PASTURE PLANT INTRODUCTION IN QUEENSLAND* —A CONTINUING NEED

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ABSTRACT

The rate of appearance, fate and areas of adaptation of subtropical and tropical grasses and legumes used in sown pastures in Queensland are examined and seven broad areas in which gaps in the present array exist are identified. These are: legumes for wet areas, cool season producing plants, grazing tolerant legumes, legumes for the dry tropics and for arable lands in the subtropics, plants for low rainfall areas, and grasses for the dry tropics.

INTRODUCTION

A number of authors, including Miles (1939), Bryan (1963), Williams (1965) and Burt and Ebersohn (1969) have dealt with the need for plant introduction, especially legumes, in Queensland and it is not proposed to go back over this ground. Many of the requirements they have defined have now been met and the present time is an appropriate one, with sown pasture development very much at the crossroads, to assess the deficiencies that remain within the suite of pasture species and cultivars that has been assembled over the past eighty odd years.

Before doing this, however, it is interesting to look briefly at the time of appearance of the various grasses and legumes that have made a contribution to sown pastures in subtropical and tropical areas of Australia, their fate and the portions of Queensland to which they are adapted.

The present paper will then look more closely at the possible role of plant introduction in solving some of the problems identified by Cameron (1975) in a review of the current state of pasture development and outstanding problems in Queensland.

Descriptions of the majority of the plants considered are given by Barnard (1969 and 1972), Humphreys (1974) and O'Reilly (1975).

TIME OF APPEARANCE

All subtropical and tropical pasture grasses and legumes appearing in the Australian Herbage Plant Register (Barnard 1972 and supplements), including those recently released and in the course of registration plus those detailed in the associated Herbage Plant Species (Barnard 1969), have been assembled in Table 1. To these have been added further plants known to have been used commercially on occasions in the past. These include the naturalized forms of species for which there are registered cultivars. Plants in this category are naturalized *Lespedeza striata* in N.E. New South Wales and S.E. Queensland; *Urochloa mosambicensis* naturalized in central Queensland, the Burdekin and North Queensland; and Hawaiian leucaena (*Leucaena leucocephala*). It is debatable where these inclusions should stop. I have chosen to include these plus plants such as *Bothriochloa pertusa*, naturalized in grazing lands, but not roadside naturalized species such as *Hyparrhenia rufa*.

In preparing Table 1 all forage crops have been excluded, whilst only lucerne (*Medicago sativa*), because of its importance in subtropical areas, has been included from the temperate species.

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TABLE 1

Species and Cultivars of Grasses and Legumes used in Queensland Pastures, their Origins, History, Adaptation and Fate

Species	Common Name	Cultivar	Region of Origin	Year of introduction or selection	Year first Use or Release	Zones of Adaptation*	Fate**	Naturalized***
GRASSES								
Axonopus affinis	Narrowleaf carpet	—	U.S.A.	1891	1910	H	3	X
,, *compressus*	Broadleaf carpet	—	Americas	1897	1902	H	3	X
Bothriochloa insculpta	Creeping blue	Hatch	Rhodesia(?)	1931(?)	Prior 1965	H & M	4	X
,, *pertusa*	Indian blue	—	?	?	Prior 1965	H, M & L	5	X
Brachiaria decumbens	Signal	Basilisk	Uganda	1930	1966	H	4	X
,, *mutica*	Para	—	Africa	1880	1900's	H	2	X
,, *ruziziensis*	Ruzi	Kennedy	Africa	1961	1966	H	3	
Cenchrus ciliaris	Buffel	American	Africa via USA	?	1956	M & L	1	X
,, ,,	,,	Biloela	Tanzania	1937	1955	M & L	1	X
,, ,,	,,	Boorara	?	?	1962	M & L	1	
,, ,,	,,	Gayndah	Kenya	1930	Prior 1945	M & L	1	X
,, ,,	,,	Lawes	South Africa	1951	1962	M	5	
,, ,,	,,	Molopo	South Africa	1940's	1958	M	3	
,, ,,	,,	Nunbank	Uganda	1949	1961	M & L	1	
,, ,,	,,	Tarewinnabar	Kenya	1950	1962	M & L	4	
,, ,,	,,	West Australian	Afghanistan	1870+	1910	L	3	
,, ,,	,,	Cloncurry	India	1926	1930's	L	3	X
,, *pennisetiformis*	White buffel	—	India	1920's	Prior 1925	L	3	
,, *setigerus*	Birdwood	Callide	Tanzania	1953	1963	H & M	3	
Chloris gayana	Rhodes	Katambora	Zambia	1951	1967	H & M	3	
,, ,,	,,	Pioneer	South Africa	1900	1905	H & M	1	X
,, ,,	,,	Samford	Kenya	1952	1963	H & M	5	
,, ,,	,,	—	East Africa	?	Prior 1945	M	3	X
Cynodon dactylon	African star	—	?	?	Prior 1925	H & M	5	X
,, ,,	Green couch	—	East Africa/India	?	Prior 1965	H	3	X
Dichanthium aristatum	Angleton	—	South Africa	1954	1962	H	2	
Digitaria decumbens	Pangola	—	?	?	Prior 1925	H & M	5	X
,, *didactyla*	Blue couch	—	South America	1900's	Prior 1925	H	2	X
Melinis minutiflora	Molasses	—	India	1920's	1930's	M & L	3	
Panicum antidotale	Blue panic	—						
Panicum coloratum var. *makarikariense*	Makarikari	Bambatsi	Rhodesia	1951	1956	M	3	
,, ,, ,,	,,	Burnett	Botswana	1954	1962	M	5	
,, ,, ,,	,,	Pollock	South Africa	1955	1961	M	3	

