a species grown in one locality will tend to differ materially from that of the same species grown in another locality, even though the two may be in the same country and not far removed from each other. The wider the difference in climate and management, the wider will be the eventual differences between the general character of the resulting variants or " strains " within the species.

At the same time, such strains are still composed of a number of types. Like the species of which they are variants, they are complex. They are stabilised within a comparatively narrow and characteristic range of variation, but while this characteristic balance of types within the strain is stable for the particular environment in response to which it has evolved, instability and variability may reappear if the environment is changed.

Effect of Soil, Climate and Farm Management

33. The effect of soil and climate can be seen in the history of English species introduced into New Zealand. In certain districts and under specially favourable conditions some of these species, e.g., white clover and perennial rye-grass, have in the course of time developed local strains which show higher productivity and longer seasonal growth than the original types : so much so, that if seed of the parent type is imported from England to-day, and sown in some of the high-production soils of New Zealand, it will have difficulty in maintaining itself against the local strains.

34. Again there is a close relation between strain evolution and farm management. This is well illustrated in some experiments with cocksfoot recently carried out at the Welsh Plant Breeding Station at Aberystwyth. Considered in respect of growth-form, habit, and time of flowering, the several varieties of cocksfoot can be classified in three main groups : those of the hay type, the intermediate or hay-pasture type, and the pasture type. Plots sown with Danish (commercial) seed, New Zealand Akaroa seed, and English old pasture seed, were compared. The following figures give the percentage of plants in each plot which were assignable to each of these three main groups.

Percentage Contribution of the three main groups of Cocksfoot, in plots sown with seed of different origin.

Origin of Seed in Plot	Percentage of Types			Percentage contribution as to date of flowering	
	Hay Types	Intermediate Types	Pasture Types	Early	Late
Danish (commercial)	66	31	3	93	7
New Zealand (Akaroa)	30	41	29	60	40
English Old Pasture	12	26	62	36	64

35. It will be seen that none of the three " strains " is entirely of one type; there is a wide range of difference between the proportions in which the plants of the three main types occur in the three strains investigated; and these proportions reflect the form of farm management under which the seed was produced. The Danish seed is harvested off leys from which a seed crop is as a rule taken only in the first and second harvest years. The Akaroa seed is harvested at irregular intervals from areas which were sown with cocksfoot some 60 years ago, but in which there is considerable re-establishment from self-shed seed, and the sward is not very dense. The English seed came from old and permanent pastures in which the sward is very dense and re-establishment from self-seeding is slight. Each of these three conditions favoured a characteristic development: the Danish favouring short-lived plants; the English favouring long-lived and dense growing plants, and the New Zealand conditions favouring an intermediate type.

Superiority of Local Strains Demonstrated by recent Research

36. The economic significance of the complex nature of herbage species and strains is this: the origin and history of the seed he is to employ is of no less importance to the farmer than the species or variety to which it belongs. That the relation between origin and suitability in this instance differs from that obtaining with some other agricultural plants, and that imported herbage seeds may prove inferior in performance, has been believed in a general way for some time. This belief has been recently confirmed by systematic comparisons between local and imported varieties which have been carried out quite independently in a number of countries. From experiments with red clover conducted in the United Kingdom, Canada, New Zealand, the United States of America, Denmark, Germany, Sweden and Russia, it has been found in each country that home-grown seed, derived from varieties which are either indigenous or so thoroughly acclimatised as to be " secondarily-indigenous," is more suitable than commercial seed derived from other countries. The same conclusion has been drawn from experiments with white clover in the United Kingdom, New Zealand and Sweden; from experiments with perennial rye-grass in the United Kingdom, New Zealand, Denmark and Sweden; from experiments with cocksfoot in the United Kingdom, New Zealand and Denmark; from experiments with lucerne (or alfalfa) in Canada, New Zealand, Hungary and Russia, and also from experiments conducted in the United Kingdom with other grasses such as timothy and meadow fescue.

37. It is probable that in refinement of technical method these experiments have been far from uniform, but most of them have been carried out over varying periods during the last 10 years,

and the degree of unanimity in the results of experiments so various in place and subject-matter seems to justify the following broad generalisations which have been based upon them. For the man-made pastures, and particularly the permanent pastures, of any country or region, those herbage seeds will be most suitable which are saved from selected old pastures in that region. In default of local supplies, the most suitable seeds will be those grown in a country or region in which the soil, the climate, and also the usage conditions most nearly approximate to those existing where the seed is to be sown for pastures, and the degree of suitability will depend on the degree in which this triple approximation is attained.

38. It should be borne in mind that what is here under consideration is not plant establishment but the performance of imported seed of a given species as compared with seed saved locally. The properties in which the inferiority is displayed may be various. It may show itself in failure to withstand a rigorous winter, or in a tendency to remain winter-dormant over a period unnecessarily long for the new environment, or in low yield of herbage, or in failure to persist over a period of years. Thus winter-killing is a frequent manifestation in continental and Canadian trials, winter-dormancy in New Zealand trials of American and Northern European seeds, while lack of persistency is frequent in foreign seed tested in trials in the United Kingdom and New Zealand.

39. It is also to be borne in mind that the inferiority of imported seed may be due not only to factors of soil and climate but also to the conditions under which the ordinary seed of commerce is grown and harvested. Where production for seed has been established on a commercial scale, and repeated seed crops are taken, there will be a considerable shedding of seed. It will be the earlier and more profusely seed-setting plants that will shed seed most abundantly, and as these are unlikely to be the most leafy and persistent, the result will be to favour the development of a type prolific in seed rather than leaf, which is the exact opposite of the type required for pasture, namely, one that is prolific in leaf rather than seed. Such conditions will have a cumulative effect even on home-grown seed. British commercial rye-grass, for instance, is now, we are told, noticeably inferior to the strain derived from Kentish old pastures.

40. Further, it is to be borne in mind that the inferiority of imported seed shown in these trials is that which is displayed by the ordinary imported seed of commerce. From the account of the nature of species and strains given above, it will be understood that while variability may be expected to follow change of environment, the narrower the range of variation within which a strain is stabilised in its orignal habitat, the greater may be its stability

when the environment is changed. In other words, strains of high local value may, if their range of variation is sufficiently narrow, retain enough of their stability in a new environment as to be preferable to ordinary imported seed. The remaining paragraphs of this section will illustrate both of these factors: the local variability of strains and the limits within which regional strains of high local value may be useful outside the region in which they have evolved.

Variability of Local Strains

41. The " Kentish Old Pasture " strain of English wild white clover is a typical and well-known example of a regional strain, showing strongly marked characteristics which have developed through long-continued response to the influence of environment, but what is equally interesting and important is that the Kentish is only one of several such strains. English wild white clover is now grown, regularly or occasionally, in upwards of twenty counties in England, and is known to comprise a number of local strains, some of which show marked differences in respect of definite agricultural characteristics. For example, it is now considered that the wild white clover grown in Wiltshire is as valuable for some districts as the Kentish has long been proved to be for others. The point to be noted is that in so small a geographical and climatic area as England, the indigenous species of wild white clover should comprise a number of strains of which at least two, one developed in the South East and the other in the South West of the area, show strongly marked but differing characteristics of special value for certain definite conditions of soil and climate.

42. In England the Kentish strain has developed under conditions of moderately high soil fertility, and while competition from taller-growing herbage may be fairly intense during the summer months, the winter period in which the plants are more or less dormant is long. When transferred to New Zealand the strain appears suitable for soils of low fertility, but if sown in areas of high fertility, such as characterise some of the rich dairy lands in that country (areas where the period in which the pastures are completely dormant is very short) it will suffer from the more intense competition in the sward. From the following table, embodying the results of trials conducted at the Research Station at Palmerston North, it will be seen that although the Kentish strain is better than the Dutch and other " commercial " imported whites (which fall off sharply as compared with the more persistent strains) it is not so successful, under New Zealand conditions, as the best among the strains locally evolved.

Productivity of strains of white clover in plots sown at The Research Station, Palmerston North, in November, 1929:

New Zealand White No. 1 = 100 at each date

	Production relative to New Zealand White No. 1 at dates specified		
	4.2.30	10.3.31	29.6.31
N.Z. White No. 1	100	100	100
N.Z. White No. 2	95	74	60
Ordinary N.Z. + trace of N.Z. White Nos. 1 and 2	97	70	42
Ordinary N.Z., free of Nos. 1 and 2	87	35	13
Kentish	68	50	50
N.Z. " Dutch " type	87	14	0.9
Dutch imported	98	7.3	0.6
Ladino imported	100	50	nil

43. These results may be compared with those of trials carried out at Aberystwyth. Here again the local strains of wild white clover, particularly the Kentish, are superior in persistence to any imported strains, including the best New Zealand white, and very much superior to the commercial " Dutch " types, imported mainly from Poland. The New Zealand strain occupies an intermediate position, being less persistent than the Kentish but more persistent than the " Dutch ". However, just as in New Zealand the Kentish strain may have a special sphere of usefulness, so in these Aberystwyth trials the New Zealand strain has given signs of one quality, i.e., abundant yield in the first years, which should make it valuable, under English conditions, for short leys. In spite of their lack of persistence, the " Dutch " whites are, for short leys, frequently preferred to the English indigenous strains, which are less abundant in their first year. The best New Zealand strain, on the other hand, is in comparison with the Kentish relatively robust and big leafed, and gives a good yield even in the first year. We have been informed, on good authority, that there is no white clover of commerce which, under suitable conditions in the United Kingdom (and also in certain parts of Australia), will normally surpass the certified New Zealand strain in the first year of growth.

44. Two other well known regional strains are Montgomery late-flowering red clover and New Zealand Hawkes Bay rye-grass. Montgomery red clover has been tried in New Zealand and has on the whole maintained its general characteristics. From a New Zealand standpoint it is a low-production type, but is less prone to winter dormancy and winter burn than other " late "

types imported from Canada, Russia, Sweden and Germany. It is considered possible that under New Zealand conditions a high-producing type may ultimately become segregated out from the Montgomery strain.

45. On the pastures in the Hawkes Bay district of New Zealand a strain of rye-grass has been evolved which is in very high demand locally. Certified seed of this strain is also finding favour among Australian farmers, who prefer it to uncertified seed in spite of a price premium of 50 per cent. In the United Kingdom the indications are that in leafiness and persistence it is superior to the ordinary British commercial, but inferior to a strain from old pastures in Kent. The supply of this Kentish strain is, however, small, and the local demand for it is increasing.

VI. THE PLANT BREEDER

46. From the examples discussed in the foregoing section it is clear that regional strains, though of great value, have a limited range of usefulness. In their own locality they are greatly superior to ordinary commercial seed, whether imported or locally grown. In a new environment they may, under favourable conditions, retain much of their superiority over other imported seed, but will be inferior to strains of a similar general character which have been locally evolved. Their progress in the new environment depends on the combined operation of three factors : the soil and climate of the new country, the farm management there employed in the fields sown for seed production, and the range of types within which the strain was stabilized in its original home. In this last factor lies an opportunity for man to improve upon nature. The narrower the range of types, the greater the stability of the strain and the wider the limits of its usefulness. By artificial selection and hybridisation, not only may the range of types be narrowed, but their balance adjusted in a desired direction. This is the contribution of the plant breeder.

47. Strain improvement is now being carried out at a number of stations in the Empire. Even in countries where establishment of species is still the major task, plant introduction and strain selection are practised concurrently, and important economic results have already been achieved. In Canada for instance, pedigree strains of alfalfa, timothy, awnless brome grass, white melilot and broad red clover have been developed, though as yet only small quantities of the selected seed have been produced. In New Zealand, in addition to the work on regional strains, a beginning has already been made with plant breeding on lines similar to those adopted at Aberystwyth. In Australia, strains of Wimmera rye-grass and phalaris tuberosa have reached a further

stage. The Wimmera rye-grass is already on the market, and arrangements for the commercial production of the phalaris tuberosa have been made.

48. Australian experience also affords some interesting examples of the useful part played by strain selection in the work of plant establishment. Thus for some time the endeavour to establish subterranean clover on the Adelaide plains was unsuccessful. The type sown was a fine leafy type which had been found suitable enough for the hill districts, but on the plains it failed to persist. Then some seed was obtained from Western Australia of a type which matures four or five weeks earlier than that commonly grown in South Australia. The early type, maturing before the end of the wet period, was able to set abundant seed, and a strain was obtained which will grow in areas with a sixteen inch rainfall, thus rendering the establishment of subterranean clover in the lighter rainfall country a relatively easy task.

49. The early maturing strain, however, produces more stem in proportion to leaf than the late maturing type, but as earliness and leafiness are considered to be inherited characters, there is ground for confidence that the genetical work now in progress will succeed in combining both properties in a single strain.

A similar difficulty in establishing New Zealand Hawkes Bay rye-grass on the Adelaide plains is being met by selection of plants showing survival value. If a few acres on the plains are planted with single plants of Hawkes Bay rye-grass, there may be, under extreme conditions, a mortality of between 40 to 60 per cent., but it is expected that by selection from among the surviving plants a strain will be evolved which will be suitable to the local conditions.

Scope for Bred Strains in the United Kingdom

50. The position in the United Kingdom—where plant breeding is directed not towards the establishment of species but to the improvement of existing strains—may be illustrated from the work carried out at the Welsh Plant Breeding Station at Aberystwyth. In broad outline, the position as revealed by this work may be summarised in the following propositions :—

(1) Practically all the ordinary herbage seeds of commerce represent hay types. Any good regional strain based on a dominantly pasture type of an important species is a first advance on the commercial seed.

