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BREEDING FOR **DRYLAND** FARMING

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Abstract

There *are over* 50 types of pasture plant commercially available to New Zealand farmers, and many of these are useful in dryland pastures. A feature unique to New Zealand is that they cover a wide range of species and genera, and even more are currently being bred or evaluated at Grasslands Division, DSIR.

Dryland breeding projects have tended to use both local adapted material and overseas seed collections, and neither approach should be ignored. Screening of plants has almost always been done outdoors, under grazing, and wherever possible in the region of intended use.

The philosophy of breeding for drought survival, ahead of production, is described with several examples from recently released cultivars. The limitations of these new cultivars are mainly in their slow establishment. The major breeding priority for dryland is for legumes capable of surviving in the competitive and severely grazed conditions of dryland pasture and of providing nutritious feed *over* several months of each year.

Keywords: plant breeding, dryland.

INTRODUCTION

The early years of pasture breeding at Grasslands Division produced cultivars that were on the whole best adapted to favourable farming conditions – fertile soils, mild climates, and controlled grazing systems. In recent years, the breeders have paid more attention to the farming regions of New Zealand that are less favoured. One of these is dryland – typified by flat land and hill country along the East Coast of both islands.

This paper will discuss three questions. Firstly, what plants are already available for use in dryland pastures and how well do they meet the needs of farmers? Secondly, are the gaps remaining likely to be filled by further breeding projects, and what breeding tactics might be used? Thirdly, how may farmers themselves get the most out of the new plants and how may they contribute to future breeding projects?

CULTIVARS ALREADY AVAILABLE

New Zealand farmers have over 50 commercial types of seed available, from which to choose their seed mixtures for a pasture sowing. Nearly all of these are on the New Zealand List of Acceptable Herbage Cultivars. This means that they are accepted by the Ministry of Agriculture and Fisheries as having a worthwhile role in farming, although not necessarily for dryland pastures. They cover the 17 species sown in Table 1, with a total of 47 cultivars. (It is of interest that the Acceptable List for the United Kingdom contains 187 cultivars, but covers only 11 species. Over half of their cultivars are ryegrasses.) New Zealand farmers can of course also buy seed of unlisted species such as browntop and chewings fescue for sowing dryland pasture, but these have not been specially bred.

Table 1: **PASTURE SPECIES ON NEW ZEALAND ACCEPTABLE LIST**

	Cultivars Certified
Perennial ryegrass	5
Annual ryegrass	3
Hybrid ryegrass	2
Timothy	2
Cocksfoot	4
Tall fescue	2
Phalaris	2
Crested dogstail	1
Prairie grass	1
Paspalum	1
Yorkshire fog	1
Lucerne	10
White clover	3
Red clover	3
Lotus	1
Strawberry clover	2
Subterranean clover	4
	47

The main points to be made are (a) the wide number and range of species available. Those bred at Grasslands Division represent a deliberate attempt to make the gene base very wide, to provide for the wide range of New Zealand farming conditions. Even within dryland, the variations in climate, soil type and farming systems are so many and so unresearched that this broad approach is justified; (b) the lack of familiarity that farmers may have with many species on the list. Farmers will be able to identify most species, but will often not know which ones to choose, let alone which cultivars within each species.

No one expects plants to grow where water is simply not available. The best that breeders can do is to develop features that will allow a plant to follow, and tap, the receding water horizon. The best example is lucerne, whose long roots locate and transport enough water to keep lucerne actively growing in a drought long after most other species stop growing. Among the grasses, tall fescue is perhaps the most similar. Phalaris has long roots as well, but the moisture obtained is used simply to keep the plant alive rather than to actively grow. In this state, the plant is able to respond rapidly to rain, especially as temperatures fall near autumn.

Our other dryland species have different features that allow growth or survival during drought. Paspalum, one of the few species of subtropical origin in New Zealand pastures, contains chemical pathways that are much more efficient in their use of water to photosynthesise carbohydrates. On the other hand, subterranean clover, which has evolved in the Mediterranean, avoids the problem

altogether by producing seed and then dying before the onset of severe drought. The species as a whole remains in a pasture by germination of this seed with autumn rains.

BREEDING PROGRAMMES NOT YET COMPLETED

If the current breeding projects are successful, dryland farmers will benefit more than most from any new cultivars resulting. Grasslands already has on trial on hill country farms, selections of browntop, chewings fescue, perennial ryegrass and crested dogstail, that we hope will add persistence, production, or nutritional quality to hill country pastures. A selection of the herb chicory will also be tested. Other efforts are underway to breed improvements into legumes such as sub clover, red and white clover, specifically for dryland. Also, we are screening the tree species called honey locust *(Gleditsia triacanthos)*, which can produce heavy loads of nutritious pods in early winter.

MAIN BREEDING PROBLEMS REMAINING

(1) Legumes:

It is difficult to find or breed legumes with the same safeguard of persistence as the grasses. The legumes tend to be more susceptible to insect damage, and are usually selectively grazed by sheep and cattle. Often they also prefer higher pH and-fertility levels than are available. Grasslands breeders are screening legumes such as birdsfoot trefoil *(Lotus corniculatus)*, crownvetch *(Coronilla varia)* and cicer milkvetch *(Astragalus cicer)* that are known to be drought-resistant, and summer-productive. Unfortunately these legumes are virtually dormant in the cool season, which means a loss of potential production in many dryland areas of New Zealand.