*H = high, M = medium, L = low Rainfall Zones. See text.
**See Table 2 for details relating to numbers.
***X = considered as having naturalized in some areas of state.

Panicum maximum	Guinea	Colonaio	South America	1930's	1950's	H	3	
" "	"	Common	South America	?	1900's	H	1	X
" "	"	Hamil	?	Prior 1935	1956	H	1	X
" "	"	Makueni	Kenya	1965	1973	H	4	
" "	"	Riversdale	Queensland	1973	1975	H	4	
" "	Panic	Gatton	Rhodesia	1936	1964	M	1	
" "	"	Sabi	Rhodesia	?	Prior 1965	M	1	
Panicum maximum var. *trichoglume*	Green panic	Petrie	?	Prior 1932	1951	M	3	X
Paspalum commersonii	Scrobic	Paltridge	Rhodesia	1931	1950's	H	2	
" *dilatatum*	Paspalum	—	South America	1870's	1890's	H	2	X
" *notatum*	Bahia	—	Americas	?	Prior 1945	H	3	
" *plicatulum*	plicatulum	Bryan	Venezuela	1956	1970	H	1	
" "	"	Hartley	Brazil	1948	1963	H	5	
" "	"	Rodds Bay	Guatemala	1932	1963	H	1	
" *wettsteinii*	Broadleaf paspalum	—	Argentina	1948	1966	H	4	
Pennisetum clandestinum	Kikuyu	Common	Zaire	1919	Prior 1925	H	2	X
" "	"	Breakwell	New South Wales	1965	1971	H	4	
" "	"	Whittet	Kenya	1960	1970	H	4	
" *purpureum*	Elephant	Common	Africa	1900's	1900's	H	3	X
" "	"	Capricorn	Brazil	1940	1962	H	3	
Setaria anceps	Setaria	Kazungula	South Africa	1949	1962	H	1	
" "	"	Nandi	Kenya	1961	1964	H	1	
" "	"	Narok	Kenya	1963	1969	H	1	
Sorghum almum	—	Crooble	South Africa	1948	1961	M	1	
Urochloa mosambicensis	Sabi	Common	Africa	1930's	1960's	M	3	X
" "	"	Nixon	Rhodesia	1936	1973	M	4	
" *panicoides*	Liverseed	—	Africa–India	1928	1930's	M	3	X
LEGUMES								
Aeschynomene falcata	Jointvetch	Bargoo	Paraguay	1948	1973	H	4	
Calopogonium mucunoides	Calopo	—	South America	1930	Prior 1965	H	3	X
Centrosema pubescens	Centro	Common	Java	1930	1950's	H	1	
" "	"	Belalto	Costa Rica	1965	1971	H	4	
Desmodium heterophyllum	Hetero	Johnstone	New Guinea	1945	1973	H	4	
" *intortum*	Desmodium	Greenleaf	Various	1953/57	1963	H	1	
" *uncinatum*	"	Silverleaf	Brazil	1944	1962	H	3	
Glycine wightii	Glycine	Clarence	South Africa	1956	1962	H	3	
" "	"	Cooper	Tanzania	1959	1962	HM	3	
" "	"	Malawi	Malawi	1960	1974	H	4	
" "	"	Tinaroo	Kenya	1945	1962	H	1	X
Lespedeza striata	Japanese lespedeza	Common	U.S.A.	Prior 1900	Prior 1925	H	2	X
" "	" "	Kaloe	New South Wales	1963	1971	H	4	
Leucaena leucocephala	Leucaena	El Salvador	El Salvador	1954	1962	HM	5	
" "	"	Hawaiian	Hawaii	?	Prior 1945	HM	5	X