(2) Investigation has shown that even the indigenous and regional strains, such as English perennial rye-grass, cocksfoot, wild white clover and Montgomery red clover, or New Zealand (Akaroa) cocksfoot, perennial rye-grass and white clover, though much superior to ordinary commercial seed, are themselves capable of great improvement.

51. As the immediate aim of the herbage plant breeder is to eliminate the less desirable members of any given plant population with which he is confronted, absolute purity in the strict genetic sense is not essential. Plant breeding, even by simple methods of procedure, is inevitably a matter of years, but although the results of advanced genetic work and hybridisation may go beyond those of simple selection, the plant breeders, who are in close touch with the farmers they seek to serve, have recognised that valuable improvement can be effected without waiting a score of years until they have reached an ideal standard of excellence. Results of practical and economic importance are achieved as soon as a strain is produced which, even if not absolutely " pure," varies within a range of types which are themselves both valuable and few.

52. Very briefly, the procedure employed, in its simplest form, is as follows. After the preliminary but very important stage of collecting regional strains, about 500 plants of each strain are planted out and in each case, if the population as a whole is acceptable after examination, and few or no undesirable forms appear, some 200 of the best plants are selected for isolation and breeding in greenhouses. A batch of 500 plants of the resultant generation are similarly planted out, and if they are generally satisfactory and conform to the parent range of types, 200 plants are again selected and isolated for breeding. If the next generation again proves satisfactory, the process of simple selection and breeding is considered complete. Each generation is meanwhile subjected to small-plot trials, and if the second generation satisfies these tests, a plot of about one acre is sown for seed production. The seed of this third generation is then tested in plot trials at a number of centres, after which it is tried out against other strains which have been bred in a similar way, those which show the best promise being accepted for multiplication and release. These competitive trials, in which the strains are tested for persistency in the sward, are continued for at least four years.

It will, of course, be understood that this description is a summary of the simplest form of procedure. Even these simple methods involve a complicated technique in respect of plot lay-out and plot comparison, while in many cases the whole procedure is of a much more elaborate nature.*

Illustrations of Progress Made

53. As illustrating the progress made, we give in the table below the results of several trials with strains of perennial rye-grass, cocksfoot, timothy and meadow foxtail, in which the relative persistency of the strains is tested by the number of tillers per unit of area in small plots grazed by sheep. It is to be understood

* Detailed accounts of technique are given in Bulletins 3, 7, and 11 issued by the Imperial Bureau of Plant Genetics (Herbage Plants), Agricultural Buildings, Aberystwyth, Wales.

that the four groups A, B, C, and D are distinct from one another, and not successive stages of the same trials. These examples are, we have been informed, typical of a mass of data showing the same general trend.

Plot trials illustrating the Comparative Persistency of Commercial and Indigenous Strains as indicated by the number of tillers per unit of area in pure species plots under grazing

	Tillers per 2½ sq. feet	Relative Tiller Growth, with Commercial = 100
(A) At the end of 2nd Harvest Year		
Perennial Rye-Grass		
Station pedigree	1,010	246
English indigenous, from Kentish old pastures	774	188
Ordinary Commercial	411	100
Cocksfoot		
Station pedigree: pasture strain	833	259
" " hay "	560	174
Danish commercial	321	100
(B) At the end of 3rd Harvest Year		
Perennial Rye-Grass		
Station pedigree	888	361
New Zealand: Hawkes Bay	279	113
British Commercial	246	100
New Zealand (South Island)	18	7
(C) At the end of 4th Harvest Year		
Perennial Rye-Grass		
Station pedigree	865	288
Commercial	300	100
Cocksfoot		
Station pedigree	845	515
Commercial	164	100
(D) At the end of 5th Harvest Year		
Cocksfoot		
Station pedigree	699	421
New Zealand	257	155
Commercial	166	100
Timothy		
Station pedigree	245	350
Commercial	70	100
Meadow Foxtail		
Station pedigree	900	570
Commercial	158	100

54. With all due allowance for the inadequacy of a numerical statement (and the figures do not necessarily exaggerate a superiority which has to be seen in the field to be fully appreciated) there can be no doubt that these are very striking results. They illustrate once more the superiority of regional strains, both imported and indigenous, over the ordinary seed of commerce, and they show that the plant breeder's strains may be superior even to the indigenous regional strains, but what at once arrests attention is the disparity between the two extremes—i.e., the breeder's strains at one end of the scale, and at the other end the ordinary commercial seed which, it is to be remembered, is still the principal source of supply for the farmer.

55. The quality under test in these trials was persistency. Earlier in our report (paragraph 10) we referred to the importance of the palatability of the herbage as one of the factors affecting the interrelation between the herbage problem, in the narrower sense, and the problem of management. Palatability varies between species and species, and between strain and strain, and is also affected by position (e.g., wet or dry patches), season, and intensity of grazing. Indigenous or breeders' leafy strains may be more succulent than the more stemmy commercial strains, but on the other hand the commercial strains of some species may be more palatable, in the first period of their relatively more rapid growth, than the slower-growing leafy strains, though these leafy strains will retain their attraction when the commercial strains have become unpalatable owing to cessation of growth or other causes.

56. The problem is complex, and systematic investigation of it has hitherto been confined to small-scale trials with sheep. The whole problem, however, can be regarded in two ways. The object may be to establish a scale of palatability, or consideration may be given to the effect of palatability on the maintenance of the sward. The more palatable the species, the more heavily it will be " punished " by the grazing animal. The most striking example is that of timothy. It has been observed in palatability trials that frequently the sheep will almost completely defoliate the timothy plots before turning to other species. The practical bearing of these preferences upon the herbage problem is that the more palatable the species the more important it is for the farmer to use high-quality strains (whether produced by the plant breeder or regionally evolved) which, on account of their greater persistency, are better able to withstand hard grazing.

57. A number of strains bred at Aberystwyth have now reached or are approaching the release stage. The species involved include Italian rye-grass, perennial rye-grass, timothy, cocksfoot, meadow fescue, tall fescue, red fescue, sheep's fescue, meadow foxtail, smooth-stalked meadow grass, sweet vernal grass, Yorkshire fog, broad red clover, late-flowering red clover and wild white clover.

In some cases, notably perennial rye-grass, timothy, cocksfoot, smooth-stalked meadow grass and the clovers, several distinct strains have been bred, each specially adapted for one of the several purposes for which the species may be used.

The strains already released to the trade include a pasture strain of perennial rye-grass, an intermediate or pasture-hay strain of cocksfoot, a pasture-hay strain of meadow fescue, and four distinct strains of timothy, ranging from the hay type to the extreme pasture type.

58. The economic effect of the plant breeder's productions in other fields—such as Marquis Wheat, which added 100,000,000 acres to the Canadian Wheat belt, or Farrer's Federation Wheat, which doubled the potential wheat-growing area of Australia—is now a commonplace. Relative to the work on cereals, plant breeding with herbage plants is still in its infancy, but the work is now widespread and likely to increase in intensity. The continued improvement in the various herbage species which constitute the sward and form the raw material of grassland farming is bound to have a cumulative effect, and the results already achieved suggest that the contribution of the plant breeder to the improvement of grasslands may eventually be comparable with the assistance given towards the improvement of cereal crops. How long the time-lag between experimental and general results may prove to be, it is impossible to say, but it cannot, we fear, be shortened unless administrators, traders and farmers watch carefully the progress of experiment, and are prepared to adjust trading conditions to the particular requirements of the problem.

VII. THE CONDITIONS OF A WIDER USE OF PEDIGREE SEED

(A) The Maintenance and Guarantee of Strain Purity

59. Quite apart from questions connected with grassland management, the problems of maintaining the purity of herbage seed and of securing its widespread use are from the nature of the case more complicated than those usually occurring with cereals. A new strain of wheat suited to a tract where wheat could not hitherto be grown with profit, will be taken up more rapidly and its multiplication and supply much more easily organised than can be expected in the case of herbage seed. Pastures are frequently grown for a number of years, and large compact areas do not fall to be sown annually. Results, though real, are often not immediately apparent. The precautions required to ensure steady supply of seed true to type are greater. The benefits obtainable from the use of superior strains are more easily obscured by differences in management, for a farmer may manage poor herbage well or good herbage badly. Again, as pastures are usually sown

with mixtures and not with a single herbage species, the general improvement resulting from the inclusion of one improved component in a mixture is not so obvious to the view as it is when the whole field has been sown entirely with the improved component. It is admittedly the aim of the herbage plant investigator to improve the seed of every component in a mixture, but though that aim may be achieved, it is impossible to ensure either that improved strains of all species will become available at the same moment of time, or that when available, they will be the sole constituents in the mixtures used in the field.

60. The step from research to practice is thus likely to be difficult. To enable it to be taken it has been found desirable in many countries to supplement the effort of the research worker and the far-sighted trader and farmer by administrative action, adjusted in each case to local conditions. The achievements of science in other branches of agriculture have rendered both the farmer and the trader more alert than formerly to watch the results of research and to profit by them, and in most Empire countries the agencies for bringing such results to their notice have been improved and strengthened in recent years. This awakening of interest should make it easier in the future to introduce such further measures, as may from time to time be found necessary and practicable, to ensure the supply of improved seeds.

Inadequacy of Regulations Based on Germination Capacity

61. It is somewhat of a paradox that the ordinary farmer, who is careful enough in the purchase of other commodities which form the stock and raw material of his business, has in the past been less anxious, and also less able, to discriminate in the purchase of herbage seed. For many years the traditional practice was to purchase on appearance, which in the case of herbage seeds is an altogether inadequate criterion. Apart from the almost microscopic size of the seed, the danger of judging from appearance, as distinct from origin and variety, may be illustrated by two examples which have been brought to our notice.

(*a*) A parcel of foreign red clover, which consisted of perfect-looking seed, plump, clean, and good in colour, proved after sowing to be practically worthless for the particular district in the United Kingdom for which it was supplied.

(*b*) A parcel of commercial rye-grass seed from an Empire country, which on appearance was perfect seed, and which was very cheap in price, proved on sowing to be quite useless, and all the money and time involved in the purchase and use of it was wasted.

62. Partial remedies have been sought by regulations in some cases providing that imported seeds shall be stained so as to be readily distinguishable by the purchaser (see Appendix C) and in

others providing that all herbage seed must be tested for such specific qualities as germinating capacity and freedom from other seeds, and a declaration of the test made on sale. As an example of this kind of control we have given in Appendix A an account of the regulations in force in the United Kingdom. Without in any way detracting from the value of such regulations (and in the United Kingdom regulations that which provides for a declaration of the *country* of origin has been mentioned to us as particularly valuable) their limitations must also be recognised. It is felt that while giving the purchaser a much needed guide and guarantee in respect of certain qualities, they may tend to place too much emphasis on standards of purity and germination. The percentage of germination, important as it is, is of value chiefly in comparing like with like : e.g. two parcels of the same variety of seed having a common climatic origin and destined for a common climatic area. It is more useful, that is, in comparing two parcels of Essex broad red clover than in comparing Essex broad red with Italian red clover, or in comparing Essex broad red with broad red grown in other parts of England. In short, seed testing as such does not emphasize the significance of strain and *local* suitability, which, as we have seen, is of primary importance.

Certification

63. It has indeed become evident, as a result of practical experience in several countries, that the growing recognition of the importance of strain in herbage seed involves a further degree of control, designed to ensure that at the producer's end the stock shall be maintained true to type, and that at the consumer's end the farmer shall have greater certainty that the seed he buys is of the character and strain best suited for his local requirements. The methods adopted to achieve this object usually include inspection and registration of the seed-producing fields on an historical basis, registration of growers, and inspection and certification of the seed crop. In Appendix B of our Report we have given a detailed account of the certification schemes at present in operation in the United Kingdom, Canada and New Zealand, and also of the Swedish organisation which several witnesses in our enquiry have singled out from among foreign systems as being worthy of special attention, particularly with reference to the distribution of breeders' strains.

64. The early stages in the establishment of any scheme of certification are necessarily slow. In the case of regional strains (which are the result of the influence of environment over a number of years) the first step is an enquiry into the history of the field and an inspection of the crop. Experience has shown that it is usually necessary to follow this with a growing-on test of samples taken from the field, since age alone has been found an inadequate

criterion. At least one year is therefore required for the process of registering the grower and the field. Some schemes, as for instance that for wild white clover in the United Kingdom, at present stop at this stage. The more developed schemes include regulations for the inspection, sealing and certification *in situ* of the crops subsequently harvested from the registered fields. Although this provision for the sealing of bags involves further organisation and some expense, it is of real advantage to growers, traders, and consumers, as an aid in establishing confidence and promoting the free movement of the produce, particularly where any appreciable proportion of the seed is grown for export.

Significance of the Success of Certification in New Zealand

65. The practical value of registration and certification is illustrated by recent experience in New Zealand. In the South Island, where perennial rye-grass is often sown in the autumn and harvested in the following year, the effect of short-rotation conditions has been to intensify the defects of the commercial type. In other parts of the country, e.g., in the North Island generally and notably in the Hawkes Bay district, permanent-pasture conditions have favoured the more leafy and persistent members of an originally very mixed population. In these districts there has thus evolved a definite strain which, in New Zealand at any rate, is altogether superior to the ordinary commercial seed. As in the case of white clover, steps have been taken to locate the areas in which the high quality strain is found, and to develop and safeguard supply by means of registration of the fields and certification of the seed. The results have been very encouraging. The acreage producing the desired strain has increased from about 2,000 acres in the season 1927-28 to over 20,000 acres in the season 1932-33, and it is expected that within a few years the only perennial rye-grass seed harvested in the country will be this certified New Zealand strain.

