REGIONAL PASTURE DEVELOPMENT AND ASSOCIATED PROBLEMS IV NORTH-EASTERN NEW SOUTH WALES

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ABSTRACT

The development of improved pastures in the sub-tropical regions of New South Wales is reviewed on the basis of progress, problems and future research needs. Although pasture development has resulted in substantial increases in productivity in some situations, there remain a number of problem areas. These include the persistence of legumes, establishment of improved species, maintenance fertilizer requirements and pasture management. Suggestions are made for future pasture research in the region.

Agricultural holdings in the North Coast Region of New South Wales cover approximately 2.5 million ha of which 250,000 ha were classified as improved pasture (including *Paspalum dilatatum*) in 1972-73. Early pasture improvement was with both tropical and temperate species such as paspalum, carpet grass (*Axonopus affinis*), white clover (*Trifolium repens*) and kikuyu grass (*Pennisetum clandestinum*). These species have become naturalised and form the base for further improvement. The unimproved area is predominantly grass pasture (carpet grass and native grasses) with a large proportion covered by *Eucalyptus* forest, tree regrowth or weeds.

Since the mid-1950's the cattle population has increased by 22% to 1.25 million (16% of N.S.W.) and there has been a substantial change in the ratio of beef to dairy cattle as a result of the marked decline in the dairy industry. Much of the increase in cattle numbers can be attributed to an expansion of pasture improvement which is indicated by the ten-fold increase in use of superphosphate (4,000 to > 40,000 tonnes $year^{-1}$) in the twenty-year period from 1953-54. Although tropical legumes and grasses have been sown throughout the region since the mid 1960's, temperate species have remained more important for pasture development.

In this review information from research and farmer experience will be summarised and the problems of pasture development and direction of future research needs defined.

PASTURE DEVELOPMENT—AGRONOMIC FACTORS

Environmental limitations and seasonal production

Growth of tropical pasture species is limited by temperature to the period from September to April; spring and early summer growth is frequently restricted by low moisture supply. In general the tropical legumes have a more restricted growth period than the tropical grasses (Colman 1971; Kemp 1974).

In autumn and winter both moisture and temperature suit the growth of temperate species. A continuity of feed throughout the year can be achieved either by the use of tropical and temperate species or the growth of sufficient carryover feed in summer and autumn to satisfy cool season feed requirements.

Lying in a climatic zone which is transitional between tropical and temperate, the North Coast Region presents problems for development of stable pastures. Successful tropical and temperate species require survival mechanisms which enable them to persist through relatively long periods of growth restriction, and, at the same time, a yield potential to take advantage of favourable conditions.

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Species

(*a*) *Legumes*

The criteria for selection of tropical legumes have included ease and reliability of establishment and nodulation, vigorous growth and competitive ability, adaptation to soil conditions and persistence under grazing. The legumes selected in the testing programmes which commenced in the 1950's and early 60's were *Glycine wightii* (cvs. Clarence and Tinaroo), silverleaf and greenleaf desmodium (*Desmodium uncinatum* and *D. intortum*), Siratro (*Macroptilium atropurpureum*), *Lotononis bainesii* and the annual *Lablab purpureus* (Macadam and Swain 1959; Wilson and Murtagh 1962; Murtagh and Wilson 1962; Murtagh, Mears and Swain 1964; Mears 1964; Mears, Murtagh and Wilson 1964; Mears 1967; Kemp 1974).

Whilst lablab bean has been generally successful, the performance of the perennial species in pastures has been extremely variable. The most successful pastures have been established on the more fertile chocolate basalt soils using Tinaroo glycine, greenleaf desmodium, Siratro and Archer axillaris (*Macrotyloma axillare*) (Everett 1974); lotononis has been successfully used on the light sandy soils. There are no tropical legumes adapted to alluvial soils despite the early evidence of suitability of the desmodiums (Murtagh *et al.* 1975). Almost without exception tropical legumes sown on red basaltic soils have failed to persist. On all soil types and throughout the region there is increasing evidence of poor persistence of the tropical legumes even following good establishment.