Table 1 — *continued*

Species	Common Name	Cultivar	Region of Origin	Year of introduction or selection	Year first Use or Release	Zones of Adaptation*	Fate**	Naturalized***
Leucaena leucocephala	Leucaena	Peru	Peru	1954	1962	HM	4	
Lotononis bainesii	Lotononis	Miles	South Africa	1952	1962	HM	1	X
Macroptilium atropurpureum	Siratro	Siratro	Queensland	—	1960	HM	1	X
,, *lathyroides*	Phasey bean	Murray	?	Prior 1879	Prior 1925	HM	2	X
Macrotyloma axillare	Axillaris	Archer	Kenya	1953	1966	H	3	
Medicago sativa	Lucerne	African	U.S.A.	1956	1963	M	5	
,, ,,	,,	Cancreep	New South Wales	—	1968	M	5	
,, ,,	,,	Hunter River	France ?	1800's	Prior 1860	M	1	
,, ,,	,,	Paravivo	South Australia	1965	1971	M	4	
,, ,,	,,	Siro Peruvian	U.S.A.	1956	1965	M	3	
Pueraria phaseoloides	Puero	—	Ceylon	1933	Prior 1965	H	3	
Stylosanthes guianensis	Stylo	Cook	Colombia	1965	1971	H	1	
,, ,,	,,	Endeavour	Guatemala	1965	1971	H	1	
,, ,,	,,	Schofield	Brazil	1933	late 1930's	H	1	X
,, ,,	Fine stem stylo	Oxley	Paraguay	1948	1969	M	4	
,, *hamata*	Caribbean stylo	Verano	Venezuela	1965	1973	HM	4	
,, *humilis*	Townsville stylo	Common	?	Prior 1900	1930's	HM	1	X
,, ,,	,, ,,	Gordon	Northern Territory	1964	1968	HM	5	
,, ,,	,, ,,	Lawson	Queensland	1964	1968	HM	5	
,, ,,	,, ,,	Paterson	Queensland	?	1969	HM	5	
,, *scabra*	Shrubby stylo	Seca	Brazil	1965	1976	M	4	
Trifolium semipilosum	Kenya white clover	Safari	Kenya	1960	1973	H	4	
Vigna luteola	Vigna	Dalrymple	Costa Rica	1956	1965	H	5	

*H = high, M = medium, L = low Rainfall Zones. See text.
**See table 2 for details relating to numbers.
***X = considered as having naturalised in some areas of state.

It is often thought that the development of tropical and subtropical pastures in Australia dates from the end of the 1939-45 War but this is not the case. Nineteen of the fifty-nine grasses in Table 1 were in use by 1945 (Fig. 1). That is one third of the total, although a number, such as *Axonopus* spp., green couch (*Cynodon dactylon*), blue couch (*Digitaria didactyla*) and *Urochloa panicoides* would not now be regarded as sown pasture plants.

The legume story is different, only six of the thirty-eight being on the scene by 1945 and these include Hawaiian leucaena and common *Lespedeza striata*. As legumes form the very basis of our sown pasture technology their later appearance in numbers is important.

