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It is probable that within every plant species there is great variation, whether it be growth, habit, disease resistance, seed or flower production, or longevity.

In the more common of the world's useful pasture grasses this variation is very marked and has led to a number of institutions taking up the improvement of certain species.

Some six years ago investigation into the strains of the more important of New Zealand's pasture grasses was commenced at this station and the object of this paper is to outline briefly some of the work being done and the benefits that have resulted from this work,

As a similar scheme is being adopted for all species it is proposed to indicate the general lines on which the work is being carried out.

The first step is the collection of material to work with. At this station it has been the practice to use the commercial seed sample as the unit. Samples from as many districts as possible in New Zealand and other countries have been obtained, chiefly through seeds merchants and other research institutions. In some institutions it is the practice to hand collect samples of seed or plants from various localities. While this method has much to commend it, it would appear that for a rapid, less costly, and less laborious method the commercial seed sample is the most satisfactory, especially in the initial stages of the work.

The second step is the testing of the material obtained. Two methods of testing can be adopted.

- (1) The sowing of seed in broadcast plots or rows.
- (2) Single plant study.

At this stage of the work the second method is quite unpracticable if it is desired to test out large numbers of samples. The first method is considered quite accurate enough for initial trials where the main object is to decide whether or not any rapid improvement can be made by the increase of certain superior lines.

In most of the species that have been dealt with it has been possible to isolate definite ecotypes such as in ryegrass the Hawke's Bay type, the Kentish old pasture type and the South Island arable land type. In brown top two distinct ecotypes have been recognised in Canterbury, the foothills type and the "dryland" type. These ecotypes have been evolved in some cases by natural selection and in other cases by conscious human agency.

The third step, which, to the general farming community has, up to the present, been most widely recognised and appreciated, is concerned with the increase of superior lines under the control of certification. Certification has two main objectives, the guaranteeing to the merchant or farmer of superior type and the elimination of inferior types. The first objective is too well-known to warrant discussion. The result of the second object is in direct proportion to the amount of certified seed sown.

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That it is achieving its object is shown by the number of lines that have come into this station for test, that while not being certified, can be traced back one, two, or three generations to a certified line. The value of certification has shown up where ryegrass samples have come in for test with a view to subsequent certification. A number of these samples whilst not certified are one or more generations removed from certified seed, and have proved to have been a mixture of true and false perennial. If certification were to be dropped this mixing of types **would** increase rapidly and the **ryegrass** position would, in a few years, be in the position that it was in some six years ago.

The fourth step deals with the improvement of certified strains which in themselves have shown almost as great a variation as has one ecotype from another. At this stage single plant study and consequent plant testing becomes necessary. The procedure generally adopted is to put out a large number of spaced single plants to be studied. The best of these are then selected and put out as tiller rows and tiller clumps. This method tends to eliminate to a very large extent chance variation due to soil fertility, disease attack, or post attack.

The next stage is the selection of a small number of the best of these plants and their mutual inter-pollination under controlled conditions in a glasshouse. Although by no means the last word in improvement methods it does afford a means of a very rapid improvement.

After this follows the -much slower but more certain process of improvement by means of breeding superior pedigree types.

It is now proposed to deal with individual species.

Perennial Ryegrass.

For a good many years there was a general but unproved opinion that ryegrass harvested from the old pastures of Hawke's Bay, Poverty Bay, and Sandon, was of a better type than that produced throughout the remaining seed producing districts of New Zealand. With the object of proving or disproving this opinion, about 100 lines of commercial ryegrass were sown in small plots at the end of 1928. Very marked differences showed up from the time of establishment. The plots sown with South Island seed came away very quickly compared with the remainder. By the end of the summer it was apparent that the plots which started off so vigorously were dying out and that the others were thriving. The following autumn a considerably greater number of plots was sown with the object of locating more accurately the limits of the districts producing the superior type. This was accomplished and it was decided to commence in 1929/30 in the Hawke's Bay and Poverty Bay districts the scheme of ryegrass certification.

Since that season when 3028 acres of ryegrass were inspected the certification scheme has rapidly grown until in the 1932/33 season the peak acreage of 22,917 was reached and embraced areas from North Auckland to Invercargill.

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With the object of exploring thoroughly the commercial ryegrass of the world a considerable number of samples have been obtained from other countries. Samples from the following countries have been tested:- England (commercial, indigenous, and selected), Scotland, Ireland, Poland, Germany, Sweden, Denmark, Russia, Czechoslovakia, U.S.A., Australia, and Italy.

These samples have covered a wide range of types ranging from the Kentish old pasture type to the extremely poor types received from U.S.A. and Italy.

