PERSISTENCE AND PRODUCTIVITY OF PASTURE SPECIES AT THREE LOCALITIES IN SUBCOASTAL SOUTH EAST QUEENSLAND

R. M. Jones* and M. C. Rees*

ABSTRACT

A range of temperate and tropical pasture species was evaluated under common grazing at three localities in the 25-35 in. rainfall zone of subcoastal south-eastern Queensland. There appears to be no place for temperate perennial grass in dryland pastures. Lucerne was a productive legume, persisting from three to six years. Annual medics were very productive in years with adequate cool season rainfall and regenerated well from seed. A range of tropical perennial grasses was successful, green panic and buffel grasses in particular. Some tropical legumes, notably siratro, persisted well with good production in years with favourable rainfall.

INTRODUCTION

The dairy industry in the eastern Darling Downs, West Moreton and South Burnett of Queensland is largely based on summer and winter forage crops (Round 1953, Rawson 1967). In order to assess the persistence and productivity of pasture species, with particular reference to the dairy industry, species evaluation trials were conducted at three localities in this 25-35 inch rainfall zone from 1965 to 1971. In this paper the results of species testing at each locality will be considered separately and a final section will discuss important species in relation to the region as a whole.

METHODS COMMON TO ALL SITES

The species sown are listed in Table 1. All were sown by hand. A randomized block design was used, usually with two or three replications and with plots 350 sq ft in area. Legume seed was inoculated with appropriate rhiziobium and lime pelleted and grasses received nitrogen fertilizer. Green panic (*Panicum maximum* var *trichoglume* cv. Petrie) was used as a companion grass with tropical legumes and a *Phalaris* hybrid (*P. tuberosa* × *P. arundinacea*) with temperate legumes.

TABLE 1

Suitability of species evaluated at each of the trial sites

(+ = poor, ++ = fair, +++ = good, — = not sown. Note that +++ does not imply that any species is the best at that site, but that it has been both persistent and reasonably productive over three or more years)

Species and Cultivar†	Pittsworth Black Earth	Pittsworth Neutral Krasnozem	Boonah Prairie	Nanango Solodic
TEMPERATE LEGUMES				
Lotus corniculatus (Empire)	+	—	—	+
L. corniculatus (Viking)	+	—	—	+
L. maroccanus (23601)	++	++	+	++
Medicago aculeata (line 6)	+++	—	++	—

(*Continued on page* 120)

*Division of Tropical Pastures, C.S.I.R.O., Cunningham Laboratory, St. Lucia, Brisbane, Queensland, 4067.

(† Names in brackets indicate cultivar and/or accepted common names. Numbers such as 23601 are C.S.I.R.O. Plant Introduction Numbers. CQ indicates a number given by C.S.I.R.O. in Queensland).

TABLE 1—*Continued*

TEMPERATE LEGUMES—*Continued*

M. littoralis (Harbinger)	+++	+++	+++	+++
M. lupulina (Black)	+	—	+	+
M. orbicularis (14530)	+++	—	+++	—
M. polymorpha (line 10)	++	—	++	—
M. polymorpha (line 11)	+++	—	—	—
M. rigidula (line 4)	++	—	—	—
M. rugosa (Paragosa)	++	—	+	—
M. scutellata (Snail)	+++	+++	+++	++
M. scutellata (12535)	+++	—	++	—
M. sativa (African)	—	—	+++	+++
M. sativa (Barker)	—	—	++	++
M. sativa (Canberra Hay)	—	—	++	++
M. sativa (Glebe)	—	—	++	++
M. sativa (Dry Area)	—	—	++	—
M. sativa (Du Puits)	—	—	++	++
M. sativa (Hairy Peruvian)	—	—	+++	+++
M. sativa (Hunter R.)	+++	+++	+++	+++
M. sativa (Rhizoma)	—	—	++	—
M. truncatula (Cyprus)	+++	+++	+++	+++
M. truncatula (Hannaford)	+++	+++	+++	+++
M. truncatula (Jemalong)	+++	+++	+++	+++
Trifolium alexandrinum (Berseem)	+	—	—	—
T. burchellianum (24132)	+	—	+	+
T. cherleri (Bennong)	+	—	—	—
T. cherleri (Yamina)	+	—	—	—
T. cherleri (14549)	+	—	—	+
T. clypeatum (14925)	+	—	—	—
T. desvauxii (13816)	+	—	—	—
T. formosum (14936)	+	—	—	—
T. fragiferum (Palestine)	+	—	—	—
T. fragiferum (Strawberry)	+	—	—	—
T globosum (S-17)	+	—	—	+
T. hirtum (Hykon)	++	—	—	—
T. hirtum (Kondinin)	++	—	++	++
T. hirtum (Sirint)	++	—	—	—
T. hirtum (Troodes)	++	—	—	—
T. incarnatum (Dixie)	+	—	—	+
T. nigrescens (29116)	+	—	—	—
T. pauciflorum	+	—	—	+
T. pilulare (29414)	++	—	—	—
T. pratense (Montgomery)	+	—	+	+
T. pratense (N.Z. Red)	+	—	—	—
T. repens (8 lines)	+	+	+	+
T. ruepellianum (20744)	+	—	+	+
T. semipilosum (27218)	++	++	++	+
T. semipilosum (40617)	+	—	+	—
T. stellulatum (14929)	+	—	—	—
T. subterraneum (Bac. Marsh)	++	—	++	+
T. subterraneum (Clare)	++	—	+++	—
T. subterraneum (Dinninup)	—	—	+++	—
T. subterraneum (Geraldton)	—	—	++	—
T. subterraneum (Howard)	—	—	++	—
T. subterraneum (Mt. Barker)	—	—	++	—
T. subterraneum (Tallarook)	—	—	++	—
T. subterraneum (Woogenellup)	—	—	++	—
T. subterraneum (Yarloop)	—	—	++	—
T. velvivolum (14934)	+	—	—	—
T. vesiculosum (31883)	+	—	—	+
T. vesiculosum (31884)	+	—	—	+
Vicia atropurpurea (XN-1)	++	—	—	—
V. dasycarpa (Downs local strain)	++	—	—	—
V. dasycarpa (15095)	++	—	—	—

