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their calves. He asked if there was not a very real danger of the same thing happening to the Romney ewe if the characters studied in the paper were concentrated on to the exclusion of lactation.

Reply:

Dr McMahon emphasised that the present paper was based on characters actually considered in selection by most of our practical breeders; not characters which, perhaps, should be selected for. At the same time, it was not easy to propound an efficient scheme for selecting ewes of high milking capacity. Mr Hamilton's paper has shown us that even in cows, selection for dairy purposes was not quite as simple as some people would like to believe. There was no very good reason to expect a vastly different situation in ewes even if milk production could be measured by one of Dr Barnicoat's techniques.

Professor C.P. McMeekan:

Stressed importance of results to practical sheep breeding. In answer to Mr Waters' query as to the relative importance of dam and sire, he pointed out that one's viewpoint here depended upon whether one was interested in improving the whole flock or the national flock, or whether the aim was to produce a few individuals of outstanding merit. If the former, the dam's contribution is so small as to be negligible: if the latter, every sire has a mother, so that individual matings become more important.

Dr F.W. Dry:

One may speculate upon the stronger inheritance claimed for fleece weight in fine wooled sheep than in Romneys. In fine wooled sheep one wonders whether the fibre type situation is simpler and variation therein less than in the Romneys. Allowing rein to the imagination, and bearing in mind that fibre type array is strongly inherited, and that in the Winsleydale there appears to be very little variation in a simple fibre type array, one would like to know whether the genetics of fleece weight is more complicated in the New Zealand Romney than in some breeds.

Reference was made to the multiplicative interaction of factors mentioned in an earlier discussion. Selection, for example, for fleece weight, might thus prove to give results exceeding expectation.

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PURPOSEFUL BREEDING OF PASTURE PLANTS

by

E. Bruce Levy, Director, Grasslands Division, Plant Research Bureau,
Department of Scientific & Industrial Research, Palmerston North.

Breeding may have for its objective the purification of a line and its perpetuation by uniform, true to type progenies, or it may resort to the mixing of genes from fairly widely differing strains or species through hybridisation, so as to produce a plant type, varying to some degree round about a common mean and especially designed to fit into a specific farming system.

In the breeding of cereals and other annual crops uniformity of type is most desirable to ensure a uniform growth and uniform maturity, irrespective of whether that crop is harvested for grain or whether it is fed in situ by stock.

In the case of herbage plants strict uniformity in regard to type is not desirable in so far as uniformity tends to produce short, sharp curves of production rather than long, broad curves of production from any one component of the mixture sown. Just as it is the purpose of seed mixtures to extend the seasonal range of pasture production, so breeding within the species or between species must have for its objective a long, broad spread rather than a short, narrow spread of production. This principle is well exemplified in the pedigree strain of white clover we have produced by breeding at Palmerston North. Here by combining winter producers, spring and summer producers we have evolved a strain of white clover with a very long spread of production, some growths being produced in this strain for 10-11 months in the year under North Island conditions. Such a performance could not be secured from any one plant aggregate purified by breeding to the one specific type.

In most species or hybrids, however, it is impossible to produce in the one bred line such a mixture of types as may be necessary to cover the agronomic demand of such a line. Thus for example in short or long rotation pastures several types of ryegrass may be needed to give full agronomic cover having in mind seasonal production, palatability and persistence of the sward. Here the plant breeder would probably not attempt total agronomic cover by any one type but would tackle the problem along the line of several definite hybrid types, these breeding true about as wide a common mean as possible and ultimately mixed in specific proportions to give the full range of agronomic cover. In other words each specific type must come to be regarded as specific entities just as now appertains in the case of seeds mixtures of different species.

In breeding there are two fundamentally opposed concepts that should be weighed carefully before a breeding programme is launched. The one seeks for its materials under that climate and those ecological conditions of soil and management where the strain is most generally to be employed. The other takes its plant type from variable sources and selects it under an environment that allows the full potential possibilities of the strain to manifest themselves in much the same way as the dairy stock breeder selects his animals on the basis of butterfat production under a system that affords a full and balanced feeding with adequate body care and comfort of the animal.