The English and Irish commercial ryegrass is very variable but all of it ranges within the false perennial type, much of it being similar to the average false perennial of New Zealand. The English old pasture ryegrass is a very distinct ecotype, but, although it is said to be the best type for English pastures it has failed to approach the New Zealand certified type in production, persistency, or disease resistance. It starts off growth late in the spring, rusts badly in the summer, and fails to make any appreciable quantity of autumn or winter growth.

Seed from other European countries has proved to be chiefly of the false perennial type and is almost invariably of a low producing and winter dormant character. This winter dormant character can very largely be attributed to the cold conditions under which the type has been evolved, these conditions being frequently unsuitable for plant growth.

As a contrast to these winter dormant types one finds that Australian ryegrass, some lines of which are very similar to the New Zealand certified type is much earlier to start growth in the spring.

So one can broadly classify the better types of ryegrass into three main groups.

- (1) The cold climate type.
- (2) The temperate climate type.
- (3) The sub-tropical type.

From experience gained here one would say that within reason it is not profitable to bring cold climate strains to a hotter climate; rather should hotter climate strains go to colder climates. This reasoning applies particularly to New Zealand. It fails when the conditions in the cold climate are too severe. For example., samples of New Zealand and Danish cocksfoot were sent for trial to Canada and were sown in a district that was under snow for several months of the year. The New Zealand Cocksfoot was killed out completely but the Danish, by virtue of its winter dormancy, was able to withstand to a certain extent the extremely cold conditions.

In confirmation of the plot trials carried out at Palmerston North a considerable number of field trials have been carried out throughout New Zealand. Up to the present time some 74 trials have been laid down for this and demonstration purposes, and another 31 have been arranged for this season. In addition to these a large number of schools have been supplied with seed for trials. All reports that have come in confirm the general opinions formed from work done at this station and in some cases have shown up additional advantages of certified strains over the uncertified. In one or two cases where a

grass-grub attack has been followed by heavy frosts the reaction of the different strains has been very marked. As far as could be seen all plots were attacked by the grub to the same degree yet the only plots to come away at all satisfactorily were those sown with the better types. There are probably two causes underlying this. The first is the greater rerooting ability of the true perennial and second is that on account of the considerably denser sward of the perennial the effect of the frost was not so severe. This latter fact has also been noticed where frosts have been severe but with no previous grub attack.

Another point of interest is the measure of weed control exercised by the better types. In the North Auckland district plots sown with certified ryegrass and white clover are maintaining a good sward of the sown species. On the other hand plots sown with poorer types were at the end of 1 to 2 years covered with a dense mat of weeds and unsown grasses such as ribgrass, lotus major, Yorkshire fog, and paspalum. At Palmerston North most of the plots sown with a poor type of ryegrass ran dominantly to volunteer white clover. In some cases the ingress of rushes has been very marked. In some trials control of Scotch and Californian thistles has been noticed.

A feature noticed at Palmerston^N and at Winton is the reaction of the strains to heavy stocking in the winter. At both places the good types stood up to this stocking quite well while the poor types poached badly. This point is of considerable importance especially in the higher rainfall dairying districts where the poaching is grsatsst.

A method of testing type not yet discussed is that by the screened ultra-violet light method. Briefly the reaction is as follows. Seedlings of ryegrass are grown on filter paper and then placed in a screened ultra-violet light. In the case of Italian ryegrass a fluorescence is noticed where the rootlets are in contact with the paper. In the case of perennial ryegrass there is no fluorescence. In false perennial lines the percentage of seedlings with a positive reaction is greater than the percentage in a true perennial, and according to the degree of hybridization with Italian so does the percentage of fluorescence seedlings vary. Within the Certified type this method gives a good indication of the freedom of the particular line from Italian ryegrass or its hybrids with perennial end has been used in connection with certification of ryegrass. Although the method will discriminate between true perennial and most of the false perennials it is not reliable when comparing types of perennial. For example lines of the following types have given a reaction similar to the certified type:- English old pasture, the best of the Canterbury old pasture and a number of Australian lines of the type previously described. For this reason it is necessary that plot tests should be undertaken in all cases where the reaction is very low and the origin of the seed unknown.

The last stage of the work at this station is the improvement of the certified strains and the introduction of pedigree strains which will be marketed through the usual channels of certification.

In this work certification has proved to be of great value on account of the very large number of lines received for test. During the last six years some 9800 lines have been received and this offers very good material to draw on for improvement work. Usually some

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five or six thousand single plants are put out each year with the object of providing information on certain lines and at the same time to provide fresh material for improvement work.

