Permanent and rotational grass are here added together because, under the long-duration ley system of Wales, they can only be separated arbitrarily, such as by assuming that 'rotational grass' refers to all leys that have not been down for more than three years.

Even under war conditions, more than 80% of the agricultural land of Wales was still under grass of some sort, while the oat crop occupied about half the land actually under the plough.

Even in pre-Mendelian days, successful breeding work with the cereals had been carried out in this country, but up till 1919 no new variety had been produced specifically to meet the requirements of Wales. As the Welsh farmer depended very largely upon his oat crop (both grain and straw) for the wintering of his cattle, it was at least necessary to investigate the possibilities of oat breeding in relation to this situation.

In 1918, both wheat and barley were also relatively important, and as methods for the breeding of these three cereals were already known, it would not have been surprising if the new Station had devoted itself to cereal breeding in relation to the requirements of Welsh agriculture.

Such a superficial view of the situation would leave out of consideration the central figure, namely, Sir George Stapledon himself. His interest in, and his knowledge of, the problems of grassland husbandry and his conviction that something could and must be done in the cause of grassland improvement inevitably led to the inclusion of the exploration of the possibilities of grass and clover breeding in the Station's early projects.

Cereal breeding

(*a*) *Wheat.*—The newer varieties of wheat must have occupied a very high proportion of the land under this crop in Wales in 1918, but in S.W. Wales many farmers persisted in growing the old variety *Hen Gymro* (Old Welsh). It would be too much to assume that this preference was due entirely to either ignorance or prejudice, and the Station considered it necessary to carry out some investigational work, although serious wheat breeding was not contemplated. Samples of this wheat were therefore collected from various farms, and preliminary studies showed that while all the lots agreed in general characteristics, each consisted of many sub-types in varying proportions. A very large number of distinct Pure Lines might easily have been isolated, but ultimately they were reduced to two, namely *Hen Gymro* S.70 and *Hen Gymro* S.72.

In the course of this work (carried out by the present writer) possible reasons for some farmers' preference for this old variety were found. (1) It was usually grown for home bread-making purposes. (2) The conditions under which it was grown were usually unfavourable. (3) The old variety, season by season, was better able to produce millable grain, particularly under adverse ripening conditions. (4) The long, slender, and tough straw made first-rate thatching material.

(*b*) *Oats.*—For purposeful oat breeding it was necessary to ascertain what plant material was available and what were the main morphological and agricultural characteristics of the different varieties. The first step, therefore, was to collect samples of as many oat varieties as possible—both British and others. The late C. V. B. Marquand studied the material and published in a Station bulletin a description and a key to the identification of the different varieties.

Marquand also made some oat crosses, but as the production of a new oat variety from hybridisation requires many years, he was only able to do the preliminary work before he left the Station.

The samples of oats collected included three Welsh 'land' varieties—Radnorshire Sprig, *Ceirch Du Bach* (Small Black Oat), and *Cierch Llwyd* (Grey Oat, *Avena strigosa*). These were studied by the Pure Line method by Martin G. Jones (now of Aberdeen). Radnorshire Sprig gave negative results. From *Ceirch Du Bach* the pure Line variety S.79 was isolated, and from *Avena strigosa* the Pure Line S.75.

After the departure of Marquand, breeding work with oats was taken over by E. T. Jones, who still remains at the head of this work.

From the fact that the newer oat varieties (although they had given good results under conditions favourable to them) had failed to displace completely the older varieties under other conditions, and the different behaviour of oat varieties under different conditions, he concluded that new varieties should be produced to meet the requirements of 'different levels of soil fertility'. This phrase is merely a convenient one to indicate broadly the position, because there are factors other than soil fertility that affect the success or failure of an oat variety, such as climate, altitude, and the purpose for which a particular crop is intended.

The range of situations to be covered will be appreciated from the fact that for land in a high state of fertility in the lowlands, especially in a high rainfall area, the ability to resist lodging may be a paramount consideration, while at the upper limit of oat cultivation in Wales, where the soil is raw and poor, illumination low, and rainfall high, an entirely different type such as *Avena strigosa*, or its equivalent the Aberystwyth-bred S.171, is required. In between, there are many grades of conditions.

A distinction must also be made between varieties for autumn and those for spring sowing, even though the area under autumn sown oats in Wales is limited. Here, however, we have a good illustration of the fact that plant breeding, even in relation to economic crops, has no restrictive territorial limits, because the autumn sown varieties produced at Aberystwyth are far more widely grown in England than in Wales.

The varieties produced and already distributed for general use are the following:

Autumn sown:	S.81, S.147, and S.172.	
Spring sown:	(*a*) for soils of good fertility ..	S.84
	(*b*) for soils of average fertility	S.175 and S.220
	(*c*) for soils of below average fertility	S.79
	(*d*) for soils of low fertility ..	S.75 and S.171*

Two other varieties may also be mentioned, although, as yet, they have not been distributed, namely, 'Maldwyn' (S.221) and 'Milford' (S.225). The former is expected to fit in under (*b*) above, and 'Milford' under (*a*).