66. The successful development of Hawkes Bay rye-grass under the certification scheme is of interest to other centres of large-scale seed production in the Empire. One in particular has been suggested to us as being especially favourable ground for some similar scheme. In Northern Ireland, which is the most important single producer of perennial and Italian rye-grass seed in the world (the annual output being about 25,000 tons), the Ministry has under consideration an experiment in growing-on pedigree strains of rye-grass from seed to be supplied from the Welsh Plant Breeding Station at Aberystwyth. Numerous trials are in progress which are designed to give the local interests concerned an opportunity of seeing demonstrated on a considerable scale the qualities of these improved strains as sward-formers and seed-producers. Should the experiment further serve as a starting point for the

establishment of a certification scheme, under conditions guaranteeing a regular renewal of the parent stock seed, the experience of New Zealand suggests that the whole of this highly important seed-producing area should ultimately derive practical benefit from the scheme.

Three important Features in developed Certification Schemes

67. In the course of our enquiry, witnesses have emphasized certain particulars which in their opinion are of special importance in a developed scheme of certification. All such schemes must in practice be to a great extent determined by local conditions, but the points to which witnesses have drawn our attention are, in fact, for the most part covered in the Canadian regulations given in Appendix B.

(i) Isolation

68. The first is the problem of isolation. Grasses and clovers are cross-fertile, and if seed crops of selected strains are to be kept true to type, stringent precautions are necessary to prevent contamination by pollen borne from neighbouring strains either by the wind in the case of the grasses or by bees in the case of the clovers. The smaller the area the greater is the risk. Preliminary results from experiments in the technique of isolation indicate the need not only to ensure that isolation areas should be as large as possible (it is not desirable that any one grower should grow more than one strain of the same species unless the fields in question are isolated by a wide margin of safety) but also to ensure that all the plants within the isolation area should as far as possible come into maximum flower together. It is to some extent an advantage that the pedigree, or breeders' " pasture," strains of most grasses flower later than the ordinary commercial types, and it is considered that precautions based on a knowledge of these physiological factors may prove as useful as those based on spatial isolation.

(ii) Frequent recourse to parent stock seed

69. Another problem is that of ensuring a sufficiently frequent recourse to " foundation stock " or " mother seed." Here a difference is to be noted between regional and breeders' strains. In the case of regional strains, so long as the registered fields are not harvested for seed at too frequent intervals, seed crops may be taken repeatedly. It is, however, generally agreed that regional strains cannot with any safety be grown-on more than once (and even so, only in very carefully selected areas), a precaution which limits multiplication of such strains for seed production purposes, in any new area, to one crop. In the case of breeders' strains on the other hand, while it is considered undesirable to take more than two seed crops from any one stand, there is this important advantage, that if the strain is sufficiently " pure " and the

growing-on areas well cleaned and isolated, it is considered safe to grow-on twice. By twice growing, under skilled supervision, the quantity obtainable would be, we are told, in the case of the clovers about 30 times, and in the case of some grasses about 80 times the quantity of the once-grown seed. Thus if the area under the original seed be adjusted to the demand and to the species concerned, the possibility of multiplication is much greater than is practicable with once-grown regional strains.

70. It must, however, be recognised that in spite of cleaning of the soil and isolation, there is always a risk, in the early stages of establishing a new strain in any area, of contamination from seed already present in the ground sown with the new strain, and consequently growing up " spontaneously " with it. The degree of safety, therefore, with which a twice-grown crop, or a second crop from a once-grown stand, can be taken, must depend on the degree in which the area concerned has been gradually " impregnated " with the new strain. " Impregnation " is attained by a succession of single crops each taken from fresh sowings with mother seed of the required strain.

(iii) PERIODIC RE-EXAMINATION OF CERTIFIED FIELDS

71. Earlier in our Report (paragraph 39) we drew attention to the deterioration of strain consequent upon too frequent cropping. Although the extent of such deterioration would be reduced in proportion as the range of variability is narrowed, the risk remains even with bred strains, which, although more homegenous than either ordinary or regional strains, are nevertheless themselves not absolutely pure in the genetic sense. For this reason, if for no other, it is desirable that any scheme of certification should provide for the periodic re-examination of fields which have been registered for the seed production of any particular strains, as well as for a differentiation in the certificate for breeders' strains between the first and subsequent crops from any one stand. In the opinion of some authorities, the second crop from a stand of once-grown seed should be designated " twice grown," even though no re-seeding has been involved.

(B) LOCAL SUPPLY

72. The supply of improved strains of seed—whether regional or breeders' strains—presents practical difficulties. In the case of regional strains, though the quantity of mother seed available is larger than that of breeders' strains, it is inadvisable that regional strains should, for seed purposes, be grown-on more than once, even in the country of origin. It has been suggested that the total supply might be increased if the once-growing of such seed could be made a regular link in the chain of supply. Farmers, however, whose interest in these regional strains has been aroused, naturally seek the original mother seed, and are prepared to pay for it. It is difficult to see how that desire can be prevented without measures

of control difficult both to justify and to administer; but even if once-growing of the bulk of the mother seed available became the accepted rule, the supply of many, and indeed of most, of these regional strains must always remain limited.

NEED FOR SEED FARMS ATTACHED TO, OR UNDER SUPERVISION OF, RESEARCH STATIONS

73. While the multiplication of the seed of regional strains is thus restricted, the reservoir of mother seed, small as it is in comparison with the supplies of ordinary commercial seed, is considerable. In the case of breeders' strains, on the other hand, the supply of mother seed is in the nature of things very small at the outset, but the possibilities of multiplication, though still limited, it is true, are nevertheless, as we have pointed out in paragraph 69 above, greater than they are with regional strains. We have indicated in sections V and VI of our Report the grounds for our belief that it is on the development and distribution of breeders' strains, such as those produced at Aberystwyth and similar stations elsewhere in the Empire, that the greatest measure of improvement in the seed available for Empire grasslands will ultimately depend. If this belief is justified, it follows that in the near future the problem of organising an increased supply of breeders' strains up to the point where they are released to the trade for sale to farmers will be one which will call for the united attention of breeders, seedsmen, farmers, and agricultural departments.

74. The problem is masked for the moment by the fact that the official plant breeding stations are for the most part only just reaching the productive stage. The strains selected for release are still few in number, and although much superior to commercial strains, are nevertheless not regarded by the plant breeder as his last word on the species concerned. In his eyes they are still experimental and preliminary to further achievement. Part of the experiment is their multiplication on a large scale under varied conditions. Hence the Aberystwyth station, in considering the terms upon which the selected strains should be disposed of to the trade in the seasons 1931-32 and 1932-33, took the view that the immediate object, both for the station and the trade, was to enable these strains to be grown-on and tried out under the most varied conditions, even at the sacrifice, on the part of the station, of measures of precaution and control. At this stage it was for instance considered unnecessary to stipulate how soon recourse should be made to mother seed, since before any appreciable damage could result from too frequent growing-on, the strains in question would, it was expected, be superseded by later and improved productions of the station.

75. The situation, however, will be very different when the herbage seed products of the plant breeding stations become more stabilised, and when the object to be attained in organising the

multiplication of the seed is not, as at present, partly experimental (as a large-scale test of the strains) and partly educational (as a large-scale demonstration to stimulate the interest of farmers), but the wider economic object of providing a supply of true-bred seed of the best strains in quantities sufficiently large to have an appreciable effect on the pastures of any particular country as a whole. In the United Kingdom, for example, the leading seedsmen are careful in selecting the farmers who grow-on by contract, and in inspecting the crops during the vegetative period and before purchase, but to ensure a general and uniform supervision of the product of the plant breeding stations during the growing-on period, something more is required than dependence on particular firms, who in any case account for only a part, albeit a considerable part, of the trade. In the first place the acreage under the direct control of the plant breeding stations, both in their immediate neighbourhood and in selected localities elsewhere, needs to be very much increased, so that the quantity of station-grown stock seed can be raised to an amount adequate for the requirements of agriculture in the country concerned. In the second place, it is desirable that means should be devised between the plant breeding stations and the trade, with the possible assistance of agricultural departments, to enable the plant breeding stations to exercise a more effective control over the growing-on of station-produced strains, by and for the trade, for seed production purposes.

76. In the case of the Aberystwyth strains, both supply and demand are still a matter of small quantities, but it is significant that in the season of 1933 the demand for the station's strains of timothy was ten times, and the demand for the station's strains of cocksfoot and rye-grass was fifty times, greater than the available supply. For a few seasons it will probably be no very difficult task to remedy this disproportion, which is, after all, incidental to the early stages in public recognition of a new product, but when that recognition brings with it a more general demand, the problem will be less simple. Ultimately, unless the amount of station-grown stock seed can be gradually increased to a quantity sufficient, after being once-grown or, at the most, twice-grown elsewhere, to meet the annual needs of farmers, one of two results follows. Either the amount of pedigree seed available for local consumption will not suffice to have any appreciable effect on the pastures as a whole, or, if supply is increased by growing-on from stock seed more than twice, the increase in quantity will be obtained at the expense of strain purity. In either case, much of the time, money and effort expended in producing the strains will have been wasted.

The Swedish Example

77. A comparison of the schemes described in Appendix B of our Report will show that provision for the needs and difficulties discussed in paragraphs 75-76 above is a distinctive feature of the Swedish organisation. Not only does the area under the direct control of the plant breeding institute in the neighbourhood of the central station at Svalöf exceed 2,500 acres, but the bulk propagation of the selected strains (which is carried out as a monopoly by the General Swedish Seed Company over a total acreage of some 30,000 acres in various parts of the country) is conducted throughout under the supervision and control of the institute. This close collaboration between research worker and trader is, in respect of the detail (and particularly of the trading monopoly), a result of local conditions which may not be practicable in Empire countries, but in respect of the end pursued and attained, the Swedish system affords an instructive illustration of what is already being done to deal with the breeding, maintenance, propagation and distribution of pedigree seed as a single problem.

(C) Price

78. Reference to the price catalogues of leading retailers in the United Kingdom shows that in the 1934 season, superior leafy strains were listed at prices between three or four times higher than those of the ordinary commercial seed. In the case of perennial rye-grass, the indigenous seed saved from Kentish old pastures was listed at 1s. 4d. to 1s. 6d., and certified New Zealand Hawkes Bay at 1s. compared with 5½d. a pound for the ordinary commercial seed. Similarly, New Zealand certified Akaroa Cocksfoot at 1s. 6d. compares with 9d. for ordinary Danish commercial. In the case of white clover, the price for wild white from Kentish old pastures was 6s. to 6s. 6d., or if " once grown ", 4s. 6d. to 5s., compared with 1s. 8d. to 2s. for imported commercial white, while the New Zealand certified strain was listed at 4s. and English wild white saved from counties other than Kent at 4s. 6d. to 5s.

79. Part of the disparity is accounted for by the low level of wholesale prices ruling in recent years. In 1933, for example, Danish Cocksfoot at 20s. a cwt. stood at a level which, we were informed, was below the cost of production, and although in 1934 it has recovered to 40s., this is to be compared with what the trade would regard as an average or " normal " figure of 56s. Nevertheless, while recent prices for the commercial seed have been abnormally low, owing to the world depression, and are already showing signs of recovery, the disparity is partly due to relatively short supply and high cost of production of the superior strains.

Improvement in the Seed Yield of Superior Strains

80. The high cost of production is attributed to the fact that by their nature the leafy strains are " shy seeders ", and the grower gets a smaller seed crop per acre than he would with the commercial types. While there is no doubt either of the principle

or the fact, there does seem to be ground for believing that the degree of difference in seed yield need not be so great as is sometimes taken for granted. In the experience of some growers the seed yield from leafy strains is rarely more than two or three-fifths of the yield one would expect from " commercial " seed of the same species. That this need not necessarily be so, can be seen from the following table, in which the range of seed yields recorded in three foreign countries is given side by side with the records of seed crops from pedigree seed produced at the Welsh Plant Breeding Station, Aberystwyth, and grown-on under supervision, by farmers in Montgomeryshire, Shropshire and Herefordshire in the seasons of 1931 and 1932. The wide range noticeable in the Continental figures itself indicates the difficulty of establishing an exact comparison, but it may be said that the yield from the Aberystwyth strains compares not unfavourably with those obtained in foreign countries, where growers are specialists in seed production, and the types grown are hay-types, and, as such, likely to be more prolific in seed than the pedigree strains.

Seed Yields in lbs. of Cleaned Seed per Acre

—	Aberystwyth strains	Range of Average Yields in 3 Foreign Countries					
		Germany		Czecho-Slovakia		Hungary	
		High	Low	High	Low	High	Low
Perennial Rye-Grass	453 (*a*)	960	400	1,056	435	600	300
" "	795 (*b*)						
Cocksfoot	640 (*c*)	640	240	435	176	450	225
"	422 (*a*)						
Timothy	501 (*b*)	800	240	—	—	450	225
"	460 (*a*)						
"	464 (*d*)						
Meadow Fescue	432 (*c*)	800	240	704	352	600	375
Red Fescue	487	480	160	498	249	—	—
Sheep's Fescue	469	—	—	—	—	525	300
Smooth Stalked Meadow Grass	221	660	120	—	—	225	120

NOTE (1) For the Aberystwyth strains, (*a*) = pasture type, (*b*) = hay type, (*c*) = hay-pasture type, and (*d*) = extreme pasture type (see Table 19 in Appendix D).