Work to date at Palmerston North, within reasonable ecological conditions of soil and climate has rather tended to support the latter plan of breeding rather than the former.

Practically all our high yielding and persistent strains of grasses and clovers have been obtained from the best ecotype areas, climatically and edaphically, the world presents, and those strains when sown under any reasonably efficient system of agriculture in New Zealand, and in the temperate climates outside New Zealand, have performed better than any natural ecotype drawn from the home area where poor growing conditions have for generations appertained. The great advantage, as I see it, in having a high potential plant is that it does as well as the low potential plant under a poor agricultural condition, and yet has in it the ability to respond immediately any improvement in the growing place is made by the farmer. Such improvement may be brought about by ploughing and working, drainage, topdressing, stock control, or by adopting a different grazing system.

There is of course a limit set for the high potential producer under perpetually low soil fertility conditions and severe climates. No high producing strain of ryegrass or white clover for example will produce more than say browntop or *Danthonia* under the natural ecological environment where these grasses assume dominance, but should those areas become ameliorated by ploughing and working, then potential high producers will beat the natural, low potential producers and will continue to do so whilst the ameliorated soil conditions persist and fertility is maintained.

It is practically impossible for any one country to breed purposefully for their product to apply beyond the range of any one major climatic zone. Thus temperate climates of the world may breed and interchange bred material often with very great advantage to both. Similarly those countries within torrid zones and those of frigid zones should be able with mutual advantage, to exchange bred material or the product of these. Whereas a natural ecotype is attuned to and is the product of the maximum severity of climatic conditions of heat or cold experienced at any time in any given locality, such climatic climaxes occur only spasmodically and often at fairly long distant intervals. It is agronomically unsound, particularly with a short, or even a long rotation system, to farm with these climatically pruned types for they are invariably low producers and are of a long winter dormant type.

Thus New Zealand strains, bred in a temperate climate give the possibility of earlier growth to somewhat colder countries, such as Great Britain, within the temperate zone.

On the other hand some British bred strains contain the factor for lateness that could be well exploited in New Zealand to spread species seasonal production and to cater for the later springs of part of the South Island. Montgomery red clover is a case in point. It fits in excellently well to provide late summer grazing and thus tends to extend the production range for red clover in the South Island particularly.

Nonetheless one must not lose sight of the fact that earliness is an essential factor for the South Island and other countries where long winters are experienced. And yet this concept of earliness can be carried too far. Winter growing forms cannot withstand the severe cold of long winters and are winter-killed, as compared with winter dormant forms that revive late in the spring and produce their quota of leafy herbage and flower in due season - usually late in the season. The marked tendency of early growing forms, should they survive the winter, is to come early and to mature early. If, however, the climatic conditions are too cold for early growth the leafy period of early maturity types is fore-shortened, stem production and flowering taking place early and at the time normal to the strain, giving an expression of steminess rather than leafiness. This tendency in the New Zealand perennial ryegrass is manifest in Great Britain, particularly so in Scotland. The incorporation by purposeful breeding of some British bred lateness into the New Zealand strain, would probably greatly enhance the value of the latter for the somewhat colder countries of the world, and would serve further to give a wider seasonal ryegrass spread within New Zealand itself. Such a strain would of course be kept separate from the present winter growing and early producing ryegrass strain we have bred here to date.

Perhaps the greatest application of purposeful breeding is to accord the breeding programme with the farming systems practised within the country or within those countries to whom the seed is exported. Roughly these farming systems may be classified as follows:-

1. Cover crops and one year leys.
2. Temporary pastures 1-2 years.
3. Short rotation leys (1-4 years).
4. Long rotation leys (1-9 years).
5. Truly permanent pastures.
6. Special purpose type to spread seasonal production of each species and to comply with the dictates of climate.