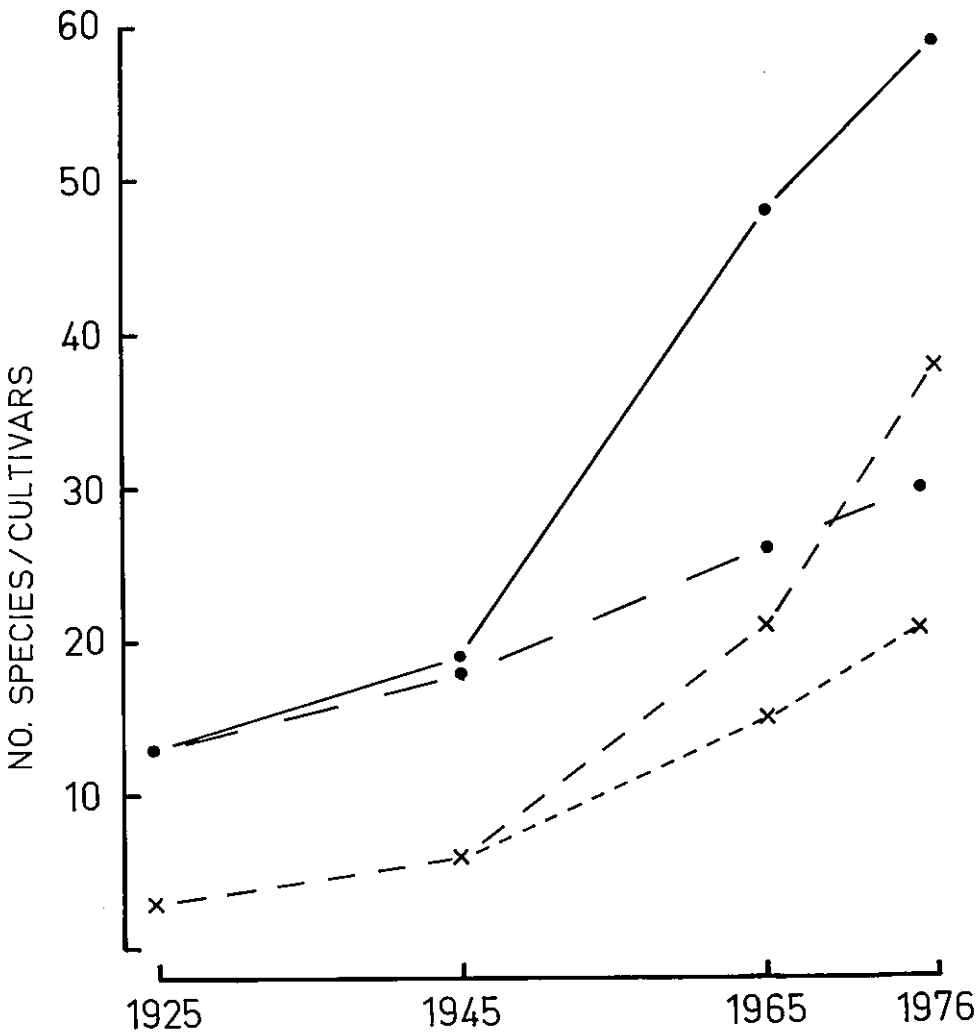

FIGURE 1

Progressive numbers of plants used in Queensland pastures.
Species and Cultivars of grasses (· ———— ·) and legumes (x —— —— – x) and
new species only of grasses (· —— —— ·) and legumes (x – – – – – – x).

The majority of grasses came into use in the twenty years after 1945 although a further eleven lines have been added since 1965. On the other hand the tempo of legume appearance is still increasing, fifteen from 1945-65 and a further seventeen in the last 10 years (Fig. 1).

Prior to 1945 all new material coming into use, except African stargrass (*Cynodon dactylon*), represented new species (Fig. 1), but since 1945 new cultivars within existing species have appeared. This has been the case more within the grasses than the legumes where there are still fewer species. Presently there are only twenty-one legume species representing fifteen genera against thirty grass species also from only fifteen genera.

FATE OF LISTED LINES

It is also worth looking at the fate of the material listed in Table 1. Only a small proportion, sixteen grasses and ten legumes, have remained in widespread use since first becoming available, whilst quite a number of both grasses and legumes have only ever been used to a limited extent (Table 2).

There are, however, a number of plants which have yet to show their real worth and become widely accepted. These include many of the recently released cultivars and plants such as Oxley fine stem stylo (*Stylosanthes guianensis*), whose relatively unimpressive appearance and difficulties with seed production and nodulation have held it back (Table 2).

There are also some lines, seven grasses, and eight legumes, which have never been used effectively. These include Lawes buffel (*Cenchrus ciliaris*), Burnett makarikari (*Panicum coloratum* var. *makarikariense*) and Samford Rhodes (*Chloris gayana*) all of which failed mainly because adequate seed supplies were not obtained early enough, and Hartley plicatulum (*Paspalum plicatulum*) which is no longer identified in commercial seed samples of that name (Loch 1976). A number of others are widely naturalized escapes from trial areas. Two, green couch and blue couch may even be native plants.

The figure of eight legumes is rather misleading as Hawaiian leucaena was introduced as an ornamental, not as a fodder plant, whilst several of the lucerne cultivars were developed for southern Australia. The remainder, Dalrymple vigna (*Vigna luteola*) and the three named cultivars of Townsville stylo (*Stylosanthes humilis*), failed to take on for other reasons.

Of the grasses at least twenty-four in nineteen species have been regarded as naturalized (Table 1). On the other hand, only nine legumes have been considered to have become naturalized. All nine are from different species.