(2) The figures for the foreign countries are taken from a Report of Mr. Gwilym Evans, B.Sc., Seed Production Officer, Aberystwyth, on a Tour through those countries undertaken in June-July, 1933.

NEED FOR IMPROVED TECHNIQUE AMONG SEED GROWERS

81. Until recently the technique of seed production had not been made the subject of detailed research in the United Kingdom, but the figures we have quoted not only justify the attention

paid to it at Aberystwyth but indicate that it is a factor of primary importance in the whole problem of grassland seeds, especially if an attempt is to be made to organise local supplies of superior strains. There is no stage in the process of raising the seed crop that does not call for systematic study on the part of the scientist and close attention on the part of the farmer. With leafy strains, even more than with ordinary commercial types, success will depend on the knowledge and use of the right time and method in sowing the seed, and on the right choice and use of manures, in relation to species, strain, and environment. No less important, and indeed decisive in its influence on yield, is the management of the field after the plants are established. This involves a number of problems of which perhaps those connected with grazing are the chief as they are the most complex, for the treatment will vary as between one grass and another, and in general as between the grasses and the clovers. In the case of the clovers, the question of grazing is particularly important in those parts of of the United Kingdom where the time of maximum flowering does not coincide with that of the maximum activity of the bees, for spring grazing may to some extent control the time at which the clover will come into flower.

82. One condition of advance in the organization of local supplies of superior strains will therefore be a more general recognition on the part of seed growers, both in the United Kingdom and in those Empire countries which aim at exporting to the United Kingdom herbage seed market, that seed growing, even if not a matter for specialists, is a business which requires systematic attention to the technical and business details. Part of the success of continental farmers is, indeed, attributed to the study which they have devoted to these factors, as well as their longer experience in organising their activities. Similarly, in some parts of the Empire which are otherwise well suited for herbage seed production, there is need for the organisation of seed harvesting and seed cleaning machinery, upon the provision of which future development must depend.

83. Nevertheless, even under the best conditions, it is in the nature of the case that the superior strains, being bred with a view to leafiness and feed value, are unlikely to be so prolific in seed as the commercial strains in which leafiness is sacrificed to seed production. In consequence, the superior strains will be more expensive to produce and their general adoption in the field will depend on the degree in which farmers realise that such strains are ultimately more economical in spite of their higher prime cost. It is in some ways unfortunate that these strains will be coming to market at a time when the effects of agricultural depression tempt the average farmer to buy the cheapest available seed material even against his ultimate interest. At such a time

he is less likely to calculate the economic value of his seed as being the raw material for the total product of his pastures over a series of years, and much more likely to consider the immediate contrast in prime cost between the cheapest and the best.

VIII. THE TRADE IN HERBAGE SEED BETWEEN EMPIRE COUNTRIES

84. The trade in herbage seed is at present mainly a matter of temperate climates, and a wide movement in the commodity is, at any rate under present conditions, a necessity, for two reasons. In the first place scarcely any country is yet organised to produce in sufficient quantity all the seed required, and in the second place, seasonal failures in local seed crops might have very serious consequences if alternative sources of supply were not available. Nevertheless, certain countries have come to predominate (in some cases almost to the extent of a monopoly) in respect of particular species. Thus Canada produces most of the alsike, Northern Ireland most of the perennial rye-grass, Denmark most of the meadow fescue, cocksfoot and rough-stalked meadow grass, and the United States of America most of the timothy to meet the demand of importing countries.

85. The discussion on strain in sections V and VI of our Report will have made it clear that from the point of view of improving the grasslands of the Empire the provision, maintenance and distribution of pedigree strains locally produced and, as such, more suitable in their own areas than imported seed, is an object more vital for Empire countries than the development of inter-Imperial trade in herbage seeds. While, however, endeavours are being made in many countries to foster the production of locally grown seed, complete self-sufficiency, even if desirable, is not likely to be attained. Some movement in herbage seed will always be taking place, and as more and more attention is given in the Empire to the herbage seed problem, the question arises whether, with due regard to the paramount importance of the factors of strain, climate, and local suitability, the strains now being developed in some Empire countries may not prove a more satisfactory source of supply for the pastures of other Empire countries, having similar climatic conditions, than the supplies at present imported from foreign countries. As an aid in developing the trade in such seeds, one requisite is a knowledge of the varieties and quantities of seed required in different Empire countries. Unfortunately present trade statistics do not, except in a few countries, suffice to give more than a general idea.

Lack of detailed Classification in Empire Trade Returns

86. From the figures given in a series of tables in Appendix D, it will be seen that the degree of detail with which herbage seeds are classified in the trade returns varies considerably between

one Empire country and another. In the case of Australia and South Africa, lucerne is the only species separately classified, and even in the total figures, grasses and clovers are not fully differentiated from other agricultural seeds. In the United Kingdom returns, the figures are grouped under the two headings of grass seed and clover seed, and give no idea of the proportion which particular species, such as red or white clover, lucerne, cocksfoot, or perennial rye-grass bear to the total. In the Canadian returns, the principal species involved are distinguished, but while the quantities imported are stated in pounds, those exported are stated in bushels.

87. We are aware that for administrative and other reasons elaborate classification should be approached with caution, but the importance of a raw material may be greater than is indicated by its market price, and the importance of herbage seed lies not in the magnitude of the trade carried on but in the part played by the commodity in the improvement of pastures. It should not be difficult to revise the classifications in those cases where it appears desirable, so as to distinguish the principal species of grass and clover seeds entering or leaving the countries concerned. As an illustration, we give side by side two lists of headings which competent authorities in Australia and the United Kingdom have suggested to us as affording a useful classification for their respective countries.

Suggested Classification of Herbage Seed for the Trade Returns of the United Kingdom and Australia

UNITED KINGDOM	AUSTRALIA
Legumes	*Legumes*
Lucerne	Lucerne
Alsike	Alsike
Red Clover	Red Clover
White Clover	White Clover
	Subterranean Clover
Other Legumes	Other Legumes
Grasses	*Grasses*
Perennial Rye-grass	Perennial Rye-grass
Italian Rye-grass	Italian Rye-grass
	Other Rye-grasses : e.g. Wimmera and Western Wolths
Cocksfoot	Cocksfoot
Timothy	Timothy
Meadow Fescue	Paspalum
Rough-stalked Meadow Grass	Danthonia
Other Grasses	Other Grasses

Review of the Position in the Principal Empire Countries Concerned

88. Australia exports subterranean clover, Wimmera rye-grass and paspalum, and imports Hawkes Bay rye-grass, Chewings fescue, red clover (and, in small quantities, other species) from New Zealand, and lucerne from South Africa. Apart from lucerne, to which we refer again in paragraph 96 below, South Africa has practically no external trade in herbage seed. The figures for the United Kingdom, Canada and New Zealand are summarized in the following table.

	Quantities in Tons (Average of 1928–32)				Values in £000 (Average of 1928–32)			
	Imports		Exports		Imports		Exports	
	Grass Seeds	Clover Seeds	Grass Seeds	Clover Seeds	Grass Seeds	Clover Seeds	Grass Seeds	Clover Seeds
United Kingdom	9,863	3,381	13,229	1,941	386	249	338	105
Canada (*a*)	4,164	715	184	3,380	141	53	298	34
New Zealand	497	213	1,993	221	35	22	130	26

(*a*) The Canadian figures are for fiscal years ending March 31st, the export figures, based on a memorandum specially supplied, being for the year 1931–32 only. Owing to a change in classification, the average for Canadian *imports* is here based on the years 1929–32. The Clover figures include alfalfa (lucerne).

CANADA

89. From the detailed figures given in Appendix D, it will be seen that the Canadian trade in grass seed is almost entirely with the United States of America, which accounts for 93 per cent. of the imports and 84 per cent. of the exports. Timothy is the principal species imported, practically the whole import coming from the United States, except for a small quantity from the United Kingdom and New Zealand. In the case of the clovers, the United States again accounts for over 63 per cent. of the exports and 44 per cent. of the imports. In the case of red clover, however, a considerable share of both imports and exports has been taken by Empire countries, and, mainly owing to an unusually large supply taken by the United Kingdom in 1932, the Empire share of the exports of red clover for the quinquennium 1928-32 is over 96 per cent. (See Appendix D, Tables 11, 12 and 13.)

NEW ZEALAND

90. New Zealand, with a herbage seed crop of 6,500 tons, more than half of which is rye-grass, is on balance a net exporter of 1,500 tons of herbage seed (Table 14) of which 65 per cent. is taken by Australia, the United Kingdam and Canada (Table 15).* Nearly one-third of the export is made up of rye-grass (going mainly to Australia) and a little over one-third is made up of Chewing's fescue (a variety much used for golf courses) which goes mainly to the United Kingdom, Canada and the United States of America. Of the other grasses, the United Kingdom takes most of the cocksfoot and crested dogstail, and the United States most of the Brown Top (Table 17). Nearly all of the clover goes to the United Kingdom and Australia (Table 17). Of the imports, two-thirds of the clover seed come from the United Kingdom, Canada and Australia, while the grass seed imports are made up of rye-grass from the United Kingdom, paspalum from Australia, timothy from the United States and cocksfoot from Denmark (Table 16).

In the total, Empire countries account for about two-fifths of the imports and about two-thirds of the exports (Tables 15, 16 and 17). Australia alone takes 39 per cent. and the United Kingdom 21 per cent. of the exports, while among foreign countries the United States, with 29 per cent., is very much the largest importer.

UNITED KINGDOM

91. In the United Kingdom, which is the largest market of the three countries under review, not only are the trade returns lacking in the detail necessary for a picture of the herbage seed position, but no exact figures of production are yet available. In the account which follows the detail is filled in from information which, though not statistically exact, is sufficiently reliable to afford a general idea of the situation.

92. Nearly all the wild white clover, and on an average about two-thirds of the red clover supplies, are locally produced. Imports of red clover come from a number of countries, e.g. Canada, Chile, Czechoslovakia, France, Germany and the United States of America. The local production of ordinary white (or "Dutch") clover varies from a third to a half of the supply, the remainder being imported, chiefly from Poland, with smaller quantities from New Zealand.

93. The seasonal variations in red clover supplies are wide, and the quantity imported ranges from 2,000 tons, in a year when the

* In the season 1932/33, the seed crop exceeded 19,600 tons.

local crop is exceptionally short, to 100 tons when home supplies are ample, while in some years exports may exceed imports.

94. The case of the grasses is different. In respect of rye-grass, and particularly of perennial rye-grass, the output of Northern Ireland, with some adjacent areas in the Irish Free State and also some other areas in Ayrshire in Scotland, makes the United Kingdom not only a large producer, but also one of the largest exporters of these seeds. In respect of most other grass seeds, however, with the exception of dogstail and small quantities of cocksfoot and timothy, the United Kingdom is dependent mainly (and in some cases entirely) on imported seed. More than four-fifths of the timothy comes from the United States and a similar proportion of the cocksfoot comes from Denmark. Sweet vernal grass comes mainly from Holland and Germany, smooth-stalked meadow grass entirely from the United States of America, rough-stalked meadow grass mainly from Denmark, meadow fescue from Denmark, United States of America and Canada, and Chewing's fescue from New Zealand.

95. It follows that the United Kingdom export of grass seed is practically confined to rye-grass. A word of explanation is, however, needed concerning the figures for United Kingdom imports and exports of grass seed shown in Tables 8 to 10 of Appendix D. On those figures, the imports of grass seed from the Irish Free State average 3,550 tons and exports to the Free State from the United Kingdom average 3,600 tons;* but seed production in Ireland is much older than the present political boundaries, and it appears from information supplied to us in our enquiry that the bulk of the quantities just mentioned really represents imports of uncleaned seed into Northern Ireland from adjacent areas in the Irish Free State, and imports of the same quantity into the Free State after " cleaning " in Northern Ireland. Some 3,000 tons must, therefore, be regarded as being duplicated in the United Kingdom returns, and the proportion of Empire grown seed in the total would be somewhat less than the figures in the tables imply.

96. In respect of one seed crop—lucerne—the United Kingdom is likely to remain dependent on imported seed, since it is only in an unusually warm and dry season that it is practicable to grow lucerne for seed in that country. The local market demand is chiefly for French seed grown in Provence, and known as Provence Lucerne, but attention is now being given to seed from South Africa, where lucerne is an important fodder crop—some 200,000 acres being under cultivation for seed in the census year 1929-30.

* For the same period, the Statistical Department of the Irish Free State gives the average annual imports into the Irish Free State from the United Kingdom as 4,500 tons and the average annual exports from the United Kingdom as 3,200 tons.

The principal varieties grown in the Union are Hunter River and Tamworth (Australian varieties evolved from a Provence original) and the Provence variety raised from seed derived direct from Provence and known as South African Provence Lucerne.