(*Continued on page* 121)

TABLE 1—*Continued*

TEMPERATE GRASSES				
Bromus unioloides (Priebe)	+++	++	++	++
Dactylis glomerata (Brignoles)	+	—	+	+
D. glomerata (Currie)	++	++	++	+
D. glomerata (Grasslands)	+	—	++	+
D. glomerata (GL 31)	+	—	—	+
D. glomerata (GL 32)	+	—	—	+
D. glomerata (GL 33)	++	—	—	+
D. glomerata (GL 34)	+	—	—	+
D. glomerata (GL 35)	+	—	—	+
D. glomerata (Potomac)	—	—	+	—
D. glomerata (23717)	+	—	—	+
D. glomerata (31869)	+	—	—	+
Eharta calycina (Veldt)	+	++	+	++
Festuca arundinacea (Demeter)	+	+	+	+
F. arundinacea (Kentucky)	+	—	+	+
F. arundinacea (18948)	+	—	—	++
Lolium perenne (Kangaroo Valley)	++	—	++	++
L. perenne (Victorian)	++	—	++	+
L. multiflorum (Florida)	++	—	—	+
L. multiflorum (Italian)	++	—	—	+
L. rigidum (Wimmera)	++	+	++	++
L. sp. (Short rotation)	—	—	++	—
Oryzopsis mileacea (2527)	+	—	—	—
Phalaris arundinacea (Commercial)	+	—	—	+
P. arundinacea (10446)	+	—	—	++
P. tuberosa × *arund.* (Allopolyploid)	++	—	+	++
P. tuberosa × *arund.* (1D Hybrid)	++	++	++	++
P. tuberosa × *arund.* (Siro 1146)	++	—	++	—
P. tuberosa (Aust. comm.)	++	—	+	++
P. tuberosa (GB-81)	++	—	—	+
P. tuberosa (Sirocco)	++	—	—	—
TROPICAL LEGUMES				
Aeschynomene falcata (11500)	+	—	—	++
Alysicarpus vaginalis (CQ 512)	+	—	—	+
Arachis prostrata (12121)	—	—	—	+
Cassia rotundifolia (16358)	+	—	—	+
Clitoria ternatia (CQ 389)	+	—	—	+
Desmodium intortum (Greenleaf)	+	—	+	+
D. sandwicense (11740)	—	—	—	+
D. uncinatum (Silverleaf)	+	—	+	+
Dolichos axilaris (17814, 25361)	+	—	+	+
D. africanum (24972)	+	—	—	+
D. biflorus (14629)	+	—	+	+
D. lab lab (Rongai—as an annual)	+++	—	++	++
Glycine wightii (Cooper)	+	+	+++	++
G. wightii (Clarence)	+	—	+	+
G. wightii (Tinaroo)	—	—	+	+
Lotononis angolensis (26293)	+	—	++	++
L. bainesii (Miles)	++	—	++	+++
Phaseolus atropurpureus (Siratro)	++	++	+++	+++
P. bracteatus (27404)	++	++	—	++
P. lathyroides (Murray)	++	—	—	++
P. lathyroides (CQ 520)	—	—	—	++
Stylosanthes guyanensis (11493)	+	++	—	+++
S. humilis (Patterson)	+	+	—	+
Teramnus uncinatus (25937)	+	+	+	+
TROPICAL GRASSES				
Brachiaria brizantha (15890)	+	—	++	—
Cenchrus ciliaris (Biloela)	+++	—	+++	+++
C. ciliaris (Gayndah)	+++	++	++	—
C. ciliaris (Molopo)	+++	++	+++	+++

(*Continued on page* 122)