TABLE 2

Fate of Plants (Species/Cultivars) Appearing in Table 1

	Grasses	Legumes
1. Have been widely planted since first available	16	10
2. Initially widely planted but now rarely if ever planted	6	2
3. Only ever planted to a limited extent	21	7
4. Plantings increasing (includes recent releases)	9	11
5. Never planted in commercial pastures (limited trial plantings excluded). Includes some naturalized plants	7*	8
Total	59	38

*Includes Hartley plicatulum which was planted to some extent and stage of disappearance can not be readily ascertained.

DISTRIBUTION OF ADAPTATION

In discussing regional pasture development in Queensland Cameron (1975) used three rainfall headings (a) high rainfall areas (>750 mm rainfall in the south rising to >1 300 mm in the far north (b) medium rainfall areas (c) low rainfall areas (<450 mm in the south rising to <700 mm in the north west (Fig. 2). It is interesting to look at the distribution of the adaptation of the plants considered earlier to these three areas (Table 3). In doing this multiple adaptation has been counted where appropriate as there are plants which straddle these subdivisions.

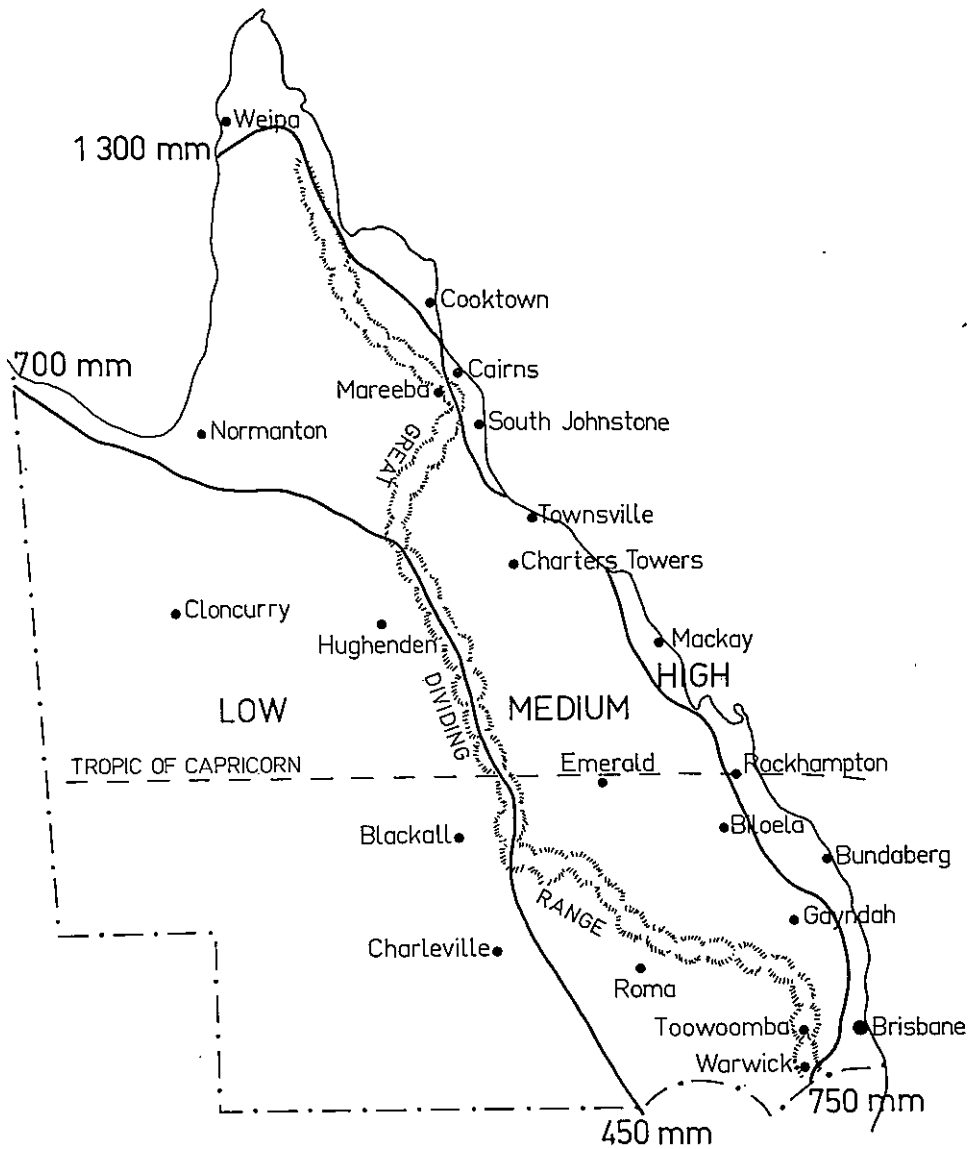

FIGURE 2

Approximate margins of high, medium and low rainfall areas as delineated in the text.