Lespedeza striata and *Aeschynomene falcata* have been selected for poor soils and/or lower rainfall (Wilson personal communication; O'Brien and Cohen 1973) and other legumes such as the native glycines and possibly some *Stylosanthes* spp. could also be useful (Wilson personal communication).

Temperate legumes, especially white clover, are used more widely than tropical legumes. Haifa white clover has many of the characteristics of the naturalised strain, but is more vigorous and higher yielding (O'Brien 1970). Kenya white clover (*T. semipilosum*) has potential as an associate of kikuyu grass growing on more fertile basaltic soils (O'Brien pers. comm.; Colman 1974).

Large quantities of New Zealand and ladino white clover, red clover and lucerne are sown, especially on alluvial soil, but these species rarely remain productive for longer than three years. Annual temperate legumes (subterranean clover, *Vicia* spp., Namoi woolly pod and purple vetch, yellow lupins—*Lupinus luteus*) oversown into grass dominant pastures reliably produce winter and early spring feed, mainly on dairy farms (Murtagh, Mears and Swain 1964; Hughes pers. comm.).

(*b*) *Grasses*

Pasture development has aimed at the improvement of carpet grass and other native grasses, by introducing legumes, and their replacement with naturalised grasses such as *Paspalum dilatatum* and kikuyu grass or with introduced grasses such as the setarias, broadleaf paspalum (*P. wetsteenii*), green panic (*Panicum maximum* var *trichoglume* and pangola grass (*Digitaria decumbens*) (Mears 1967; Kemp 1974).

Temperate perennial grasses are sown only on relatively small areas usually for irrigated pasture and are readily replaced by warm climate grasses. Annual ryegrasses and oats sown on clean seedbeds provide part of the winter feed supply on dairy farms.

Establishment

The preparation of a clean seedbed is the most successful method of establishment for tropical pasture species in N.S.W. There are a number of agronomic problems including cultivation on slopes, soil erosion, high soil temperatures (Murtagh 1970) and weed growth associated with cultivation. Alternative methods of establishment including chemical seedbeds, minimal cultivation and a range of sowing techniques have been successful. Direct sod-seeding of tropical legumes into grass dominant pasture was unsuccessful (Murtagh 1963, 1973; O'Brien unpublished data).

In practice most tropical pasture sowings in the region are preceded by some form of cultivation. Frequently cultivation and sowing is made in a single operation using large disc implements combined with seed and fertilizer distributors. Although these methods give satisfactory establishment of tropical species in recently cleared or native grass areas, poor results have been observed in areas originally under carpet grass. There is apparently a need for much more severe cultivation, including fallow, or cropping with lablab bean then oats, in carpet grass. This is in contrast to the success of establishment of temperate legumes by oversowing (Murtagh, Mears and Swain 1964). Recent results in the Clarence and Richmond/Tweed areas have confirmed the success of broadcast sowings of white clover and Kenya white clover into carpet grass in autumn (O'Brien pers. comm.; Martin pers. comm.). Future pasture development will of necessity be based on such cheaper techniques.

Fertilizers and nodulation

Plant nutrition studies have aimed at defining nutrient deficiencies on soils of the region, determining the fertilizer requirements for pasture establishment and nodulation of legumes, the fertilizer rates required for maintenance of pasture production, and responses to nitrogen fertilizer.

(*a*) *Nutrient deficiencies*

Phosphorus is the major deficiency on all soil types with the possible exception of some alluvial and chocolate basalt soils. In addition, sulphur, molybdenum, calcium and potassium deficiencies are widespread (Havilah and Mears 1968; Mears 1969; Havilah pers. comm.). Responses recorded to lime can be attributed mainly to release of molybdenum although with *Glycine wightii* Mears and Barkus (1970) also measured a response to calcium on red basaltic soils. Havilah (pers. comm.) has obtained responses to liming on Clarence Valley soils with a wide range of species but the causes are undefined.