TABLE 1—*Continued*

TROPICAL GRASSES—*Continued*				
C. ciliaris (Nunbank)	—	—	+++	—
C. ciliaris (Tarewinnabar)	—	—	+++	++
Chloris disticophylla (26785)	++	++	+	—
C. gayana (Callide)	—	—	+++	++
C. gayana (Pioneer)	++	++	+++	+++
C. gayana (17757)	—	—	+++	—
C. gayana (24508)	—	—	+++	—
C. gayana (Samford)	—	—	—	++
Digitaria decumbens (Pangola)	++	—	++	—
D. pentzii (7920)	—	++	++	++
D. smutsii (38869)	—	—	+++	—
D. sp. (16267)	—	+	++	+++
Eragrostis curvula (14369)	+++	—	—	+++
Paspalum dilatatum (Commercial)	+	—	++	—
P. guenoarum (20324)	+	—	++	—
P. notatum (11863)	+	—	—	—
P. notatum (9073)	+	—	++	—
P. plicatulum (Hartley)	+	—	+	—
P. plicatulum (Rodds Bay)	+	—	+	—
Pennisetum clandestinum (Kikuyu)	+++	—	+	—
Panicum coloratum var. *makarikariense* (Burnett)	+++	+	++	+
P. coloratum var. *makarikariense* (Pollock)	+++	+	++	+
P. coloratum var. *makarikariense* (Bambatsi)	+++	+	—	+
P. coloratum (14375—Kabulabula)	+	+	+++	++
P. coloratum (16796—Kabulabula)	+	—	+++	—
P. maximum (Green panic)	+++	+++	+++	+++
P. maximum (Sabi & Gatton)	—	—	—	+++
Setaria sphacelata (Kazungula)	++	—	+	++
S. sphacelata (Nandi)	+	—	+	+
S. sphacelata (32848)	—	—	+	+
S. sphacelata (32930)	+	—	+	+
S. sphacelata (33453)	++	—	+	+
Urochloa bolbodes (16734)	+	++	+	—
U. mosambicensis (6559)	++	—	—	—

Details of sowing dates, fertilizer applications and grazing frequency are listed in Table 2. Rainfall data (Table 3) show that both wet and dry summers and winters were experienced at each locality.

Yield was usually measured once a year from either two 10 sq ft or five 4.5 sq ft quadrats per plot. Each species was harvested during its growing season.

EASTERN DARLING DOWNS

Soils of the eastern Downs can be conveniently grouped as deep arable black earths, shallow black earths which are arable but erosion susceptible, and non-arable soils. Pasture studies were concentrated on sites near Pittsworth representing the latter two groups, a Beauaraba shallow black earth and Southbrook neutral krasnozem respectively (Thompson and Beckmann 1959). Some sowings were made on a deep Irving black earth for comparative purposes.

Severe cracking in dry periods, a high wilting point (28%) and seedling establishment problems (Leslie 1965) are limitations to the use of black earths for pastures. The neutral krasnozem has a wilting point of 16% and does not crack. The problems associated with pasture establishment on this non-arable soil have been considered separately (Jones 1972).

TABLE 2

Details of methods at experimental sites

Locality	Soil	Dates of sowing (month/year) temperate legumes	temperate grasses	tropical legumes	tropical grasses	Nitrogen on grass lb/ac/annum	Other Fertilizer Establishment /acre/annum	Maintenance /acre/annum	Grazings per year
Pittsworth	neutral krasnozem	5/66	5/66	1/67	1/67, 2/68	nil/50*	20 lb S equiv.ϕ	20 lb S equiv.	6
Pittsworth	shallow black earth	5/66, 5/68	5/66, 5/68	1/67	2/67, 2/68	200	20 lb S equiv.ϕ	20 lb S equiv.	4
Pittsworth	deep black earth	5/66	5/66	1/67	2/67	200	20 lb S equiv.ϕ	20 lb S equiv.	4
Boonah	prairie	5/67, 4/68	5/67	2/68	2/68	150	5 cwt Mo super†	1 cwt super	4
Nanango	solodic	5/65, 7/68	5/65	2/66	1/66	200	4 cwt Mo super†	(2 cwt super) (0-5 cwt KCl)	6

(* summer grasses sown with lucerne/annual medic, winter grasses given 50 lb N/ac/annum; ϕ based on Jones (1970); † based on unpublished trials).

TABLE 3

Seasonal Rainfall and minimum terrestrial temperature for Experimental Sites (1965-1971) in inches

Site	Winter Rainfall (April-September)							Summer Rainfall (October-March)							Lowest terrestrial minimum
	Average	1965	1966	1967	1968	1969	1970	Average	65/66	66/67	67/68	68/69	69/70	70/71	
Pittsworth	9	—	9.7	9.4	11.2	8.0	5.6	17	—	19.8	12.2	16.8	14.7	27.9	14°F
Boonah	10	—	—	15.9	13.4	8.6	5.1	22	—	—	16.4	9.9	17.7	41.8	—
Nanango	10	12.8	12.0	10.7	7.5	8.4	5.2	20	23.0	26.5	19.9	11.9	23.5	36.4	16°F

RESULTS

(i) *Temperate Legumes*

Establishment was good, barrel medic (*Medicago truncatula*), for example, averaging 65% emergence of viable seed. Barrel medics, harbinger medic (*M. littoralis*) and snail medic (*M. scutellata*) regenerated and produced well. These medics spread with plot edges extending at the rate of 9-12 in. a year. Plots without sown medic were gradually invaded by naturalised burr medic (*M. polymorpha*) and woolly burr medic (*M. minima*). The yield of burr medic was approximately equal to that of barrel medic while the yield of woolly burr medic was about two-thirds that of barrel medic.

Results from the deep and shallow black earth (Table 4) show that vigorous medic growth depressed Phalaris hybrid yield and, unlike the grass yield, medic yield was less on the deep soils. There were no interactions between soil type and yields of medic species.