A brief reference must also be made to E. T. Jones's contribution, based upon researches of a more academic character, to the discussion of the origin of 'fatuoid' types which appear in oat varieties. Such 'fatuoids' resemble the variety in which they occur in general morphology, but in some spikelet and grain characters they closely resemble the wild oat.

* Further information concerning these oat varieties will be found in the Station's Leaflet, Series S, No. 5.

Grass breeding

It is today difficult to realise how little was known in 1919 concerning even the most common grass species. Systematists sometimes recognised (and named) certain varieties and/or forms, but it was not customary to grow these under relatively uniform conditions to ascertain whether the distinctive characters would then be maintained. Much less was it usual to ascertain whether these characters were inherited. In fact, practically nothing was known concerning variation within a grass species.

As the possibility of producing new and distinct strains of the same species must ultimately depend upon either existing variations or the possibility that variation may occur, the point was of first importance in relation to grass breeding.

The whole question of the production of new grass strains for agricultural improvement was approached with an open mind. It was not even assumed that the better known British species were in fact the best material for improvement. Consequently, in the early 'Potentiality Trials' of the Station, many exotic 'curiosities' found a temporary place.

The most important conclusions from these trials were that (1) within any normally cross-fertilised grass species a great variety of types exist; (2) this variation extends to many characters (which may be simple or complex) and in different directions; (3) a comprehensive population representing many different sources of origin consists of a multitude of types; (4) these types can be graded into broad groups on such characters as (*a*) date of flowering, (*b*) habit, (*c*) colour, (*d*) tillering capacity, and so on. From the breeding point of view, the different response given by the various types to different systems of treatment and management was of particular significance, and it was clear that such variation already existed as would fully justify attempts to produce new strains that would represent what would be regarded as the most valuable types in relation to the various requirements of grassland husbandry.

While these studies in variation were in progress, anticipating favourable results, attention was also being given to the development of a satisfactory breeding technique.

Hitherto, practically nothing was known, even in the case of the commoner grass species, concerning flowering habits, degree of self-fertility, the effect of inbreeding upon vigour, methods of controlling pollen movement, methods of hand hybridisation and so on. Yet such matters were of first importance in relation to effective and purposeful grass breeding and strain building.

It is sufficient here to state that the results of investigations in these directions were satisfactory and that it was found that even such difficult subjects as the herbage grasses could now be handled and manipulated for breeding purposes using methods capable of giving perfectly reliable results. Gradually, also, a technique for strain-building from plants whose breeding characteristics had been ascertained by means of progeny tests was developed. The routine work in connexion with selection, crossing, testing, re-selection and so on is, however, enormous, and usually anything from 15,000 to over 20,000 new single plants are planted out each season for study over two years.

It is not the policy of the Station to produce a multiplicity of strains of any one grass species. What is intended is to produce a relatively small number of strains of different type so that practically the whole range of the species, in so far as valuable strains are concerned, will be represented. Whether some or all of these strains will then be blended together or used separately for sward formation will depend upon the conditions and the type of sward desired.

It may now be a pertinent question to ask whether the Station has in fact achieved anything worth while through its grass breeding work. One answer will be found in the continued increase in the demand for the seed of these strains. A second answer is found in the swards that have been formed by their use. From the Station's point of view, both answers are highly satisfactory under various conditions, but, even so, it may be repeated here that no 'universality' is claimed for these strains. The conditions under which they are capable of giving satisfactory results must be ascertained by trial.

The following are the strains already established and distributed. For general information the names of the breeders are given in brackets:

Cocksfoot (Sir George Stapledon)	Strains S.26, S.37, and S.143
Perennial ryegrass (T. J. Jenkin)	Strains S.23, S.24, and S.101
Timothy (T. J. Jenkin)	Strains S.48, S.50, and S,51
Red fescue (T. J. Jenkin)	Strain S.59
Meadow fescue (A. R. Beddows)	Strains S.53 and S.215*

Other grass species have not been entirely neglected. A considerable number of strains other than those tabulated have been established and await further detailed work for their development.

Academic studies on grasses have been concerned with the genetics of perennial ryegrass; the fertility characteristics of many species; the inter-relationship of *Lolium* and *Festuca* species; and (mainly by graduate research students) the cytology of various interspecific and intergeneric hybrids and their derivatives.

Breeding of leguminous herbage plants

The initial situation with regard to the clovers was very similar to that in the grasses with the exception that (1) different main groups of red clover types were already recognised, and (2) it was known that wild white clover seed gave sward results very different from those given by ordinary cultivated seed.

Preliminary work on the clovers was carried out by various members of staff, but effectively the whole of the work in this department up to his death in 1943 is attributable to the late Captain R. D. Williams.

As in the case of the grasses, little detailed knowledge of the clovers was available, and although broad groups were

* Further particulars of these strains will be found in the Station's Seed Growers' Leaflet No. 10.