It is noticeable that by far the greatest number fall into the small proportion of the state within the high rainfall area. Some grasses (11), but no legumes, have been regarded as adapted to the low rainfall area. This latter subdivision makes up possibly half the total area of Queensland.

The nineteen legumes considered adapted to the medium rainfall zone include three only marginally adapted (Siratro (*Macroptilium atropurpureum*), Cooper glycine (*Glycine wightii*) and Miles lotononis (*Lotononis bainesii*)). There are also the three Townsville stylo cultivars, Paterson, Lawson and Gordon, not accepted by commerce, together with five lucernes, only one of which is widely planted and three leucaena cultivars, only one (Peru) of which is available but is not yet accepted in commerce. The remainder are phasey bean (*Macroptilium lathyroides*), virtually no longer used, Oxley fine-stem stylo, yet to be widely accepted, Verano Caribbean stylo (*Stylosanthes hamata*), common Townsville stylo and the recently released Seca shrubby stylo (*S. scabra*).

This is therefore a much more serious situation than the raw figures reveal, particularly when we look at the substantial area and wide variety of environments that this subdivision represents. It is also the major zone in which sown pastures have been established (Table 4). Almost 2 million ha of the 3.04 million ha in this subdivision would be "grass only" pastures.

TABLE 3

Distribution of adaptation of the different species and cultivars by rainfall areas.

	Rainfall Areas in Fig. 1		
	High	Medium	Low
Grasses	36	28	11
Legumes	31	19	Nil

TABLE 4

The Approximate Distribution of Effective Sown Pastures based on Predominant Class in Each Shire as at June, 1974

	'000 ha
High Rainfall Areas	
Wet Northern Coast	57
Atherton Tablelands	38
Central Coast	77
S.E. Coast (Mainly Wallum)	128
S.E. Sub Coastal	121
Total	421
Medium Rainfall Areas	
Mainly Brigalow	1 769
Mainly Gidgee	279
Heavy Soils	90
North of Mackay (Dry Tropics)	472*
E. of Dividing Range (S. of Mackay)	324**
W. of Dividing Range (S. of Mackay)	102
	3 036
Low Rainfall Areas	21***
State Total	3 478

*Inc. 450 000 ha sown and naturalized Townsville Stylo.

**Inc. 20 600 ha sown and naturalized Townsville Stylo.

***Excludes gidgee areas which have been included with medium rainfall areas.

MAJOR GAPS

Much has been achieved. There is now a suite of cultivars for the high rainfall areas which will allow some pasture to be developed in most situations whilst in the southern half of the medium rainfall areas there is an adequate range of grasses except for the heavy textured basaltic soils where establishment of existing grass cultivars is unreliable.

There are, also, other important gaps that still need attention. These include legumes adapted to particularly wet sites in high rainfall areas, plants capable of making better use of cool season rainfall and more legumes that will tolerate heavy grazing. There is a need for more and better adapted legumes in the medium rainfall areas and a better suite of grasses in the northern dry tropics. There is also a need for a wider range of plants for the low rainfall areas, mainly for rehabilitation of denuded areas.

Wet area legumes

There are substantial areas in parts of the high rainfall zone that become quite wet over summer, such as the wallum heath in south Queensland, the low lying solodic soils on the Mackay coast and low lying areas on the wet tropical coast. The grass situation here is adequate with such plants as pangola (*Digitaria decumbens*), the setarias (*Setaria anceps*) and para grass (*Brachiaria mutica*), but few legumes are available that are persistent and productive. Phasey bean (*Macroptilium lathyroides*), Dalrymple vigna (*Vigna luteola*) and the temperate *Lotus* spp. have some value, whilst white clover (*Trifolium repens*) is used on the wallum areas (Wright 1973) but more are required. These areas are productively quite important as they maintain favourable moisture relationships further into the dry season than the more elevated country around them. They are also more susceptible to frosts so some frost tolerance in such plants would be important.

A collection of plants potentially suited to these situations is presently being assembled for testing at Mackay (Bishop, personal communication).

Cool season species

In southern Queensland a considerable, although erratic, winter rainfall is received. The present suite of subtropical plants is, however, prevented from growing at this time of the year by frosts and even just low temperatures.