TABLE 4

Yield of 6 legumes and associated Phalaris *hybrid on two black earths at Pittsworth: sown 1966, growth period 21.v.68 to 23.viii.68*

Legume Species	Legume Yield (lb dry matter/acre)		Grass Yield (lb dry matter/acre)	
	Shallow black earth	Deep black earth	Shallow black earth	Deep black earth
Jemalong barrel medic	1654	1069	73	130
Cyprus barrel medic	1744	942	118	144
Snail medic	932	562	213	330
Ladino white clover	0	2	334	841
Lousiana white clover	0	0	399	805
Black medic	0	0	683	658

(Difference between soils $P < 0.01$ for both grass and legumes; difference between species $P < 0.001$ for both legumes and grasses; Yields connected by a line are not significantly different.)

Lucerne in swards persisted satisfactorily for five years on the black earth although density decreased with accompanying weed ingress.

(ii) *Temperate Grasses*

The larger seeded temperate grasses averaged 25-70% emergence of viable seed whereas the smaller seeded cocksfoots (*Dactylis glomerata*) averaged 12% emergence.

Rye grasses (*Lolium* spp.) and *Phalaris* hybrid were the highest yielding grasses in the first season, but the latter gave the highest yields in the third and fourth years. *Phalaris* hybrid persisted much better when sown with annual medics than with lucerne (Table 5). The cool season yields of *Phalaris* hybrid fertilised with nitrogen were approximately equal to that of Jemalong barrel medic (Table 6), but the phalaris persists for only three to five years.

Prairie grass (*Bromus unioloides*) and Wimmera rye grass (*Lolium rigidum*) were the only annual species sown. Both produced over 3,500 lb dry matter/acre in four months after sowing. During the fourth winter Wimmera rye grass failed to regenerate and prairie grass was then the highest yielding of all winter grasses.

(iii) *Tropical Legumes*

The establishment percentage of viable seed ranged from 47 to 59% for Phasey bean, Cooper and Clarence glycine (*Glycine wightii*) and siratro (*Phaseolus atro-*

TABLE 5

Density of Phalaris tuberosa × arundinacea *hybrid sown with six temperate legumes on a shallow black earth at Pittsworth*

Associated Legume	Density of Phalaris (plants/sq ft) months after sowing 9	34
Lucerne (Hunter River)	5.58	0.01
Barrel medic (Jemalong)	4.39	0.54
Medicago orbicularis	4.61	0.56
Trifolium semipilosum	6.95	0.68
T. subterraneum (Clare)	4.48	0.77
Medicago rugosa	7.94	0.81
L.S.D. at $P < 0.01$	1.37	0.14

TABLE 6

Average yield of Phalaris *hybrid fertilized with nitrogen and of Jemalong barrel medic on five soils*

Locality	Soil	No. years in comparison	Average winter/spring *Phalaris* yield (lb/ac)	Average annual medic yield (lb/ac)
Pittsworth	neutral krasnozem	4	720	1100
Pittsworth	shallow black earth	5	1450	1900
Pittsworth	deep black earth	3	1480	1040
Boonah	prairie	3	900	1635
Nanango	solodic	6	827	782

purpureus), to 6% for lucerne and was negligible for *Lotononis bainesii*. A poorer establishment of lucerne than of Siratro has been measured on each of the three occasions when both were sown in summer.

Three annuals, Phasey bean (*Phaseolus lathyroides*), *Dolichos lablab* and *Dolichos biflorus* gave the highest yields in the establishment year when nine of the twelve tropical species yielded more than lucerne. In the second summer Phasey bean was the only annual to regenerate and the four highest yielding perennials were, in order, *Phaseolus bracteatus*, lucerne, Siratro and Cooper glycine. In the third summer lucerne yielded 1840 lb/ac and the next best species, *P. bracteatus*, 320 lb/ac. By the fourth summer there were only very isolated plants of Siratro and *Lotononis bainesii* remaining but lucerne was still a productive stand although lucerne persistence was poor thereafter. However Siratro and fine stem stylo (*Stylosanthes guyanensis*) have persisted for over five years on the neutral krasnozem, but their yields have usually been low.

(iv) *Tropical Grasses*

Twenty-seven tropical grass cultivars sown on the shallow black earth in 1967 averaged 19% emergence of viable seed and 10 cultivars sown in 1968 averaged 7% emergence of viable seed. Despite the fact that tropical grass sowings were irrigated to assist emergence, seedling emergence of viable tropical grass seed was less than for temperate grasses. Two sowings were insufficient to allow selection of species for seedling emergence, e.g. *Panicum coloratum* (Kabulabula) had emergence percentages of 42% and 2% in the first and second sowings respectively whereas green panic gave 13% in the first sowing and 26% in the second. There was also considerable death of young plants due to frosting in the first winter after sowing (Jones, 1969).

Green panic (*Panicum maximum* var. *trichoglume*) was the outstanding grass on the neutral krasnozem especially when grown with lucerne and medic. The density of green panic increased with time, the death of some plants during winter being more than compensated for by re-establishment from seed. It was repeatedly noted that green panic on the krasnozem responded well to isolated summer rainfalls of approximately one inch which had little effect on the black earth. In this region soils such as the stony neutral krasnozem are generally regarded as 'poor' soils when contrasted with deep black earths, although this extrapolation from suitability for crop to suitability for pasture can be quite misleading.