97. From Table 18 in Appendix D, it will be seen that the exports of lucerne seed from South Africa are irregular, but in 1931 and again in 1932 the quantity exported to the United Kingdom exceeded 40 tons. South African Provence Lucerne is already competitive in price. It is therefore more than ever important that as progress is made in the United Kingdom market, the utmost care should be taken to maintain quality; and it is all the more satisfactory that in South Africa steps have already been taken to that end. The import of lucerne seed into South Africa is prohibited except under licence, and a number of regulations are in force, designed to maintain a standard of quality in the seed exported. Every bag (which itself must be of a prescribed quality and contain a prescribed net weight of seed) is officially inspected. The seed is tested, and a certificate of inspection is issued. No consignment may be exported unless it is sound, and attains a germination capacity of at least 92 per cent. with not more than 2 per cent. of impurities.

Conclusion

98. The foregoing account shows, as might have been expected, that the existing trade in herbage seed is largely a trade between neighbouring countries: New Zealand with Australia; Canada with the United States; the United Kingdom with the Continent of Europe. At the same time it also shows that in the case of particular varieties these confines may be broken, as for instance by white clover from New Zealand, red clover from Canada, or lucerne from South Africa. Similarity of climate, and with it the foundations of an interchange of suitable seed are not necessarily dependent on geographical proximity, and almost every kind of climate is to be found within the British Empire. To areas such as New Zealand, Northern Ireland, and many parts of Canada, which are already established as centres of seed production, there may be added in the near future others, such as Tasmania and parts of British Columbia where the climate is considered so favourable that the possibilities of seed production may one day be great.

99. It must however be remembered that, having regard to the general superiority of the locally grown seed for the pastures of any particular locality, the main supply of any Empire country should be this locally grown seed, and the opportunities of other Empire-grown seed in a given Empire market will lie principally in replacing seed at present imported from foreign countries. In every case it will depend on the climatic suitability of the particular

variety, a fact which renders impossible any general estimate of the chances of an increased interchange of herbage seed between Empire countries. It is however clear, both from the existing trade, and from the examples of particular cases which we have discussed earlier in our Report, that apart from general climatic similarity between any two countries (e.g., New Zealand and the United Kingdom) those countries are in the best position to develop their export trade which in the first place have, by breeding or natural selection, evolved regional or breeders' strains showing strongly marked characteristics and usefulness for special purposes, and in the second place, have introduced measures of organisation and control designed to ensure maintenance of type and correct description, and thereby to establish confidence among purchasers overseas.

100. The general result of our enquiry, however, has been, as we have emphasised throughout our Report, not so much to show the existence of a valuable trade into which Empire countries have immediate opportunities of entry, but rather to show that the effect of the trade upon the grasslands and their products is far greater than the monetary value of the trade itself, and that for this very reason the seed problem demands the closest attention.

101. The primary task therefore is the breeding, maintenance, propagation and distribution of local supplies, especially of breeders' pedigree strains. The significance of strain in pasture plants is now recognised by agricultural authorities and prominent farmers throughout the world. It should not be long before their lead is followed by the farming community as a whole. When that happens, it is to be expected that the pasture-seed trade of the world will begin to adapt itself to working on a basis of pedigree and type. In such an event, those countries in which the production and distribution of herbage seed have been organised on a strain basis will enjoy a double advantage : not only will they reap the benefit to be derived from improved pastures, but they will also be in a position to increase their share of the trade in herbage seed.

102. The successful accomplishment of the task outlined in the foregoing paragraph involves organisation and control. If economic benefit is to be gained from the work of the plant breeder, the plant breeding stations need to be supplemented by seed farms for the maintenance and multiplication of economic supplies of stock seed, true to type, while in the further stages of commercial growing-on and distribution of the seed for sowing in pastures, there is similar need for organised supervision to ensure strain purity all the way to the purchasing farmer. We have described in our Report representative examples of existing measures of organisation and control, and have drawn attention to certain features and problems which, in our view, are of special importance. We

express no opinion on particular measures or the degree in which they may be adapted to local conditions, but we believe that the idea behind them all—the idea, namely, of the fundamental importance of strain and climatic origin in pasture plants—is one which, in the interests of the grasslands, should ultimately prevail.

G. H. Ferguson (*Chairman*) Frederic Hudd	Canada
H. J. Wilson Thomas Allen	United Kingdom
F. L. McDougall C. L. Baillieu	Australia
C. J. Parr R. S. Forsyth	New Zealand
J. H. Dimond	South Africa
J. W. Dulanty	Irish Free State
Edgar R. Bowring William C. Job	Newfoundland
B. N. Mitra P. P. Ginwala	India
J. W. Downie	Southern Rhodesia
R. V. Vernon Edward Davson	Colonies and Protectorates

D. T. Chadwick (Secretary)
Lionel Bradgate (Assistant)

June, 1934

APPENDIX A

Seed Testing in the United Kingdom

1. Legislation for the control of the sale of seeds in the United Kingdom began with the Adulteration of Seeds Acts of 1869 and 1878, which made it an offence to sell seeds which had been killed; adulteration of parcels of useful seed being at that time effected by the addition of dead seeds of other varieties which increased the bulk but were not revealed in the field since they never came up. In the testing of seeds private initiative preceded official action for some years, the first official station being established in Ireland in 1900, and it was the need for stimulating home food production during the war of 1914-1919 that led to the establishment of an official seed testing station in England. There are now four stations in the British Isles—one in the Irish Free State, one in Northern Ireland, one in Scotland and one in England at Cambridge.

2. The United Kingdom Seeds Act of 1920, which is a consolidation of temporary provisions issued during the war, makes it an offence to offer for sale any of the seeds scheduled in the Act unless they have been tested either at an official station or at a station licensed by authority or, in the case of garden seeds, " in any other sufficient manner ". Equally important are the declarations that must be made on a sale. These include, besides the fact that the test has been made according to the Act, the purity per cent. (except for cereals), and the germination per cent. resulting from the test; the name of the seller; and further, in the case of certain seeds which include grass and clover seeds, the country of origin, and certain other particulars such as the presence of injurious weeds (e.g. dodder), and the number of hard seeds, etc. Any misdescription, e.g., of the country of origin, would be an offence under the Act, and one or two successful prosecutions in this respect have had a salutary effect.

3. The Act empowers the Ministry to grant licences to private firms which enable them to test their own seeds (but not those of other people) for declaration under the Act. This was a recognition of the initiative of those firms which already possessed well-established and well-equipped seed testing plant together with a staff trained for the work. There are now about 80 such private stations, all under supervision by the Ministry, which regards the supervision of private stations as an important side of the administration of the Act. The owners of these stations are required to put duplicate portions of each tested sample in reserve and keep them properly stored for three months. The inspectors on their rounds take a selection of these duplicate samples, together with particulars of the figures given in the records kept at the

station, and the samples are then sent to the official station at Cambridge for check-testing. In order to promote uniformity in method between the various stations, a batch of material is distributed periodically from Cambridge. Samples go to each of the private stations, and the results are tabulated and compared with one another and with the results obtained at the official stations.

4. The seed testing stations give the actual percentage of purity and germination for each sample, but the declaration made by retailers on small packets of garden seeds usually states that the seed contained in them has been tested in conformity with the Act, and comes up to the authorized minimum percentages. This use of a minimum claim does not, however, mean that the retailers are content to conform to a minimum percentage as a maximum average. On the contrary, there is good reason for believing that on the whole the standard of purity and germination attained is definitely above the prescribed minimum.

5. As a check on the trade, officials of the Ministry go into shops and warehouses and other places where seeds are sold or stored for sale, and take control samples which are check-tested at the official seed testing station and compared with the declaration made on sale. In addition to this control, any farmer may send seeds to the Cambridge station to be tested by what is known as the " farmer's sixpenny test ". The report so made, is, of course, for the farmer's information only, and is marked " not valid for declaration ", i.e., it cannot be used as a declaration for sale to another person.

6. The Seeds Act of 1920 enables the purchaser in the United Kingdom to know, with a considerable degree of security, whether or not the material which he buys is likely to be satisfactory in respect of purity and germination. Not only must all seed be tested before sale, but in addition every farmer can, with a minimum of trouble and expense, have this particular purchase officially tested.

7. The Ministry has been active in drawing attention to the objects of the Act and to the facilities available, and in this connection has been able to reinforce the inspectorate by drawing on the services of agricultural officers in all parts of the country whose duties are not primarily concerned with the Seeds Act. In the twelve years during which it has now been in operation not only has the Act worked smoothly, but a marked improvement in respect of the particulars with which it deals has been accompanied by an increasing appreciation of its value by farmers and seedsmen alike.

APPENDIX B

Certification of Grassland Seed Crops in the United Kingdom, New Zealand, Canada and Sweden

(i) UNITED KINGDOM

1. The first national scheme for the certification of a grassland crop in the United Kingdom was that for wild white clover, which came into operation in England and Wales in 1930 through the joint efforts of the National Farmers' Union and the Ministry of Agriculture and Fisheries. There were good reasons for this choice of a beginning. Not only had the demonstrations of research workers drawn attention to the special value of wild white clover in the formation of pastures, but in more than one district, regional strains, of which the Kentish is a familiar example, had developed with characteristics of special value for certain localities and purposes. The object of the national scheme is to encourage the production of such strains, to assist the grower in obtaining a market and a fair price for his produce, and to afford some measure of guarantee that the purchaser will get what he asks for.

2. The scheme imposes three tests for every field which is to be registered as an approved field: an enquiry into the pasture history of the field, an inspection of the crop, and a growing-on test of samples of the seed. The growing-on test involves a period of at least a year before a field can be registered.

3. The account of the history of the field giving, e.g., its age and the source of the seed sown in it, is investigated by a local County Committee. The record distinguishes two grades: grade A, or old pastures, i.e., fields which have been under grass for not less than 10 years, and grade B, or fields that are " once-grown " from seed taken from such old pastures. The records of those fields which satisfy the scrutiny of the local Committees are forwarded to the Central Wild White Clover Committee of the National Farmers' Union in London, which arranges with the Ministry for a field inspection during the vegetative period. If this proves satisfactory, some 200 clover heads are collected by the inspector later in the season, and forwarded to the official seed testing station, and subjected to a growing-on test. The following summer the growing-on plots are examined by a Committee representative of the growers, the trade, and the inspectorate, and if this final test is again satisfactory, the field is recorded by the Central Committee as an " approved " field. Subsequent crops from any such field are eligible for a certificate.

4. At present a single record that a field is " approved " will hold good for a number of years, but it is expected that, as the scheme develops, periodic inspections will probably be made of fields already approved.

5. In addition to the national scheme, there have been three or four efforts to organise the certification of certain regional strains by local associations of growers, among which that of the Montgomery Association may be specially mentioned, since in certain particulars it goes further than the national wild white clover scheme. The object of the Association (which was formed about ten years ago and later developed into a fully-organised co-operative society) is to maintain a supply of seed which it can guarantee to possess the characteristic properties of the true local strain. The field inspection, which is annual, has hitherto been carried out by officers of the Welsh Plant Breeding Station. After threshing, the seed is sent to the Association's own seed-cleaning depôt, samples of the cleaned seeds are sent to the Cambridge station for testing, and the bulk is graded according to the station's purity and germination report. Growers are free to make their own sales, but it is interesting to note that all consignments are despatched from the central seed-cleaning depôt, and in bags bearing the seal of the Association, which also sends out the invoices and collects the accounts. Not all the local growers of Montgomery red clover are as yet members of the Association, which is therefore considering the question of registering a trade mark for the seed grown by its members and sold under its seal.

6. Local associations have also been formed in the Vale of Clwyd (for red clover), in Cornwall (for Cornish marl red clover) and among the seed growers of North Lindsey in Lincolnshire. In this last instance, the primary object has been not so much to foster a local strain already established but rather to restore a regional strain from among local varieties which, in the course of commercial production, have lost their identity. Ultimately, however, it is hoped that local production of the strain thus re-established may replace the present supplies which, though described as English, are sometimes once-grown or even twice-grown from imported seed.

(ii) NEW ZEALAND

7. The certification scheme now in operation in New Zealand has certain features which are of interest apart from the details of the scheme. In the first place, it has not been developed from experience with cereal crops, but has been designed from the start to meet herbage seed problems. Secondly, it is based on a systematic survey of the grassland areas of the Dominion.

Thirdly, it is imbued with the hope that it may ultimately enable the grassland seed production of the Dominion to be established entirely on a " strain " basis.

8. In the preliminary investigation a very large number of seed samples derived from all over New Zealand were brought together for a comparative test at Palmerston North. In view of the limited facilities available it was then decided that the detailed work should be concentrated on a few species, and on account of their economic importance perennial rye-grass and white clover were given priority. A considerable body of data, however, has been accumulated relative to other species, such as cocksfoot and red clover, as a basis for further study.

9. The lines tested at Palmerston North were derived in the main from the following sources.

(*a*) Samples of commercial seed direct from the seed trade and recognised growers.

(*b*) Samples of known origin submitted for test in the normal way to the New Zealand official seed testing station.

(*c*) Seed or turf collected from a very wide range of habitat in New Zealand, including

(i) old pastures of repute, from which seed would normally not be tested,

(ii) roadsides, and

(iii) thickets or waste places.

10. In addition to the actual plot tests made at Palmerston North, a reconnaissance survey of an ecological nature, and with a definite " strain " bias, was conducted throughout the potential seed growing districts of the Dominion. This reconnaissance was of considerable value particularly as a source of information on the regional distribution of various " types " within the species under investigation.

11. Under the certification scheme the Dominion is now divided for administrative purposes into 23 zones, which usually bear a convenient relationship to the districts allotted to the various field instruction officers of the Department of Agriculture. The whole scheme is controlled by the Department through the combined efforts of the Field Divisions and the Plant Research Station at Palmerston North.