The next step is the selection of the best of these. The percentage of good plants in certified lines is very small, and if one takes the very best probably only about 1/2% are worth continuing with, although from past trials about 15% to 20% are of quite a good type. Those selected plants are put out as tiller rows and single plants and kept under observation for two years when the best of these are again picked out for breeding from. In the initial stages of the work a fair improvement has been attained by mass selection. Last season six plants were split up and planted in a glasshouse. These were allowed to inter-pollinate and a small quantity of 3/4 lb of seed was obtained. This seed was more than sufficient to plant out three quarters of an acre in plants spaced on 2 feet each way. It is intended to harvest this block this coming season and the resulting crop will be sown out on some fern after which the line will come into the scheme of certification as a pedigree line.

That such a manner of improving upon the ordinary certified line is justified is shown by results from trials conducted at Marton under the alternate system of mowing and grazing. These trials have shown the improved line to be slightly but definitely superior to the certified mother seed.

ITALIAN AND WESTERNWOLTHS RYE GRASS.

In these species as in Perennial ryegrass there is great variation from line to line and within each line. Samples marked as one or other of the two have been tested and so far as New Zealand trade samples are concerned one can say that there is no difference between the two, the majority of the lines being very mixed in type. Individual lines range from dominant false perennial of various types through Westernwolths to Italian. The number of lines dominantly of a good type of Italian that are on the market is very small. Several good lines have been located and are being increased under the control of certification.

With regard to Westernwolths no work is being done on this as it is considered that there is very little use for this extremely short lived type at the present time unless, perhaps, to replace or be associated with barley or oats as quickly maturing green feed.

Wimmera ryegrass is another extremely short-lived type. It produces a very large amount of feed in a short time but after the first cut, even given favourable conditions, it fails to survive. Although undoubtedly useful for some parts of Australia it is not considered that there are any districts in this country where climatic conditions would justify its sowing.

In the foregoing species it has not been possible to locate any definite ecotypes in New Zealand. This can be accounted for by the fact that they are primarily annual crops and consequent wide distribution and mixing of lines of seed has lessened the chances of the evolution of ecotypes.

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The Winmerra ryegrass is a very definite ecotype selected for the short-growing season of parts of Australia and as its scope in Australia is comparatively limited it has successfully maintained its type.

Of overseas types only a few have been tested but the few that have been under trial have appeared to be of a more uniform type and superior to even the better of the New Zealand lines.

Work is in hand at this station to put out a mass selected improved line and this season some 9000 plants from a selected line have been put **out** for a seed crop.

COCKSFOOT.

On analysing results from samples obtained from fifteen cocksfoot seed producing countries the following ecotypes have been noticed:-

HAY TYPES.

Extreme. High seed producing, very low leaf producing, disease susceptible and winter dormant type from Russia. Similar ones have been received from Norway and Scotland.

Ordinary Hay Type.

Non-persistent, high seed and low leaf production and winter dormant from U.S.A., Germany, Canada, and Czecho-Slovakia.

Improved Hay Type. From Germany, Denmark, and Sweden.

DUAL PURPOSE TYPE. New Zealand, Ireland, and England.

PASTURE TYPE. Wales and Welsh plant breeding station.

Of these types the dual purpose type is the one of most value in New Zealand on account of its persistency and high leaf and seed production.

The hay types of which the Danish is the best known are of very little value and the Government certification scheme aims at the exclusion of all types but the dual purpose or New Zealand type.

Although in the past a large amount of Danish cocksfoot was sold in this country very little of it is being harvested at the present time and sold as New Zealand cocksfoot. Some six hundred samples of cocksfoot have been received for test and of these only ten have proved to be of the Danish type. All of these were unstained and were therefore presumably harvested in this country and sold as being of New Zealand origin.

AGROSTIS SPECIES.

Of the agrostis species the most common and most useful at the present time is brown top. It is the best from the point of view of both lawn and hill country pasture. Red top, of which a large amount was previously imported and sold, is occasionally found as an impurity in New Zealand grown brown top. As this grass, on account

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of its coarseness and non-persistency under mowing or grazing, is quite useless New Zealand Brown top is being certified to as being free from red top.

A distinct ecotype has been noted coming chiefly from the drier and poorer parts of the Canterbury plains. This is a wiry, rhizomatous type of plant and is of very little value for pastures. Its uses for lawns has not been fully investigated up to the present time, but indications are that it is not nearly as good as the ordinary brown top.

The area of brown top harvested in connection with certification varies considerably from season to season but so far the acreages passed have ranged from 14000 acres to 22000, most of this being in the South Otago district although South Canterbury and North Otago contribute a certain amount.