There was no clear cut superiority of any particular tropical grass in the shallow black earth. The yields of four selected grass cultivars (Table 7), illustrate that there was marked variability in yield from year to year due to rainfall variability. Buffel grass was a persistent and consistently productive species. All makarikari panic cultivars were slow growing in the establishment year but were productive in the second and third years, although they markedly decreased in vigour and density in the fourth summer. Transplanted kikuyu (*Pennisetum clandestinum*) gradually thickened up and yields improved with time.

TABLE 7

Yields and yield ranking of six out of twenty-six tropical grasses established in February 1967, on a shallow black earth, Pittsworth

Cultivar	Yields (lb dry matter/acre) Growth Period				
	28.ii.67-10.v.67	24.i.68-10.iv.68	10.xi.68-21.i.69	28.xi.69-6.iv.70	31.i.71-24.iii.71
Kikuyu (planted 9/67)	—	156 (16)	1877 (8)	268 (6)	2066 (1)
Gayndah buffel	149 (7)	344 (8)	2335 (3)	772 (1)	1433 (2)
Biloela buffel	330 (1)	585 (3)	2135 (5)	387 (3)	866 (3)
Pioneer rhodes	220 (2)	802 (1)	4506 (1)	609 (2)	275 (5)
Makarikari panic	39 (16)	778 (2)	3673 (2)	222 (8)	117 (7)

The 1967 sown summer grass trial fertilized with nitrogen became increasingly dominated by two annual grasses; summer growing *Urochloa panicoides* and winter growing prairie grass. Both grasses have yielded over 2,000 lb/ac in some growth periods and have reduced spring and early summer growth of perennial grasses. Kikuyu and buffel grass were least affected but makarikari panic was very severely retarded.

TABLE 8

Yields at two sampling dates of a lucerne/grass mixture and of sward lucerne sown January, 1967 on a shallow black earth, Pittsworth

Species	Yields (lbs dry matter/acre) 20.i.69		18.iii.71	
	Lucerne/Grass	Lucerne sward	Lucerne/Grass	Lucerne sward
Lucerne	1236	1842	246	645
Green panic	386	—	1020	—
Makarikari	770	—	660	—
Weed	(T)	(T)	256	1250
Total	2392	1842	2182	1773

(T = Trace of weed)

In 1967 a headland of 0.04 ac on the shallow black earth was sown to a mixture of lucerne, green panic, makarikari panic and *Panicum coloratum* (Kabulabula). The Kabulabula panic died out but the other species persisted well (Table 8). The lucerne/grass mixture was very stable and four years after sowing contained only 12% weed. Table 8 also lists yields from adjacent sward lucerne plots which had twice the lucerne density of the mixed pasture.

II. WEST MORETON SITE

The experimental site nine miles north of Boonah, originally under silverleaf ironbark (*Eucalyptus melanophloia*), is representative of a major soil type classified by Paton (in press) as Churchbank subgroup. This soil/vegetation association is currently little used for cropping. The prairie like soil is derived from basic igneous rock, and on the trial site has a depth of 20-24 in.

RESULTS

(i) *Temperate legumes*

Lucerne cultivars, which were harvested whenever growth occurred in the first three years, produced less total annual dry matter than some annual species in winter/spring. However the production of lucerne was limited by below average summer rainfall. Lucerne gradually died out during the dry summers and was nearly eliminated in the very wet 1970/71 summer. If cropping is extended to this soil type, lucerne should be an effective short term ley. Kenya white clover (*Trifolium semipilosum*) died out in the drought of 1968/69, but has subsequently established readily from seed previously produced.

Jemalong and Cyprus barrel medics, Harbinger medic and snail medic yielded over 1,500 lb dry matter/ac in 1967, 1968 and 1969. In a later sowing, Jemalong and Hannaford barrel medics and Clare and Dinninup subclovers (*Trifolium subterraneum*) produced similar yields in 1968 and over 3,000 lb dry matter/ac in 1969. All failed when winter rainfall was very poor.

High dry matter yields in the year of sowing, of above 3,000 lb/ac, were also recorded from rose clover and *M. polymorpha* but these species were not as productive after the first year though swards re-established.

All medics set seed in spring 1969 but not in the dry 1970 spring. Despite this and the exceptionally wet 1970/71 summer, there was good medic regeneration in July 1971 with the density of barrel medics ranging from 9 to 74 seedlings/sq ft. Three subclover cultivars, Geraldton, Clare and Dinninup had from 15 to 29 seedlings/sq ft whereas the remaining subclover cultivars (Table 1) had less than 2 seedlings/sq ft.

(ii) *Temperate grasses*

All cultivars established readily in May 1967. In the following spring rye grasses and prairie grass yielded over 3,000 lb dry matter/ac and Currie cocksfoot, Grasslands cocksfoot and *Phalaris* hybrid yielded over 2,000 lb dry matter/ac. By the second spring only *Phalaris* hybrid, yielding 650 lb dry matter/ac, warranted sampling. No perennial species survived into the third winter, though prairie grass regenerated from seed.

(iii) *Tropical perennial legumes*

In the dry summers that prevailed in the first three years of the tropical species trial, all tropical legumes sown were unproductive but lucerne cultivars included in this trial produced up to 2,500 lb dry matter/ac per year. However in the wet 1970/71 summer almost all lucerne plants died but Siratro and Cooper glycine gave good yields. Table 9 shows the contrasting trends in productivity and persistence of these two tropical legumes and of three lucerne cultivars.