12. We have already referred in our Report to the strains of perennial rye-grass and white-clover, which were the first to be certified under the scheme. Although these are the most important, both economically and in respect of the acreage already certified, the sceme is being progressively extended to all the grass and clover crops harvested in New Zealand, and already includes the

fine strain of cocksfoot from the Akaroa peninsula; New Zealand Brown Top (certified free from Red Top), and also New Zealand grown seed of Montgomery late-flowering red clover and English wild white clover.

13. The seed crops are inspected when in flower by an officer of the Department of Agriculture, and the seed subsequently tested for purity and germination at the Plant Research Station. A sample from each field is then subjected to a growing-on test, the report of which is usually available in about five months. If this test proves satisfactory, subsequent crops from the fields concerned are eligible for certification. In that case, as soon as the crops are ready for threshing, the grower notifies the local inspector, who superintends the branding and sealing of the seed containers in the field. At the cleaning station the sacks are weighed, and an official removes the seals. After cleaning of the seed, the sacks are re-filled, weighed, re-sealed and tagged. The official tag shows the registered number of the farmer who grew the seed, the number of the certificate of germination, and the standard (e.g. Mother Seed, Permanent Pasture Seed, etc.) of the contents of the sack. The registered number of the grower includes an indication of his district and the particular field on his farm where the seed was grown, e.g. H.B./61 E, that is to say, seed from " field E " on the farm registered as 61 in the Hawkes Bay district. All sacks of certified seed delivered from the cleaning station bear a certification tag both inside and outside.

14. Owing to the rapid increase in the acreage of rye-grass covered by the scheme (which now amounts to 20,000 acres) it is, we are informed, not possible for the present to carry out a plot test for every rye-grass field harvested. Field inspections, however, are maintained, and all samples are subjected to the ultra-violet lamp test, experience with which has indicated that a well defined correlation exists between the recognized New Zealand perennial rye-grass strain and the percentage of seedlings showing fluorescence.

15. In certain other cases, modifications of the main scheme have also been found necessary, at any rate for the present. With Brown Top, for example, plot tests are not conducted at the central station. Field inspections are made and certification aims purely at a guarantee of freedom from Red Top. One other modification is particularly interesting, as an example of the possibility of co-operation between organised growers and official bodies in the work of certification. In the case of cocksfoot, we are informed, the routine of certification is now carried out by the Akaroa Seed Growers' Association, under the guidance of the Department of Agriculture. Cocksfoot duly sealed by the Association is officially recognised as being certified seed of known origin and of an approved regional strain.

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16. The three " standards " under which the seed is classified are :—

M, or Certified Mother Seed

P.P., or Certified Permanent Pasture Seed

F.H., or Certified First Harvest Seed—further differentiated as First Harvest Maiden (F.H.M.), and First Harvest one year, two year seed (F.H.1, F.H.2) etc.

17. To qualify as " Mother Seed " the crop must be taken from pastures which are least five years old, and in the growing-on test the sample must conform to the special standard of *strain* purity demanded for the grade. Permanent Pasture Seed may be any harvest *except the first*, taken either from an area sown with Mother Seed, or from an area from which the sample conforms, in the growing-on test, with the standard of strain purity for the grade. The distinction between P.P. and F.H. is introduced because in the case of the first harvest it is not yet certain how far the field will be free from volunteer growth etc. in subsequent years. In the P.P. Grade, on the other hand, it can be regarded as reasonably certain that the quality is high enough for use in the laying down of permanent pasture, though not quite " old " enough or otherwise good enough to be used as Mother Seed.

18. The significance of the sub-classes in the " First Harvest " grade may be seen from the following tabular arrangement.

Seed sown September 1933	Crop in January 1934	Crop in January 1935	Crop in January 1936
Description of seed crop	Maiden*	F.H.1	F.H.2
Age of pasture	One year old	Two years old	Three years old
Seed sown March 1933	**Crop in January 1934**	**Crop in January 1935**	**Crop in January 1936**
Description of seed crop	Maiden	F.H.1	F.H.2
Age of Pasture	One year old	Two years old	Three years old

* usually no crop

Thus " first harvest maiden " indicates that the area was sown in the autumn and harvested the following summer; " first harvest one year seed " indicates that the area was sown in the spring, missed one harvest season, and was harvested in the following summer. In all cases, however, the " F.H." grade indicates the *first* harvest taken from any particular sowing.

(iii) CANADA

19. The schemes at present in operation in the United Kingdom and New Zealand were designed primarily for the certification of regional strains; strains, that is, which in the course of years have developed in certain districts in response to the influence of

local conditions. On the other hand the Canadian and Swedish systems, now to be described, are derived from experience with cereal crops, which have been the subject of plant breeding experiments for many years. Two consequences can be observed. In the first place, as a result of experience of the value of seed type for cereal crops, there is a much more active desire among wheat farmers to ensure a supply of suitable seed than can be said to exist among pastoralists generally, and farmers' societies have provided not only the initiative but a basis for the organisation. In the second place, the object of the organisation is not so much to provide for the certification of strains which are already grown in considerable quantities in their several districts, but rather to devise methods by means of which small quantities of seed produced by the plant breeder may be multiplied under adequate supervision and supplied to the market in bulk and true to type.

20. In Canada the inspection and grading of cleaned seed in respect of germinating capacity and purity from weed seeds (which is compulsory) is carried out by Government inspectors. In addition, the registration and certification of seed crops (which is voluntary) is carried out conjointly by the Canadian Seed Growers' Association and by officers of the Seed Branch of the Dominion Department of Agriculture. The field inspection is made by officers of the Department in accordance with standards and regulations established by the Association, which itself acts as a crop registration bureau. In the case of crops or varieties which are not yet eligible for registration under the regulations of the Association, a " seed crop certificate " may be issued by the Department if on field inspection the particular crops are found true to type and free from weeds in conformity with standards prescribed by the Minister. Registered crops on the other hand are awarded a " Crop Registration Certificate ".

21. The Canadian Seed Growers' Association classifies all seed crops under the following categories :—

(1) Foundation stock; i.e., the seed produced by the plant breeder,

(2) Élite stock; i.e., the seed grown from foundation stock,

(3) Registered stock; i.e., seed grown on a large scale from élite stock, for sale in bulk to farmers for their pastures, and registered in accordance with the rules of the Association.

22. The method adopted by the Association is to place foundation stock with one or more selected farmers who are regarded as " key " growers of élite stock. The élite stock grower then provides a supply of seed for the registered seed growers who produce for the market. As will be seen from the detailed regulations given below, stringent precautions are taken to ensure the isolation of

each variety grown, and while registered stock may be grown repeatedly from a stock once registered, repeated field inspections are required in the case of certain crops to ensure that the stock remains true to type and free from cross-pollination.

23. The General Regulations, as amended in 1932, are as follows :—

1. Only members in good standing in respect to membership fees, etc., are eligible to participate in the benefits of seed crop registration.

2. A crop to be eligible, must be produced by methods and handled by equipment approved by the Association.

3. A crop must not be sown on land which has previously grown a different strain, or an unregistered strain of the same kind, until after a lapse of time, as specified for the various crops.

4. A field for the production of élite stock or registered stock, unless otherwise protected, must be separated from other varieties of the same kind by a distance sufficient to protect against contamination by crossing, as specified in the rules for inspection of the crop concerned.

5. A field for the production of élite stock must be planted in a manner to permit of effective rogueing and inspection, as specified for each crop.

6. Except upon authority from the executive, registration will not be granted where the grower of foundation stock, élite stock, or registered stock is producing more than one variety or strain of the same kind of crop.

7. A crop must be produced under the *bona fide* supervision of the member applying for registration. Except upon written authority from the executive, which may be granted in very special circumstances, the land on which the crop is grown must be owned or leased by the applicant.

8. Both élite stock and registered stock must pass field inspection by authorised inspectors.

9. Élite stock of perennial crops may retain this classification as long as the stand endures and is properly protected from crossing with other strains.

10. Élite stock of annual and biennial crops may retain this classification so long as the plants conform to the standards laid down for the crop concerned.

11. Registered stock may retain this classification so long as the plants conform to the minimum standards laid down for the crops concerned.

12. To maintain the eligibility of a given stock from generation to generation in the hands of the same grower, annual field inspection and crop registration are necessary, but seed inspection and sealing are not necessary unless the seed changes hands.

13. The responsibility for securing field inspection rests with the grower himself. Official application forms may be obtained from the Secretary or any provincial director of the Association, or from the district seed inspectors of the Dominion Seed Branch. Applications for inspection should be mailed by the grower directly to the District Seed Inspector of the Dominion Seed Branch.

14. The field inspector will make a crop inspection report in triplicate. The original copy of this report will be sent to the central office of the Association, the duplicate copy to the District Seed Inspector of the Dominion Seed Branch, and the triplicate copy will be handed to the grower.

15. If an inspector is in doubt as to the proper report to make on a given field, it shall be his duty to refer the difficulty at once to the provincial referee plant breeder.

16. If a grower is dissatisfied with the crop inspection report he has the privilege of applying within ten days to the District Seed Inspector for a re-inspection by the provincial referee plant breeder.

17. When seed of a registered crop is transferred to a second owner or agency for cleaning, inspection, sealing and disposal, such shipment shall be accompanied by the original copy of the crop registration certificate, the declaration of which shall have been completed by the grower.

18. Élite stock seed, registered seed and seed for which a crop registration certificate has been issued shall automatically lose its status unless a report of the quantity so held, together with a statement showing that satisfactory precautions are being taken to avoid contamination in storage, is sent to the Secretary before July 1st annually.

24. All clover, grass, fodder and grain seed offered for sale in Canada must be in a container bearing a brand, tag or label on which is clearly stated, besides the name and address of the seller and the specific designations of the seed, the serial number of the official seed inspection certificate and the name of the grade which was awarded in that certificate. There are three grades denoting three standards adopted by the Department of Agriculture in respect of such qualities as germination capacity and freedom from weed seeds. Seed from registered crops is graded as Registered No. 1, No. 2, or No. 3; other seed as No. 1, No. 2 or No. 3, and seed mixtures are graded as No. 1, No. 2 or No. 3 mixture. Seed of a quality below the prescribed standards are designated as rejected, and may not be offered for sale.

25. To obtain a grade on registered seed the grower applies to the nearest inspection office for seed inspection and submits a sample of his re-cleaned seed from fields that have passed field inspection and for which he holds a crop registration certificate. The sample submitted is analysed for weed seeds and other impurities, and germinated, and the report is taken by the inspector to the grower's premises or central cleaning plant where the seed is examined, graded and sealed by him in containers to which he attaches seed inspection certificate tags containing the information required under Section 5 of the Seeds Act.

26. To obtain a grade on the general seeds of commerce the procedure differs somewhat from that used in the case of registered seed. The seller submits a sample of his cleaned seed to the nearest government inspection office for analysis and grade and receives a control sample certificate of grade. The seller takes the responsibility of the variety being true to name, if the variety name is given, and of the seed he sells being similar in quality and grade to the control sample.

(IV) SWEDEN

27. In Sweden the production and distribution of pedigree strains is carried out through the co-operation of two bodies, the Swedish Seed Association and the General Swedish Seed Company, the scientific work being handled by the Association and the propagation and sale of the seed by the Company. The objects of the Association, which was formed in 1894 by the fusion of two earlier associations of landowners and farmers, is to produce and maintain improved varieties of agricultural plants by means of intensive plant breeding and extensive field trials, and also to bring home to agriculturists the importance of using the best seed. For some years the investigations dealt almost entirely with cereal crops, but since 1904 grasses and clovers have been included, and the work now covers all the important agricultural plants of Sweden.

28. The Association consists of some 900 members (agriculturists and others interested in its aims, as well as a certain number of foreign members) but as the subscription is only about 5s. 6d. per annum, the funds of the Association are supplied almost entirely from two other sources: a Government grant and contributions from the General Swedish Seed Company. The Government grant is an annual vote based on a detailed estimate submitted by the Association. Contributions from the Company consist of a fixed sum in payment for the monopoly of the varieties supplied by the Association, royalties when sales exceed a stipulated sum, and a further contribution to defray the cost of inspections carried out by officers of the Association.

29. The management is conducted by a Board of Administration consisting of 7 members and 2 deputies, of whom the Swedish

Government appoints the Chairman and 4 other members, and the Association elects 2 members and 2 deputies. It is clear therefore that the position of the Swedish Seed Association is now that of a semi-official and grant-aided plant breeding institute and inspectorate rather than that of an association of seed growers in the ordinary sense of the term.

30. Besides the Plant Breeding institute at Svalöf the Association maintains eight branch stations, which have been established in selected areas in Sweden so as to meet the varying climatic conditions of the country. The experimental breeding at Svalöf is conducted by the Association on its own land, which covers some 40 acres, and on land leased from the Company which owns some 2,500 acres in that locality. In addition to this acreage at Svalöf, the Company owns three branch establishments and controls 30,000 acres in various districts, including over 700 farms, on which seed is grown on contract. The Company, which is quite distinct from the Association, sells to farmers in Sweden and also to foreign purchasers, either direct or through intermediaries.

31. The methods adopted by the Association and the Company for the production and distribution of selected seed are of special interest not only for the several field tests which selected strains undergo before being passed for bulk propagation, but also for the degree of control which is exercised during the stage of large-scale propagation itself.