(*b*) *Establishment fertilizers*

Rates of 250 to 500 kg ha^{-1} superphosphate are recommended for sowing of tropical and temperate pastures on most soil types throughout the region. On poor soils up to 750 kg ha^{-1} are recommended. The value of high initial dressings to establish an adequate level of available phosphorus in the soil has been clearly demonstrated on grazed pastures (Mears 1973; Havilah, O'Brien and Cohen pers. comm.).

The application of part of the establishment fertilizer dressing as molybdenised superphosphate largely overcomes the major nutrient deficiencies of phosphorus, sulphur, molybdenum and calcium. At establishment, soil potassium levels are generally adequate for permanent pastures, although cases of K response by annual temperate legumes have been demonstrated (Colman 1964).

(*c*) *Seed inoculation and nodulation*

The principles for successful nodulation of legumes have been summarised by Cloonan (1964). Factors responsible for the poor nodulation of *Glycine wightii*, including soil temperature effects, seed coatings and soil amendments, have been studied (Philpotts 1972, 1973). The results confirmed the frequent occurrence of poor or slow nodulation in glycine which is not evident with other tropical legumes.

(*d*) *Maintenance fertilizers*

Grazing experiments in the Clarence Valley on shale derived soils have investigated the maintenance fertilizer requirements of a naturalised white clover pasture which had previously received 1500 kg ha^{-1} superphosphate (Havilah, O'Brien and Cohen pers. comm.). An application rate of 250 kg ha^{-1} of superphosphate was needed to maintain soil phosphate at the optimum level for pastures carrying 2.5 steers ha^{-1}. In practical terms, on pastures with a history of above optimum superphosphate use, it is possible to forego maintenance dressings in one or two years without affecting animal production. With much lower initial dressings it is likely that animal production would decline if adequate maintenance dressings were not applied. Also, at higher levels of animal production larger maintenance rates could be expected.

The continued productivity of pastures will also depend on the correction of other mineral deficiencies which may become apparent following development. Responses to additions of potassium on grazed pastures have been observed and the post-establishment requirements of molybdenum are being investigated (Havilah pers. comm.).

(*e*) *Nitrogen fertilizer*

Responses to nitrogen fertilizer by tropical grasses have been defined in terms of rate and time of application for both northern and southern areas of the region (Colman 1970, Kemp 1973). Significant changes in botanical composition have also resulted from nitrogen fertilizer application (Mears 1973; Martin pers. comm.). Of particular importance is the response to nitrogen fertilizer in spring and autumn for provision of out-of-season feed and as a reliable source of nitrogen in areas where legumes are non-persistent. In higher rainfall areas, intensive animal production can be supported on grass dominant pastures fertilized with nitrogen throughout the growing season (Mears 1973; Colman and Kaiser 1974).

On dairy farms nitrogen fertilizer is used for provision of early spring feed from tropical grasses or for the stimulation of growth in late summer and autumn for carry-over into winter. Limited areas have been fertilized year round for intensive beef production. It is possible that use of nitrogen fertilizer for pastures will decline in the future because of large increases in price relative to product prices. This emphasises the need to find stable, productive legumes.

ANIMAL UTILIZATION

The beef and dairy industries are almost entirely based on naturalised or native grass. Pasture improvement has ranged from the introduction of legumes to the complete replacement of existing vegetation with legumes and grasses. These pastures have been evaluated at Wollongbar and Grafton to determine their nutritive value, potential for animal production and the need for feed supplements.

Nutritive value studies

Results of pen feeding trials have shown:—

(a) Limitation of nitrogen content and digestible dry matter in carpet grass and native grasses (Jeffrey and Holder 1971; Hennessy, Dettmann and Williamson 1973; Cohen 1974).

(b) Low nutritive value of tropical species compared with temperate species (Jeffery and Holder 1971).