TABLE 9

Dry matter yields and sward density of lucerne and the most productive tropical legumes at Boonah, sown February, 1968

(a) Dry matter yield

Species	lb dry matter per acre harvested on dates					
	6.ix.68	8.i.69	16.vii.69	12.xi.69	13.xi.70	19.iii.71
Lucerne						
Hunter River	1040	290	1050	1590	1040	T
Hairy Peruvian	1530	860	1380	1430	670	T
African	1570	710	1220	1190	470	T
Siratro	T	T	T	T	T	1930
Cooper glycine	T	T	T	T	T	2010

(T = negligible yield)

(b) Plant density

Species	Plants per sq ft				
	Seedlings 10 weeks after sowing	ix.68	vi.69	ix.70	v.71
Lucerne					
Hunter River	14.6	2.5	1.8	1.4	0.05
Hairy Peruvian	9.7	2.3	2.0	0.9	0.09
African	7.9	1.6	1.4	0.7	0.05
Siratro	0.14	N.M.	N.M.	N.M.	0.09
Cooper glycine	0.09	N.M.	N.M.	N.M.	0.05

(N.M. = Not measured)

(iv) *Tropical grasses*

Some dry matter yields of the most productive grasses are summarised in Table 10. High summer yields were produced by a number of species, particularly green panic, rhodes grass, buffel grass and the Kabulabula strain of *P. coloratum*. Green panic also showed early spring and late autumn vigour when soil moisture permitted and therefore appeared the most suitable grass. It persisted well when some plants of Callide and C.P.I. 17757 rhodes grass, *P. coloratum* (Kabulabula) and all plants of *Setaria sphacelata* died during the 1968/69 summer drought. *Digitaria smutsii* C.P.I. 38869 showed high yielding ability after a very slow establishment.

III. SOUTH BURNETT SITE

Small plot screening trials were sown at Nanango, in the South Burnett region, from 1965 to 1968. Until clearing in 1964, the trial site was woodland, dominated by narrow leaf ironbark, (*Eucalyptus crebra*). The soil is a solodic-type derived from granodiorite with six inches of pale grey loamy sand topsoil with a pH of 5.5-6.0 in a 1 : 5 suspension in water, over a brown sandy clay subsoil. Most of this soil/vegetation type is uncleared or only partly cleared and is not used for cropping.

TABLE 10

The dry matter yields of the most productive tropical grass species sown at Boonah

Species		lb dry matter per acre harvested on dates			
		7.vi.68	8.i.69	14.iv.70	10.v.71
Green Panic		1300	1920	3800	2230*
Buffel grass —	Tarewinnabar	1280	900	3550	3620
	Nunbank	1210	1170	3420	2990
	Molopo	1080	690	2360	4040
	Biloela	1460	1080	2940	4380
	Gayndah	T	T	1920	2590
Rhodes grass —	Pioneer	1970	1960	1010	2200
	CPI24508	1100	2030	1500	1790
	CPI17757	2320	1380	1800	3200
	Callide	2160	1500	2400	2180
Pangola		T	740	1240	2820
Setaria-Kazungula		960	1070	T	T
	CPI33453	820	1380	T	T
	CPI32848	690	1460	T	T
	CPI32930	860	T	T	T
Paspalum dilatatum—commercial		T	670	T	T
Panicum coloratum —	CPI14375	480	1070	3480	5100
	CPI16796	1680	1860	2900	7200
Digitaria spp —	CPI38869	T	1450	3540	3430
	CPI16267	T	T	2800	2540
L.S.D. 5%		696	641	1337	1759
1%		959	890	1853	2443

(* Green panic growth appeared to be retarded during the very wet summer: T = Trace).

RESULTS

(i) *Temperate Legumes*

All species nodulated satisfactorily. African, Hairy Peruvian and Hunter River were the most persistent lucerne strains. African and Hairy Peruvian yielded as well or better than Hunter River for the first three years whereas Du Puits density declined rapidly after two years. At sowing the lucerne plots were split for a lime application of 2 ton/ac, and after five years the limed subplots yielded 50% more than controls. Lucerne also persisted better when sown in widely spaced strips than when sown in a sward. Harbinger medic and Jemalong, Hannaford and Cyprus strains of barrel medic were the most persistent and productive annuals.

(ii) *Temperate Grasses*

All species persisted well in the first two winters and production was particularly good from the *Phalaris* species, rye grasses and veldt grass (*Erharta calycina*) which yielded from 3,000 to 4,000 lb dry matter/ac over the 1966 winter. However, there was widespread death during the second and third summers and after three years only *Phalaris* hybrid and *P. arundinacea* (C.P.I. 10446) remained productive and these had largely died out by the following year.

(iii) *Tropical Legumes*

Siratro was the most persistent and productive tropical legume and has spread by seed. Cooper glycine was the only other twining tropical legume to persist. Fine-stem stylo improved in successive years in both density and yield, but received a set back in the wet 1970/71 summer. There was considerable plant death in this summer which was at least partly caused by violet root rot. *Aeschynomene falcata* and *Arachis prostrata* have persisted though yields have been lower than for fine-stem stylo. *Lotononis bainesii* and *L. angolensis* have also persisted, with higher yields from *L. bainseii*.