Within the traditional clovers, our studies so far suggest that it would be possible to improve cool season growth and also improve persistence by the use of Mediterranean material (Williams *et al.* 1978). Two selections in red clover that contain Moroccan genes are under trial, and both show these two improvements (Anderson 1970). In the short term at least, breeders are unlikely to greatly increase summer production under drought conditions. Natural variants simply do not exist. Long-term projects are underway that aim to hybridise white clover with tap-rooted species such as *Trifolium uniflorum* and *T. ambiguum*, and also the drought-resistant species Kenya clover *(T. semipilosum)*, but even if the crosses are successful there are expected to be large problems in seed production.

(2) Establishment:

Most plant breeders appreciate the problems of establishing new pasture on unploughable country. It is a problem they find difficult to solve. Most of the species mentioned above are slower to establish than ryegrass, and this obviously increases the period they are prone to drought, disease or insects, or to competition from other species or weeds. Farmers must accept that these slow cultivars should not be sown with high seed rates of ryegrass, and that first-year grazing should be lenient.

BREEDING APPROACHES USED

The choice of species to use for dryland breeding has been dominated by one main principle – to increase overall stability of production and reduce the risk

of catastrophe. Since catastrophe can result from drought, overgrazing, pest damage, etc., it has been necessary to look for species with a fair degree of tolerance to each one of these factors. Obvious candidates are tall fescue, phalaris and cocksfoot. Compared with perennial ryegrass, each one is slow to establish, and so needs lax grazing in the first year. But once established, each will survive far better than ryegrass and grow reasonably well in all seasons.

With persistence and production virtually guaranteed in these species, our main breeding target has been to improve nutritional value. All three species have palatability problems, but the new Grasslands cultivars of each one are improvements in this respect.

Once the species for a breeding project is chosen, there are several ways of assembling useful breeding material from which to begin selection. Perhaps the most common one is by collection from old pastures within the dryland region itself. The theory behind this approach is that such material must be well adapted to the total environment (climate, pests, grazing management, etc,), if it has survived for a long time, especially if seed production over this period has been low or absent. Collections from old pastures are a very popular method for breeders – they account for almost one third of the cultivars available in the U.K. The most recent example in New Zealand that has some use in dryland is the Nui/Ellett material from Mr Ellett's farm at Mangere. Although this seedline is obviously well-adapted to his farm, there is little evidence to call it an ecotype that actually evolved there. It may instead have been imported long ago from some quite distinct source in Europe, perhaps a Mediterranean country. What is more certain is that the new 'Grasslands Tahora' white clover bred for moist hill country, is based on an ecotype. It was bred entirely from plants collected from old hill country pastures, plants that were clearly an evolutionary adaptation to the severe grazing systems and infertile soils on hill country (Williams *et al. 1982).*

The second approach is to assemble seedlines from several sources. This would include commercial outlets, botanical gardens and wild collections – both overseas and. in New Zealand. Most of these seedlines would of course be unadapted to dryland grazing, but there is always a possibility that one or more will be immediately useful. The new prostrate cocksfoot called Wana (Rumball 1980) is such a case. It is a simple selection from seed collected in N.W. Spain. It might have been possible to predict that it would contain cool-season activity because of its Mediterranean origin, but certainly not to predict its high resistance to disease and to overgrazing. In most projects however, overseas lines are not well adapted to New Zealand conditions. They must be crossed with New Zealand lines, in order to combine the best features of both.

The next stage in a breeding project is to screen the collected material, in order to identify promising lines. The approach at Grasslands has been to do as much as possible of this work outdoors, under the natural conditions of climate, grazing, etc, and in the region of intended use. The programme which led to Maru phalaris, for example, involved spaced plant and sward trials in a dry Wairarapa site, and moved back to the Manawatu only for information on seed production (Rumball 1980). It can be argued that the process would have been quicker and simpler if a single plant character had been decided upon as being the one crucial to success in dryland, and to have screened for it in controlled laboratory conditions. This approach has had very little success in herbage breeding, perhaps because the total environment is so much more complex than for

crops or horticultural species.

The final stage in a breeding project is to check the selected material for sufficient uniformity, firstly to make it distinct from other cultivarsfor certification requirements, and secondly to provide short intense periods of interpollination and seed ripening.

ROLE OF THE FARMER

(1) It is in the common interest of all farmers that they bring to the notice of MAF or DSIR, any local pasture that appears to be more productive, persistent or have some other advantage over commercial cultivars. It may have some immediate value to other parts of the country.

(2) Farmers must be prepared to inform themselves about new pasture cultivars, and to experiment with them on a small scale. Because of research limitations, no new cultivar will ever be launched with a guarantee of financial profit to pastoral farmers. On the other hand, *no* New Zealand-bred cultivar has yet failed to find a useful role. Dryland farmers have an (unwanted) opportunity to resow expired pastures more often than most, and should use this opportunity to try new cultivars.

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