(c) The higher crude protein and dry matter digestibility of kikuyu pasture relative to other local grasses (Jeffery and Holder 1971).

Seasonal changes in nitrogen, phosphorus, potassium and calcium contents, Ca:P and K:Ca + Mg ratios (Colman and Kaiser 1974; Mears and Humphreys 1974) and sodium (Mears 1973) have been measured for fertilized kikuyu pastures. N, K and Mg appear to be adequate for most forms of animal production, although Royal (pers. comm.) has estimated that levels of sodium, calcium and phosphorus may only meet 20, 70 and 80% of an average dairy cow's requirements for maintenance and production. Similarly Kaiser (pers. comm.) has suggested that sodium and calcium may also be limiting post-weaning growth rates of dairy beef calves.

Phosphorus content of unfertilized carpet grass in the Clarence Region varied from 0.043 to 0.107% (Cohen 1972) and native grasses from 0.06 to 0.130%

(Garden pers. comm.). Following superphosphate application, phosphorus concentration ranged from 0.16-0.30% (Havilah, O'Brien and Cohen pers. comm.; Garden pers. comm.).

Response to supplementary feed

Protein and energy supplements gave a positive response on both unfertilized carpet/native grass pastures (Sparke and Lamond 1968; Hennessy, Dettmann and Williamson 1973; Cohen 1974) and on fertilized kikuyu pastures (Jeffery *et al.* 1970; Jeffery and Buesnel 1972; Royal and Jeffery 1972; Colman and Kaiser 1974; Royal 1974) when fed to either beef or dairy cattle. Efforts to partition the response between nitrogen and energy have given conflicting results. Hennessy, Dettmann and Williamson (1973) obtained responses to urea and molasses in pens, whereas Cohen (1974) reported a response to molasses only. Thus, responses to urea-molasses supplements vary between pastures and field studies need to be conducted to verify pen experiments. Selection of green material by grazing animals can probably provide adequate nitrogen for maintenance except for a short period in winter. For growing, reproducing and lactating animals the period of sub-optimal nitrogen content of pasture may be much longer (Cohen 1972; Cohen and O'Brien 1974). It is likely that digestible energy intake is deficient throughout the year, irrespective of pasture type.

Responses to mineral supplements including phosphorus, are equally variable. On the extremely low quality carpet grass pastures of the Clarence, Cohen (1972) showed that liveweight performance of steers or breeding cows and calves was unaffected by phosphorus supplements, although bone phosphorus was linearly related to P content in the diet (Cohen 1973). On kikuyu and paspalum pastures, responses have been obtained to feeding mixtures of bone flour, tricalcium phosphate and sodium chloride (Kaiser unpubl. data; Royal 1974) but the contribution of individual elements has not been determined.

Animal production

Increased production per animal and per unit area have been measured following pasture improvement (Table 1). Application of superphosphate and the introduction of temperate legumes into naturalised pastures has resulted in increased production per animal and per hectare and improved fertility of beef cows. Grazing of tropical pastures resulted in substantial increases in production per unit area, compared with native and naturalised pastures, but clearly indicated their limitations in terms of production per animal compared to temperate pastures or concentrates.

Nitrogen fertilizer application to tropical grasses increased production of beef and butterfat per hectare at least three-fold compared with naturalised pastures. Production per animal at similar stocking rates was higher on nitrogen fertilized pastures compared to pastures receiving only superphosphate.

The major limitation of tropical pastures improved with legumes or fertilized with nitrogen, appears to be the low intake of digestible nutrients (particularly energy). It is likely that fundamental advances in understanding the processes governing intake and digestibility of pasture need to be made to determine the importance of physical characteristics (Stobbs 1973), cell wall constituents (Minson 1971) and mineral composition (Minson 1973; Rees, Minson and Smith 1974).

PROBLEMS, FUTURE RESEARCH AND DEVELOPMENT

Pasture research programmes in the North Coast Region of N.S.W. have provided sufficient basic information to enable the efficient development of pasture systems for both dairy and beef cattle. There are, however, many problems requiring further research:—

(a) Low nutritive value of tropical grasses.
(b) Poor persistence of legumes.