(iv) *Tropical Grasses*

Cultivars of *Panicum maximum* and buffel grass have persisted and produced well (Table 11). Makarikari panic cultivars have persisted but yields have been very poor.

TABLE 11

Highest yielding tropical grasses at Nanango in 1968 and 1970, sown 1966. Yields as lb/acre dry matter

Species	1968 Yield (6.iii.68-18.iv.68)	Species	1970 Yield (27.viii.70-5.xi.70)
Molopo buffel	1900	*Eragrostis curvula*	3030
Digitaria sp. (16267)	1870	Green panic	1960
Pioneer rhodes	1465	Sabi panic	1800
Eragrostis curvula	1390	Biloela buffel	1540
Kazungula setaria	1335	Gatton panic	1390
Samford rhodes	1225	Molopo buffel	1300
Gatton panic	1165	Tarewinnabar buffel	950

Pioneer rhodes grass has usually outyielded other rhodes grass strains although there was some death of all rhodes grasses in dry periods with subsequent recovery. Death of some cultivars, particularly Nandi setaria, *Panicum coloratum* (Kabulabula), Samford rhodes grass and *Sorghum almum* appeared to be caused by severe frosting of established plants 30 months after sowing.

IV. GENERAL EVALUATION

This section draws together findings from the previous three sections dealing with the eastern Darling Downs (Pittsworth), West Moreton (Boonah) and South Burnett (Nanango).

(i) *Lucerne*

Lucerne has been a productive species at all three sites. Persistence has usually been satisfactory for at least three years and on the Downs black earth for six years. Hunter River lucerne at both Boonah and Nanango was initially outyielded by African and Hairy Peruvian but subsequently was the highest yielding cultivar. Similar findings were recorded at Biloela (Cameron 1968) and Narrabri (Saunders 1970). Rain grown lucerne appears to average some 5,000 lb of dry matter/ac/annum in this region. Even allowing for the problem of efficiently utilising erratic lucerne growth, lucerne has obvious potential for wider use in the dairying feed year.

Further work may assist in defining the best way to extend the use of sward lucerne and it may also be possible to reduce the effects of erratic rainfall on lucerne growth by decreasing the sward density. Paltridge (1955) had some success using inter-row cultivation to control the otherwise unavoidable weed growth in low density lucerne. Another approach is to sow low density lucerne swards with desirable annuals to compete with undesirable weeds (e.g. mintweed *Salvia reflexa*) during good growing conditions. Some farmers on the Downs have accomplished this with snail medic and *Urochloa panicoides*. This approach also reduces bloat hazard.

On the black earths of the Downs there appears to be no advantage in using lucerne/grass mixtures for ley pastures as contrasted with pure lucerne, particularly as lucerne can be readily established in these soils in the cooler months and as the unreliability of summer grass establishment is well documented (Leslie 1965). Furthermore, sowing a lucerne/grass pasture in warmer months can increase the risk of poor lucerne establishment. For longer term pastures there is an advantage of lucerne/grass pastures in that the gradual death of lucerne is compensated for by spread of associated grass tussocks, avoiding the weed invasion that occurs when sward lucerne thins out (Table 8).

(ii) *Other temperate legumes*

Barrel medic cultivars and Harbinger medic were consistently successful with good production, seed set and regeneration. Jemalong barrel medic and Harbinger tended to be slightly higher yielding cultivars. The yield of medics in dryland pasture will depend on pasture management and cool season rainfall, but their average annual yield will probably approach 1,000 lb dry matter/ac (Table 6), ranging from nil to over 3,000 lb/ac.

Good medic yields on the Downs depend on adequate cool season rainfall and occur approximately once in every two or three years (Leslie personal communication). Such years are naturally good years for fodder oats which also give good feed in late winter and early spring. However dryland medics will presumably be less reliable than fodder oats, as oats are grown on summer conserved moisture as well as winter rain, and will probably only partly replace oats as a source of winter-spring feed. However nitrogen fixation by medics would increase soil nitrogen and stimulate summer grass growth and in good seasons medic could be used as a major source of winter/spring feed and some oats be retained for grain or hay. Furthermore, medic is a high quality feed until the onset of leaf and pod fall (Jones and McLeod 1971).

Experience on the Downs suggests that snail medic; and possibly barrel medic, have considerably less bloat hazard than naturalised burr medic (*M. polymorpha*). Consequently introduction of these medics when fertilizing undisturbed grassland with sulphur may reduce the possibility of sulphur fertilization leading to bloat problems through dominance of burr medic (Hilder and Spencer 1954). Further work on the interactions between medic species, soil type, management, suplhur response, pasture composition and bloat hazard is warranted.

Observations at Nanango suggest it could be difficult to maintain medic with the local practice of late winter burning of dry standing native pasture. Such burns have killed medic plants before they set seed.

Kenya white clover has been far more persistent than white clover and in some sowings has been more persistent, though less productive, than lucerne. Seedling regeneration has occurred at all sites. Satisfactory nodulation has been achieved with rhizobium strains CB782 and CB778 or CB526 + CB763 + CB2031 + CB2032 but yields have been very low except in periods of sustained favourable rainfall. Death in one sowing at Nanango appeared to be due to a combination of dry periods and nematode infestation.