32. The selected varieties are first grown in " pedigree " plots, and then subjected to small-scale field trials in order to obtain as early as possible a preliminary numerical comparison of their yield capacity. Comparative trials on a larger scale then follow, in order to eliminate all but the best strains, which are next tested in further trials conducted at such of the branch stations as are situated in districts for which the strains are considered suitable. Those which are most successful are entered in the variety trials of the local Agricultural Societies. Although the control in these local trials is less rigorous than that employed at the Stations, the test is a valuable link in the series, since the main object is to continue the comparative trials under widely varying conditions, and in each locality the new strains are tested against others already established in the district. At a conference between the Heads of Departments concerned in the main and branch stations it is then decided whether any of the new material (which by this time will have undergone a series of comparative trials covering five years or more) is to be handed over to the Company to be propagated on a large scale and put on the market.

33. Small quantities of selected seed are then delivered to the General Swedish Seed Company, which, under a contract sanctioned by the Swedish Government, holds the sole right to propagate and sell " original Svalöf " seed. It was considered that to distribute

the plant breeder's product to a number of different growers for uncontrolled propagation would involve a risk (particularly in the case of plants which are cross-fertilized) of a loss of strain purity. In the hands of the monopoly, however, the new varieties are propagated for two or three years on its own extensive estates and on other farms specially suitable, in each case under the supervision and control of the Swedish Seed Growing Association.

34. During this stage, regular field inspections are made by officials of the Association during the vegetative period, careful records are kept of every field concerned, and in addition samples of the seed harvested are tested at the Central Control Station at Stockholm. The Company is allowed to take bulk seed into store only when the results of the seed testing and the records of the inspections of the fields from which the seed is derived are both satisfactory. On arrival at store, the bulk is again sampled and tested to compare with the sample previously drawn. The results of this test are recorded and must be stated on every package of the seed in question, however small, which further must be tagged and leaded by an agent of the Control Station.

35. Field inspections during the " growing-on " stage serve as a check on genetical impurity, disease, or other defects, and whenever the results are unsatisfactory the distribution of the particular crop is prevented. It is however recognised that when cross-fertilized plants are propagated on a large scale, complete prevention of gradual admixture of crosses or other deviations from the parent type is almost impossible. As a check on this tendency, periodical deliveries of fresh supplies of seed of established varieties are made by the Association to the Company, which is thus enabled to propagate afresh and ensure that " original Svalöf " seed as put on the market is kept true to type.

36. Another check has recently been introduced. Trial plots at the Central Control Station are sown with all types of seed sold by the Company as " original Svalöf " seed, and the resultant plants are compared with the original types. It is claimed that the results of this particular test are demonstrating the value of the Svalöf system as a method of breeding and distributing selected strains, true to type, from the plant breeding station to the farmer.

APPENDIX C

The Staining of Imported Seeds

1. The object of regulations requiring a declaration of origin for imported seeds is to help the purchaser to select the types best adapted to his local needs. With the same end in view, some countries have introduced regulations which oblige the exporter to stain a certain proportion (say 10 per cent.) of each consignment, in such a way that the whole consignment is readily distinguished from seed unstained or stained another colour.

2. It must be recognised that in any scheme for the staining of seeds the details are important. The determining factor should be the suitability of the particular seed for the climatic conditions of the importing country. Thus the regulations in the United States of America prescribe a special colour for Canadian seed, which happens to be well suited to the climatic conditions of the United States, while seed from warmer or less suitable climates is required to be stained another colour, and a third colour is prescribed for seed which is merely " adaptable ". It would defeat the object of any such scheme if it were used for fiscal or protective purposes. Merely to stain all seed exported to the United Kingdom, for example, would mean that no distinction would be made between imported seed of a climatic origin quite unsuitable, and seed from other countries having climates less unlike that of the United Kingdom. Again, to stain on a two-colour basis (on " Empire and foreign " lines) would obscure the comparative merits of different seeds of Empire origin. In the case of seed from Empire countries such as New Zealand or Canada, where effective certification schemes are in force, it would be desirable, in the interests of producers and consumers alike, that any colour scheme adopted should distinguish between certified and uncertified seed.

3. Nor is it necessary that all species should be stained. Where, for example, a seed of foreign origin is no less suitable or more suitable than that obtained from other sources, no staining need be required. It has been suggested to us, on good authority, that it would not be difficult to determine which of the seeds or groups of seeds at present imported into the United Kingdom should be made subject to staining regulations. There seems, for example, to be no call at the moment for staining the seed of crested dogtail or rough-stalked meadow-grass. On the other hand, white clover and cocksfoot have been mentioned as examples of seed for which such regulations would be valuable, and the following arrangement has been put before us as an illustration of the way in which the

colour differentiation in these cases might be determined according to suitability for the particular requirements of the United Kingdom.

Red Clover	
(*a*) Home grown	Unstained
(*b*) Empire grown	Red
(*c*) Northern, Central and Eastern Europe (including Russia), and U.S.A.	Blue
(*d*) Italy and Mediterranean countries, and South America	Violet
White Clover	
(*a*) Home grown wild white	Unstained
(*b*) New Zealand *registered* strains	Red
(*c*) Other sources	Blue
Cocksfoot	
(*a*) Home grown	Unstained
(*b*) New Zealand	Red
(*c*) Other sources	Blue

4. While it is clear that the preparation of a scheme for the staining of imported seeds in any Empire country in which it has not already been introduced would require careful thought, there are two considerations which tell strongly in favour of the device. First is the fact that staining has proved a practical success in those countries in which it has been tried. By such means Canada and the United States are able to exclude unsuitable types of European clover, and New Zealand now excludes much undesirable cocksfoot. Secondly, the educational value of actually staining the seed is very great, for to stain the seed is to put an effective label on every parcel of it that changes hands, and that too no matter how frequently it changes hands. The attention of the purchaser is drawn to the label with a certainty not easily attainable by invoices, letter or placards, and the vendor himself is protected against much of the irritating inconveniences involved in the extraneous " marking " of goods.

APPENDIX D

Statistical Tables

Table 1

Values of Gross Imports of Grassland Products into the United Kingdom in 1932

	Foreign £	Empire £	Total £
Meat (Excluding Pig Products and Poultry)	27,595,348	15,251,464	42,846,812
Living Animals for Food (excluding Swine)	—	9,621,443	9,621,443
Butter	19,725,174	21,329,968	41,055,142
Milk and Cream (all forms except sweetened)	1,097,883	910,486	2,008,369
Cheese	1,121,964	7,967,793	9,089,757
Hay	2,206	16,620	18,826
Grass and Clover Seed	304,537	215,130	519,667
Horses, Cattle and Lambs for breeding	170,332	1,738,207	1,908,539
Hides and Skins	2,611,304	2,481,692	5,092,996
Wool	4,907,687	28,357,076	33,264,763
Bones	50,649	29,389	80,038
Bladders, Casings and Sausage Skins	318,509	179,145	497,654
Animal Hair	748,759	39,455	788,214
Total	58,652,352	88,127,868	146,780,220

Table 2

Proportion of Grassland Products in the Exports of Four Empire Countries, 1931-32

	Total Domestic Exports (excluding Bullion)	Grassland Products	Grassland share per cent.
	£ millions		
New Zealand	34·9	31·6	90·5
Australia (*a*)	93·7	51·1	54·5
South Africa	18·3	7·9	43·2
Irish Free State	25·8	12·4	48·1

(*a*) " Recorded Values ": June 1931—June 1932.

TABLE 3

Summary of United Kingdom Imports and Exports of Clover and Grass Seeds: Average of 1928-1932, *Calendar Years*

	Tons	£
(A) Clover Seed		
Imports: foreign	2,064	155,419
,, Empire	1,317	93,322
Total	3,381	248,741
Re-Exports	288	23,091
Net Imports	3,093	225,650
Exports of United Kingdom Produce	1,941	105,457
Import Balance (+)	+1,152	+120,193
(B) Grass Seed		
Imports: foreign	5,562	276,142
,, Empire	4,301	110,333
Total	9,863	386,475
Re-Exports	510	36,315
Net Imports	9,353	350,160
Exports of United Kingdom Produce	13,229	338,231
Balance		
Import (+)		
Export (−)	−3,876	+11,929
Grass and Clover Seeds together: Balance	−2,724	+132,122

TABLE 4

Percentage share in United Kingdom Imports and Exports of Clover and Grass Seeds (Based on average annual quantities for 1928-32)

Clover Seed				Grass Seed			
Imports		Exports		Imports		Exports	
Canada	35·1	Germany	19·6	Irish Free State	36·0	Germany	30·3
Poland	18·4	France	15·9	Denmark	24·6	Irish Free State	26·7
Germany	11·7	Irish Free State	15·1	France	10·2	France	15·1
France	8·0	Canada	10·5	U.S.A.	9·6	Netherlands	11·0
Chile	6·7	Belgium	10·4	Germany	7·8	Belgium	5·1
U.S.A.	5·2	Netherlands	7·5	New Zealand	6·1	U.S.A.	3·0
Latvia	3·6	U.S.A.	5·8	Netherlands	2·1	Australia	1·9
New Zealand	3·5	Denmark	3·8	Canada	1·5	Denmark	1·7
		New Zealand	2·3				
Other Countries	7·8	Other Countries	9·1	Other Countries	2·1	Other Countries	5·2
—	100·0	—	100·0	—	100·0	—	100·0
Empire Share	39·0		29·7		43·6		29·7

TABLE 5

Gross Imports of Clover Seed into the United Kingdom

	Cwts.					£				
	1928	1929	1930	1931	1932	1928	1929	1930	1931	1932
Latvia	5,312	1,277	1,826	1,758	1,982	20,173	4,918	6,367	5,826	5,393
Denmark	1,582	698	644	476	1,134	6,006	2,783	2,198	1,585	4,863
Poland	23,308	16,125	7,938	6,939	7,896	89,766	51,216	23,837	32,426	39,526
Germany	12,542	9,572	5,928	6,375	5,187	48,577	37,825	17,883	26,916	24,566
France	2,575	1,690	5,823	12,818	4,000	8,130	4,597	20,838	57,951	17,404
Czechoslovakia	3,180	1,975	445	276	242	12,382	8,060	1,274	1,129	1,044
United States of America	909	4,337	2,861	2,803	6,537	4,294	18,772	10,665	10,334	19,742
Chile	4,553	2,715	2,634	2,744	9,986	19,771	7,820	7,110	9,718	25,262
Other Foreign Countries	3,061	1,778	2,280	4,446	3,170	13,229	5,121	8,916	15,402	15,480
Foreign Total	57,022	40,167	30,379	38,635	40,144	222,328	141,112	99,088	161,287	153,280
New Zealand	2,024	1,541	2,166	3,433	2,528	13,746	10,950	15,036	20,558	16,986
Canada	15,315	15,126	21,363	22,459	44,367	64,029	60,094	64,027	61,123	135,833
Other British Countries	143	58	154	460	610	581	284	578	1,501	1,284
Empire Total	17,482	16,727	23,683	26,352	47,505	73,356	71,328	79,641	83,182	154,103
Total	74,504	56,894	54,062	64,987	87,649	300,684	212,440	178,729	244,469	307,383
Empire share per cent.	23·5	29·4	43·8	40·5	54·2	26·1	35·2	44·5	34·0	50·1

TABLE 6

United Kingdom Re-exports of Clover Seed

	Cwts.					£				
	1928	1929	1930	1931	1932	1928	1929	1930	1931	1932
Germany	835	1,074	929	1,482	3,142	3,068	3,557	2,730	4,306	8,226
United States of America	906	—	—	363	157	4,403	—	—	1,331	1,181
Other Foreign Countries	748	174	582	283	849	3,060	451	2,190	735	2,445
Total to Foreign Countries	2,489	1,248	1,511	2,128	4,148	10,531	4,008	4,920	6,372	11,852
Irish Free State	2,137	721	1,004	784	2,233	11,098	3,922	3,731	3,296	9,363
Australia	1,351	970	512	367	682	6,120	3,821	1,801	1,218	2,448
Canada	2,931	270	—	378	68	14,331	1,326	—	2,416	376
Other British Countries	1,053	328	58	138	1,313	5,064	1,417	217	601	5,207
Total to Empire Countries	7,472	2,289	1,574	1,667	4,316	36,613	10,486	5,749	7,531	17,394
Total	9,961	3,537	3,085	3,795	8,464	47,144	14,494	10,669	13,903	29,246

TABLE 7

Clover Seeds: Exports of United Kingdom Produce

	Cwts.					£				
	1928	1929	1930	1931	1932	1928	1929	1930	1931	1932
Denmark	331	3,504	1,790	1,328	533	669	8,450	3,352	2,604	1,195
Germany	5,385	9,311	6,670	8,214	8,478	14,909	25,794	12,244	15,670	19,653
Netherlands	3,070	4,943	2,806	1,658	2,032	10,196	17,089	7,466	4,885	5,087
Belgium	3,081	4,192	1,700	6,215	5,023	4,849	8,763	3,780	9,029	9,493
France	5,831	7,640	3,534	5,540	8,229	8,129	15,873	5,941	8,203	17,297
United States of America	3,827	5,581	309	1,224	278	18,573	21,467	1,195	2,975	1,574
Other Foreign Countries	982	1,505	503	9,490	1,726	3,073	5,353	1,259	12,555	2,696
Total Foreign Countries	22,507	36,676	17,312	33,669	26,299	60,398	102,789	35,237	55,921	56,995
Irish Free State	3,884	11,732	5,150	4,906	3,735	17,932	32,989	20,702	18,788	16,362
New Zealand	1,749	1,561	571	109	376	8,868	6,969	1,783	284	1,510
Canada	2,117	12,913	3,894	1,412	49	12,904	42,980	13,373	5,244	650
Other British Countries	349	2,134	544	116	352	1,738	8,632	2,425	475	1,336
Total Empire Countries	8,099	28,340	10,159	6,543	4,512	41,442	91,570	38,283	24,791	19,858
Total	30,606	65,016	27,471	40,212	30,811	101,840	194,359	73,520	80,712	76,853
Share per cent. to Empire Countries	26·5	43·6	37·0	16·3	14·6	40·7	47·1	52·1	30·7	25·8