Lotononis and Oxley fine-stem stylo have better growth at this critical time whilst lucerne and the annual *Medicago* species are important over winter. However they are not widely adapted to all areas and all uses.

Of the grasses Narok setaria (Barnard 1972) and Makueni guinea (*Panicum maximum*) (Mackay 1974) have been specifically released because of their better cool season growth. Common kikuyu (*Pennisetum clandestinum*) is also important as an autumn/spring producing plant (Quinlan *et al.* 1975) and green panic (*Panicum maximum* var. *trichoglume* cv. Petrie) is valued in medium rainfall areas for its ability to make growth in warm, moist periods in winter (Marriott and Winchester 1951). As well Bambatsi makarikari does not frost readily but also does not grow actively at this time of the year (Cameron and Mullaly 1970).

Plants that are not affected by frost or even just low temperature could make a major contribution to pasture productivity in Southern Queensland.

Some progress has been made in this direction with, in addition to those mentioned above, such recently released cultivars as Belalto centro (*Centrosema pubescens*) (Barnard 1972) and Safari Kenya white clover (*Trifolium semipilosum*) (Mackay 1973). These have yet to come into widespread use, and more work is needed, especially in southern areas.

Grazing tolerant legumes

There are a number of legumes which thrive under and are even encouraged by heavy grazing pressures. These include Townsville stylo, lotononis and hetero (*Desmodium heterophyllum*). However, the basic legumes in most pasture mixtures in the

high rainfall areas, the viny Siratro, desmodiums and glycines, are sensitive to stocking pressure and this is probably the major factor determining their persistence and effectiveness in pastures. Siratro in the Mackay area is sensitive to a stocking rate greater than 1.67 beasts ha^{-1} (Walker pers. comm.).

There is a distinct conflict between growth habit and persistence to be overcome here. Those plants presently capable of persisting under heavy grazing are susceptible to over-shading by tall, vigorous grasses in mid-summer. On the other hand the viny types which are bulky and productive and are able to keep up with these grasses do not appear likely to be able to provide forms that will regrow rapidly from the crown when closely and frequently defoliated. It is possible that the northern wet tropics solution of grass/bag nitrogen or short grass/short legume areas to take stress periods will be the solution. This will need to be coupled with a widespread recognition of the defects of plants such as Siratro and the desmodiums.

The dry tropics legumes—Rays of hope

Until recently Townsville stylo was the only legume that could be used in the medium rainfall areas north of Mackay, but this plant, whilst widely naturalized, has not proved highly successful in sown pastures because of its instability when sown with a fertilizer input.

There is, however, a range of complementary legumes now in various stages of evaluation. Verano Caribbean stylo and Seca shrubby stylo have recently been released and a further group of lines is showing promise within the genus *Stylosanthes*.

The dry tropics still require further plant introduction to provide coverage of the diverse environmental and use situations that occur there. The majority of the plants eventually selected will need to be very well adapted, with a high ability to naturalize and spread from minimal establishment techniques and possibly widely spaced points of introduction. Initially their major role will be that of improving the dry season nutrition of the livestock, rather than increasing carrying capacity. As a result, ability to hold green palatable leaf or seed pods well into the dry season will be important. Ready seed set, and therefore cheap seed, and tolerance of relatively infertile soils will also be essential if they are to find economic uses. A wide range of genotypes could be required as there will be little scope for modifying the natural environment to suit particular plants.

Arable lands in the subtropics

It is probable that the *Stylosanthes* and other legumes developed for the dry tropics will find a role in more southerly areas on the acid and lighter textured soils, although full testing of these, including species such as *Stylosanthes fruticosa*, discarded for various reasons in the north, will be necessary in southern areas. One line of *S. fruticosa* (CPI 40615) in particular is showing promise at Charleville (Smith, personal communication). Varieties such as Siratro, Miles lotononis and Oxley fine-stem stylo will also prove useful in the more humid margins of the southern portion of the medium rainfall division, on the acid, lighter textured soils.

The neutral to alkaline, heavier textured areas, which provide the main presently or potentially arable lands, represent a major problem area. Lucerne, leucaena and the medics all show some promise on these lands but all have drawbacks and a wider array of plants is required.

The majority of these will need to be plants that can be incorporated within ley rotations on cultivation land. They will therefore need to be readily established with final crops in the rotation, achieve high productivity early in the first grazing year, be less susceptible to grazing management and free of problems such as bloat and soil desiccation encountered with lucerne, and be more reliable in production than are the annual medics. Seed also will need to be readily and cheaply produced as periodic resowing is involved. Highly effective nitrogen fixation, for fertility restoration, and preferably some winter productivity and tolerance of heavy grazing will be important

features of such plants. Grazing pressures will at times be high due to smaller property sizes and proportions of the property devoted to cropping at certain times of the year.