TABLE 1

Beef and dairy production from pastures in Northern New South Wales

Class of animal, locality and reference	Pasture and Stocking Rate		Animal Performance	
(a) GRAFTON		(animals ha^{-1})	liveweight gain kg $hd^{-1}day^{-1}$	kg ha^{-1}
Hereford heifers and calves birth to weaning (Cohen & O'Brien 1974)	Natural grass	0.5	0.65 (calves)	—
	oversown clover/super	1.1	0.80 (calves)	—
Hereford heifers (Garden pers. comm.)	Native (N)	0.82	0.12	39
	N+Super (S)	0.82	0.18	58
	N+S+Clover (W)	0.82	0.28	91
	N+S+W+ Lotononis (L)	0.82	0.45	146
Hereford Steers (Havilah pers. comm.)	Natural grass +white clover +super	1.6	0.32	187
Hereford heifers (O'Brien pers. comm.)	Natural grass (N)	1.1	0.11	45
	N+Clover (W)	1.6	0.21	124
	N+W+ Lespedeza (L) with super	1.6	0.31	181
(b) WOLLONGBAR Angus steers (Mears & Humphreys 1974)	Kikuyu, Nat. clover+ super	3.3	0.38	452
	+134 kg N/ha	4.9	0.33	607
	+336 kg N/ha	7.4	0.37	1006
	+672 kg N/ha	11.1	0.31	1266
Dairy beef cows and calves, birth to 28 weeks (Kaiser 1974)	Mixed grass+N 2 calves/cow	1.00 cows	0.75	410
		1.75 cows	0.73	697
		2.50 cows	0.62	845
		3.25 cows	0.59	1014
Dairy beef calves (Kaiser 1974)	Kikuyu+N	4.9	0.57	—
		9.9	0.51	—
		14.8	0.46	—
			butterfat kg $hd^{-1}year^{-1}$	kg ha^{-1}
Dairy cows (Holder 1967)	Carpet grass, Paspalum, kikuyu	1.03	98	92
Dairy cows (Holder, Swain and Colman 1963)	Naturalised pasture +20% *Vicia sativa*	1.03	122	125
Dairy cows (Colman, Holder & Swain 1966)	Natural pasture supplemented with 16% *Glycine*, 20% *vetch*, 20% sub-clover	1.45	100	144
Dairy cows (Colman 1970)	kikuyu/glycine +56 kg N/ha	1.79	118	212
Dairy cows (Jeffery *et. al.* 1970)	kikuyu/glycine	1.85	85	156
Dairy cows (Colman & Kaiser 1974)	kikuyu	2.47	98	241
	+336 kg N/ha	4.94	82	405
Dairy cows (Dale & Holder 1968)	Lucerne Hay +concentrates	pen fed	18.1 kg F.C.M. day^{-1}	
	kikuyu/glycine	*ad lib*	8.2 kg F.C.M .day^{-1}	

(c) Suitable methods of establishment.
(d) Efficient use of fertilizer.
(e) Pasture management.
(f) Supplements for grazing animals.

In addition there are more specific problems related to the integration of native and improved pastures, undesirable botanical changes, insects and plant diseases and the adoption of technology by farmers.

In summary, it is suggested that future research should be directed in three ways:—

(i) Continued biological research with the objective of providing better pasture species, improved establishment methods, more efficient fertilizer use and appropriate utilization strategies to meet current and expected production demands.

(ii) The long term, low cost development of natural vegetation and its utilization in association with conventional improved pasture.

(iii) The quantitative evaluation of technology leading to the development of models which synthesise the wide range of "on-farm" situations and provide the basis for improved decision making and increased levels of adoption.

The achievement of such research goals will be enhanced by improved liaison between research organisations and a strengthening of producer/research worker/extension worker contacts.

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