TABLE 8

United Kingdom Gross Imports of Grass Seeds

	Cwts.					£				
	1928	1929	1930	1931	1932	1928	1929	1930	1931	1932
Denmark	53,174	36,616	53,011	49,579	50,031	168,785	113,565	158,087	96,264	66,064
Germany	10,430	27,137	16,091	11,456	12,345	37,158	78,564	54,012	31,912	26,576
Netherlands	4,418	7,335	4,146	3,527	2,027	16,495	22,708	15,763	9,624	5,663
France	21,355	36,226	15,749	21,593	5,571	43,193	74,491	31,630	64,696	16,021
United States of America	7,031	22,163	21,809	24,086	18,465	16,283	58,505	51,477	45,931	29,564
Other Foreign Countries	4,904	2,586	6,782	3,226	3,298	11,237	5,924	15,718	7,433	7,369
Total Foreign Countries	101,312	132,063	117,588	113,467	91,737	293,151	353,757	326,687	255,860	151,257
Irish Free State	60,769	103,512	67,630	62,317	60,460	51,154	87,588	51,939	42,529	32,071
South Africa	400	—	200	—	100	1,280	—	640	—	325
New Zealand	22,213	8,717	11,045	11,738	6,245	78,875	43,104	54,488	47,753	27,350
Canada	5,243	2,926	3,850	2,095	397	8,262	5,839	10,438	5,332	1,281
Other British Countries	225	7	20	—	—	1,359	15	45	—	—
Total Empire Countries	88,850	115,162	82,745	76,150	67,202	140,930	136,546	117,550	95,614	61,027
Total	190,162	247,225	200,333	189,617	158,939	434,081	490,303	444,237	351,474	212,284
Empire share per cent.	46·7	46·6	41·3	40·1	42·3	32·5	27·8	26·5	27·2	28·7

TABLE 9

United Kingdom Re-exports of Grass Seeds

	Cwts.					£				
	1928	1929	1930	1931	1932	1928	1929	1930	1931	1932
Germany	6,327	2,428	2,695	3,210	984	26,721	10,120	11,863	11,613	1,687
Netherlands	2,195	1,439	1,405	902	645	7,720	6,770	5,855	4,003	1,959
France	2,060	742	586	594	455	5,520	2,542	2,011	2,227	1,380
United States of America	373	—	73	437	10	1,625	—	335	2,480	138
Other Foreign Countries	1,278	570	838	1,267	567	4,737	2,617	2,755	3,909	1,167
Total Foreign Countries	12,233	5,179	5,597	6,410	2,661	46,323	22,049	22,819	24,232	6,331
Irish Free State	3,062	2,149	1,845	1,166	2,587	9,032	6,490	5,470	3,374	5,487
New Zealand	1,515	1,040	94	238	510	6,913	4,399	441	834	1,127
Other British Countries	1,325	1,019	749	519	1,135	5,567	3,793	3,606	866	2,424
Total Empire Countries	5,902	4,208	2,688	1,923	4,232	21,512	14,682	9,517	5,074	9,038
Total	18,135	9,387	8,285	8,333	6,893	67,835	36,731	32,336	29,306	15,369

TABLE 10

Grass Seeds: Exports of United Kingdom Produce

	Cwts.					£				
	1928	1929	1930	1931	1932	1928	1929	1930	1931	1932
Denmark	3,044	3,803	5,668	6,831	3,545	5,447	5,241	7,740	8,075	4,551
Germany	81,164	94,275	95,427	79,535	49,704	121,142	112,969	114,250	88,152	45,742
Netherlands	28,442	36,730	30,197	30,460	20,022	41,933	47,495	38,647	34,373	19,284
Belgium	9,660	14,804	12,477	14,632	15,473	15,043	20,143	17,225	17,620	15,681
France	34,577	53,471	45,185	37,705	28,749	42,674	56,932	45,955	33,351	23,465
United States of America	11,129	10,776	7,363	5,116	5,871	20,129	18,190	12,587	7,287	7,810
Other Foreign Countries	10,505	6,242	9,352	12,323	16,205	15,864	9,254	14,064	18,690	16,892
Total Foreign Countries	178,521	220,101	205,669	186,602	139,569	262,232	270,224	250,468	207,548	133,425
Irish Free State	74,392	72,089	66,174	67,451	73,314	119,542	107,764	104,683	89,614	82,780
Australia	166	8,649	9,334	3,227	3,839	681	11,836	13,686	4,602	3,830
Other British Countries	1,752	3,041	5,507	1,736	1,773	4,737	6,573	10,566	2,863	3,501
Total Empire Countries	76,310	83,779	81,015	72,414	78,926	124,960	126,173	128,935	97,079	90,111
Total	254,831	303,880	286,684	259,016	218,495	387,192	396,397	379,403	304,627	223,536
Empire Percentage	29·9	27·6	28·3	28·0	35·7	32·3	31·8	34·0	·31·8	40·3

TABLE 11

Canadian Imports of Clover and Grass Seeds: Average of 1929-32 (Fiscal Years) in Cwts.

	Alfalfa	Red Clover	Other Clover	Clover Total	Timothy	Other Grass	Grass Total
United Kingdom	7	3,494	1,475	4,976	27	560	587
New Zealand	—	291	80	371	8	782	790
Denmark	—	—	(a)	(a)	24	32	56
France	—	2,320	98	2,418	—	1	1
Germany	—	98	—	98	—	42	42
Netherlands	—	—	(a)	—	—	38	38
Poland	—	—	42	42	—	—	—
U.S.A.	1,676	2,857	1,792	6,325	75,800	2,137	77,937
Total, including other countries	1,749	9,061	3,497	14,307	77,694	3,594	83,288

(a) Less than 1 cwt.

TABLE 12

Canadian Exports of Clover and Grass Seeds: Average of 1928-32 (Fiscal Years) in Bushels

	Alfalfa	Alsike	Red Clover (a)	Other Clover (b)	Clover and Alfalfa Total	Grass Seed Total
United Kingdom	38	34,834	9,628	1,053	45,771	2,409
New Zealand	—	2,414	—	—	2,414	997
Other Empire Countries	—	194	30	41	268	135
Denmark	66	1,043	—	7	1,116	—
France	—	5,116	—	89	5,205	1,406
Germany	12	6,345	108	3	6,471	6,983
Netherlands	3	464	30	—	437	154
U.S.A.	5,550	70,177	265	33,914	110,967	65,341
Total, including other foreign countries	5,799	121,321	10,013	37,727	174,860	77,720

(a) 45,447 bushels to the United Kingdom in year 1931–32
(b) 13,000 bushels to Russia in year 1931–32

TABLE 13

Percentage Share of Empire Countries and U.S.A. in Canadian Imports and Exports of Clover and Grass Seeds (Average of 1928-32, Fiscal Years)

	Imports		Exports	
	Empire	U.S.A.	Empire	U.S.A.
Alfalfa	(a)	95·8	(a)	95·7
Alsike	—	—	30·9	57·8
Red Clover	41·8	31·5	96·1	2·6
Other Clovers	44·5	51·2	2·8	89·9
All Clover (b)	37·4	44·0	27·7	63·5
Timothy	(a)	97·6	4·5	84·1
Other Grass	37·3	59·5		
All Grass	1·6	93·6		

(a) Negligible
(b) Including Alfalfa (lucerne)

TABLE 14

Summary of New Zealand Exports and Imports of Clover and Grass Seeds (Average of 1928-32) in Tons

	Exports	Imports	Export (—) or Import (+) Balance
Red Clover	106	42	— 64
Alsike	89	75	+ 26
White Clover		40	
Other Clover	26	56(a)	+ 30
Total Clover	221	213	— 8
Cocksfoot	79	138	+ 59
Brown Top	139	—	— 139
Chewings Fescue	751	—	— 751
Crested Dogstail	175	—	— 175
Ryegrass	722	59	— 663
Paspalum	—	91	+ 91
Timothy	—	149	+ 149
Other Grasses	127	60	— 67
Total Grass	1,993	497	— 1,496
Total Grass and Clover	2,214	710	— 1,504

(a) Including 11 tons of Lucerne

TABLE 15

Destination of New Zealand Exports of Grass and Clover Seeds: Average of 1928-32

	Quantities in cwts.			Percentage share of Total		
	Grass	Clover	Grass and Clover	Grass	Clover	Grass and Clover
United Kingdom	7,089	2,196	9,285	17·8	49·6	20·9
Canada	2,094	296	2,390	5·3	6·7	5·4
Australia	15,394	1,845	17,239	38·6	41·7	39·0
Germany	1,268	26	1,294	3·2	·6	2·9
U.S.A.	12,900	42	12,942	32·3	·9	29·2
Other Countries	1,129	22	1,151	2·8	·5	2·6
Total	39,874	4,427	44,301	—	—	—

TABLE 16

New Zealand Imports of Clover and Grass Seeds: Average of 1928-32, *in cwts.*

	Alsike	White Clover	Red Clover	Other Clover (a)	Clover Total (a)	Cocks-foot	Pas-palum	Rye-grass	Timothy	Other Grass	Grass Total
United Kingdom	94	201	301	164	760	101	12	928	5	101	1,147
Canada	1,203	44	112	2	1,361	—	—	—	335	67	402
Australia	—	17	2	507(a)	526	16	1,785	1	—	12	1,814
South Africa	—	—	—	166(a)	166	—	—	—	—	—	—
Denmark	—	8	—	3	11	2,567	—	—	12	61	2,640
France	—	18	196	31(a)	245	—	—	14	—	8	22
Germany	10	236	35	210	491	—	—	—	12	40	52
Poland	—	242	53	—	295	—	—	—	—	—	—
U.S.A.	186	—	73	6(a)	265	—	20	217	2,588	646	3,471
Total, all countries	1,498	807	841	1,124(a)	4,270	2,768	1,817	1,186	2,969	1,206	9,946
Empire Total	1,297	264	443	850(a)	2,854	117	1,797	931	342	196	3,383
Empire share per cent.	86·6	32·7	52·7	75·6(a)	66·8	4·2	98·9	78·5	11·5	16·2	34·0

(a) Including Lucerne

Table 17

Exports of Clover and Grass Seeds from New Zealand: Average of 1928-32, in cwts.

	Red Clover	White Clover	Other Clover	Total Clover	Cocks-foot	Brown Top	Chewings Fescue	Crested Dogstail	Rye Grass	Other Grass	Total Grass	Total Grass and Clover
United Kingdom	638	1,258	300	2,196	858	645	2,519	2,146	629	292	7,089	9,285
Canada	296	—	—	296	1	224	1,557	32	267	13	2,094	2,390
Australia	1,183	480	182	1,845	648	115	383	127	12,622	1,499	15,394	17,239
Germany	—	22	4	26	—	18	339	667	—	244	1,268	1,294
U.S.A.	—	24	18	42	—	1,689	9,898	142	878	293	12,900	12,942
Total including other countries	2,118	1,790	519	4,427	1,573	2,774	15,028	3,506	14,444	2,549	39,874	44,301

Table 18

Exports of Lucerne Seed from the Union of South Africa, in cwts.

	1927	1928	1929	1930	1931	1932
United Kingdom	660	200	—	126	880	862
New Zealand	309	—	205	240	160	545
Kenya	75	131	174	48	18	56
Holland	410	—	—	295	—	—
France	—	—	—	—	—	1,970
Germany	4,755	—	100	100	400	591
Belgium	—	—	—	—	—	981
Italy	405	—	—	295	401	2,171
Argentina	—	—	—	8,055	16,386	—
Other Countries	404 (a)	1	293 (b)	109 (c)	4	201
Total	7,018	332	772	9,268	18,249	7,377

(a) 400 cwts. to St. Helena. (b) 290 cwts. to Australia. (c) 104 cwts. to Australia.

Table 19

Seed Yield from Pedigree Strains bred at the Welsh Plant Breeding Station, Aberystwyth

Species	Character of Strain	Station No. of Strain	Yield in lbs. of dressed seed per acre	Season
Italian Rye-Grass	—	S.22	797	1932
Perennial Rye-Grass	Hay	S.24	795	1932
Perennial Rye-Grass	Pasture	S.23	453	1932
Cocksfoot	Hay-Pasture	S.26	640	1931
Cocksfoot	Pasture	S.29	422	1931
Timothy	Hay	S.51	501	1932
Timothy	Pasture	S.49	460	1931
Timothy	Extreme Pasture	S.50	464	1931
Meadow Fescue	Hay-Pasture	S.53	432	1931
Red Fescue	—	S.59	487	1932
Sheep's Fescue	—	S.58	469	1932
Smooth-stalked Meadow Grass	—	S.63	221	1932

(24760) Wt. P. 1007. 21. 7500 8/34 P. St. G. 372.