There is also a need for grasses with greater ability to establish on heavy textured soil. These need to come into production rapidly as they will be used mainly in rotation pastures, but at the same time they should not have weed potential in these crop lands.

The low rainfall areas

Presently the buffel grasses and one or two other species will grow along the wetter margin of this area, mainly on the more fertile soils. Cloncurry buffel (*Cenchrus pennisetiformis*) has in the past been sown on the high phosphate flood plains of the rivers of the north-west, and the true buffels have been widely sown on the gidgee scrubs developed in the central-west, whilst limited sowings of buffel grasses have been made on the mulga soils. Once established these can persist and spread slowly in wetter years (Ebersohn and Lucas 1965, Christie 1975), but there is still a need for other grasses for revegetation of denuded areas and sowing into developed mulga lands. In the main, however, encouragement of the preferred native species is probably a better approach and will be the basis of most future research.

Any introduced grass, and several are showing some promise, such as *Eragrostis curvula*, *Anthephora pubescens* and *Schmidtia bulbosa* (Smith, personal communication), will need to be very hardy, and to seed and naturalize readily. Hopes of readily meeting these criteria are not high.

The need for and role of introduced legumes in this country are far less clear at this stage and the chances of obtaining them are probably less than in the eastern areas. The need for a nitrogen input, however, may be much less. *S. fruticosa* is the only legume to show some promise and it still requires much more testing.

Dry tropic grasses

Whilst the legume position is showing considerable promise in the dry tropics the grass position is presently less encouraging. *Urochloa mosambicensis* and the buffels have grown well in places, but have tended to dominate Townsville stylo. It is unlikely that they will combine any better with Verano but may do so with Seca.

The need for such grasses, however, is far from clear. Certainly Townsville stylo tends to suppress the native grasses when fertiliser is applied, leading to an unstable weed dominated situation. Whether this will be the case for less fertility demanding species now on the horizon remains to be seen but it is highly likely that many of the native grasses, especially in the far north, will not stand the higher levels of utilisation that adapted and useful legumes will permit. Whether pure legume stands can remain stable remains to be seen. Townsville stylo could not in areas where it had not become naturalized and southern experience with temperate legumes would also suggest that this is not likely to be the case. Pure legume pastures are generally unstable and susceptible to weed invasion.

If this is so, grasses could eventually become the major need from plant introduction in the dry tropics for the development of stable sown pastures tolerant to minimal management.

CONCLUSIONS

Queensland is a big state covering 18° of latitude with a rainfall range from 200 mm to over 3 300 mm per year, with soils ranging from deep fertile self mulching types derived from basalt to shallow very infertile soils of tertiary origin. It is not unexpected, therefore, that there are still many environmental situations for which suitable species for sown pastures are not available. Rather, it is perhaps a measure of the success of past efforts that I have only been able to define seven broad groupings where presently deficiencies exist.

A few attributes are common to all pasture plants likely to find a use. These include broad adaptability—our level of intensity of livestock production is such that plants only suited to limited areas are not likely to come into use. Broad latitudinal,

soil, rainfall and temperature adaptation is essential. Ready seed production and simple establishment requirements are also important; in fact ability to spread naturally will become increasingly important whilst labour remains expensive relative to product price. There appears little chance of this situation improving in the future.

It is perhaps a measure of the greater success with grass than with legume introduction that a lot more grasses are considered to be naturalized, although longer time and a greater variety of genotypes could also be important here.

Most new plants will need to be less sensitive to soil phosphate fertility than has been the case with past releases, especially legumes, provided this can be achieved without greatly reducing their ability to inject nitrogen into the grazing system.

Less sensitivity to grazing management will also be important in plants where production is more extensive and property and livestock management of a low order for no other reason than the larger areas that have to be covered on each property with a similar labour force.

The browse shrubs also demand more attention than they have received. When more become available, landholder resistance to this type of plant may have to be overcome. These plants, however, offer a most attractive way of carrying high protein feed further into the dry season in northern areas.

Many of the problems identified in this paper are under active study. This, however, is a slow process, despite the progress made in recent years in speeding up the evaluation and selection procedures. The present economic problems of the pastoral industries should not be allowed to reduce presently planned efforts to overcome the existing deficiencies in the pasture species array. If these programs go ahead on schedule we should see considerable progress over the next few years.

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