Thus we have the following to provide for:

1. Breeding for short but highly productive periods of growth, cover crops, etc., - up to 1 year. Western wolths and pure breeding lines of Italian ryegrass quick to establish and highly productive.
2. Breeding for temporary 1-2 year leys. Good leafy Italian ryegrass types that persist well into the 2nd year in virtue of some hybrid blood. Good leafy and bulky strains of broad red clover that have at least a good 2 year persistency.
3. Breeding for short leysystems 1-4 years. Good leafy and persistent hybrid ryegrass types (two types probably required): Persistent broad red clover or hybrids of these with Montgomery red clover. Early establishing white clover of the No.1 type or possible hybrids of these with Ladino type. Good leafy, bulky and early establishing strains of cocksfoot and timothy.
4. Long rotation leys 1-9 years. Good leafy and highly persistent hybrid ryegrass strains. Persistent Montgomery red clover, No.1 white clover, good leafy and bulky strains of cocksfoot and timothy.
5. Truly permanent pastures of high productivity. Good leafy and highly persistent strains of perennial ryegrass, cocksfoot, white clover, timothy, crested dogstail and other species. Hybridisation may still play an important part in the evolution of strains superior to those of species-purity.
6. Truly permanent pastures of low productivity - hill country. This farming system calls for the improvement of numerous species that present difficult breeding and difficult seed production problems. Little or nothing to date has been accomplished in this direction. The species concerned are:- Persistent types of perennial ryegrass, cocksfoot, red and white clover. Improvement in crested dogstail, browntop, Danthonia, Yorkshire fog, sweet vernal, Lotus major and the host of annual clovers the most important of which is subterranean clover.
7. Special purpose pastures under any one of the above systems having in mind extension of seasonal production of the main pasture species and to provide for variations in climate within the country of production or for export to those countries of somewhat severer climatic conditions during the winter.

Purposeful breeding as outlined above definitely enlarges the concept of the seed mixture sown and contributes in no small measure to the component parts of those seed mixtures by the creation of hybrid types. Just how wide those hybrid types may be depends on the ability of the hybrid strain to breed relatively

true to the type. The narrower the type the more likelihood of true breeding, and the wider the type the more is one likely to get segregation and differentiation of type as one generation succeeds another in seed production.

From a commercial point of view the wider and less specific the agronomic type the better and purposeful breeding must take cognisance of this agronomic truth.

I have in mind for example the short rotation ryegrass that is now coming on to the market. The question is, are farmers to regard this as all-sufficient for short rotation purposes or should they merely regard it as one strain of ryegrass in the short rotation pasture mixture. The same is true of long rotation and truly permanent pastures. Purposeful breeding in the sense of agronomic application would serve agriculture best if it were possible to breed relatively wide true breeding lines rather than narrow and over specific lines. In order to provide for the possibility of more than one short rotation ryegrass type the present selection is designated H1 = hybrid No.1.

I am of the opinion that New Zealand's export of seeds would greatly increase if we catered more for the temporary, short and long rotation systems of the world rather than for the relatively small areas of truly permanent pasture. Great Britain and America do not want truly permanent pasture strains and at best the New Zealand strains in Great Britain are regarded as suitable for short rotation pastures.

It is my contention that, apart from our clovers, our perennial grasses have not been bred for short rotation systems, but for pastures of long duration. Irish ryegrass, Ayrshire ryegrass, Danish and Swedish cocksfoot, and the American hay types of timothy are more suitable for short rotation than are the New Zealand strains or the super pasture strains of Great Britain.

In conclusion, I am rather inclined to play with the concept of special pedigree types of herbage seeds that may be regarded as the elite mother seed and which would be separately produced in New Zealand and on no consideration be exported as such, but blended in mixtures to constitute a composite strain for wide rather than narrow farming systems.

In this way could be formulated a plan for the protection of the New Zealand evolved mother strains. Theoretically, there is the machinery to patent plant types. In practice there is nothing to stop any country reproducing the strains most suitable for the farming systems of that country. The export of blends would preclude the wholesale use of mother seed by any country specifically for seed production purposes.