(ii) *Temperate grasses*

Given favourable nitrogen and moisture conditions, perennial temperate grasses yielded well in the first two years after sowing. After this, there was a decline in yield and vigour and no species remained productive after three years. *Phalaris tuberosa* × *arundinacea* hybrid was the best temperate perennial grass, yielding more than *Phalaris tuberosa*, though much less than tropical grasses in summer. The Sirocco cultivar of *P. tuberosa* was very productive in the establishment year, but yielded very poorly in summer and did not persist as well as the hybrid. *Phalaris* hybrid was, at some grazings, less acceptable to cattle than other grasses. These results are in general accord with experience in southern Australia (McWilliam *et. al.* 1965; Gidley 1967; Saunders 1969). However, although temperate perennial grasses can remain productive for up to three years, there is no apparent commercial role for these species in view of the equivalent seasonal contribution of lucerne and medics (Table 6).

Prairie grass persisted and produced well as an annual on the Downs following continued nitrogen application. Nitrogen also had a marked effect on both persistence and production of this species in irrigated pasture at Biloela (Cameron, Courtice and Mullaly 1969). However, comparison with medic and lucerne again points to little practical value of prairie grass and nitrogen.

(iii) *Tropical legumes*

Dolichos lab lab could merit inclusion in crop rotations on deeper soils both on account of its role in milk production (Hamilton *et al.* 1970) and nitrogen fixation.

Siratro was the most successful tropical legume with good plant persistence, good productivity in favourable years and seedling regeneration. Cooper Glycine showed comparable productivity and persistence, but did not set seed before being frosted. Miles lotononis was also productive in favourable years at both Boonah and Nanango, though mainly as an annual or biennial with cool season germination. Fine-stem stylo showed some promise after slow early growth.

Although at Boonah and Nanango the best tropical legumes yielded much less than did lucerne in the first three to four years after sowing, they are persisting for longer than lucerne. Consequently both tropical legumes and lucerne are realistic choices for pastures in these areas, using appropriate management for the different species.

No native legumes approached the productivity of the better suited sown legumes. *Glycine tabacina* and *G. tomentella* were the most productive native species.

(iv) *Tropical grasses*

A wide range of summer grasses has persisted at all sites. At Boonah, Nanango and the Downs neutral krasnozem site, green panic has persisted, yielded well and given relatively good cool season growth. As green panic has good compatibility with both tropical legumes and lucerne (Young and Daly 1967; Roe, Rees and Jones, unpublished) it is well suited to this region. Buffel grass has persisted well at all sites but does not have the cool season yields of green panic. Pioneer rhodes grass has at times been a high yielding grass, but has partly died out in dry periods. Makarikari panic has shown greater potential on the Downs black earth than on other soils. *Eragrostis curvula* has yielded well at the two sites where it has been grown, but could not be recommended because of its possible weed potential (Auld and Searsbrick 1970). *Setaria sphacelata*, even Kazungula which is the hardiest cultivar, probably requires a more reliable summer rainfall than is received in these areas.

CONCLUSIONS

The results have confirmed that persistent and productive species are available for the thirty inch rainfall zone of south-east Queensland. Many of the successful species such as lucerne, medics and green panic have failed in similar trials in the fifty inch rainfall zone where white clover, setaria and *Phalaris* hybrid have been successful (Rees, 1972). Although no new species can be confidently suggested for inclusion in current recommendations (Anon, 1970) for this region, the results presented have added to the available agronomic knowledge of the species discussed.

ACKNOWLEDGEMENTS

Grateful acknowledgement is made to Mr. P. Blinco, MacFarlane Bros. and Mr. A. P. Beatty for provision of the experimental sites, to Mr. R. Roe for advice and to Mr. M. L. Graydon, Mr. R. W. Burcher and Mr. G. A. Bunch for technical assistance. The project was financed by the Australian Dairy Produce Board.

REFERENCES

ANON (1970)—Crop and pasture planting guide. Division of Plant Industry. Queensland Department of Primary Industries. Advisory Leaflet No. 1058.

AULD, B. A., and SEARSBRICK, B. D. (1970)—Chloromelas lovegrass in the Tenterfield area of New South Wales. *Journal of the Australian Institute of Agricultural Science.* **36**: 296-7.

CAMERON, D. G. (1968)—Lucerne as a pasture legume. *Queensland Agricultural Journal.* **94**: 534-43.

CAMERON, D. G., COURTICE, J., and MULLALY, J. D. (1969)—Effect of nitrogen fertilization and slashing on the Priebe prairie grass (*Bromus unioloides*) component of an irrigated pasture. *Queensland Journal of Agricultural and Animal Sciences.* **25**: 353-8.

GIDLEY, V. N. (1967)—Pasture grasses for the New England tablelands. *Agricultural Gazette of New South Wales.* **78**: 446-53.

HAMILTON, R. I., LAMBOURNE, L. J., ROE, R., and MINSON, D. J. (1970)—Quality of tropical grasses for milk production. Proceedings of the XI International Grassland Congress, Surfers Paradise, Australia, 860-4.

HILDER, E. J., and SPENCER, K. (1954)—The influence of sulphur on natural Medicago pasture. *Journal of the Australian Institute of Agricultural Science.* **20**: 171-6.

JONES, R. M. (1969)—Mortality of some tropical grasses and legumes following frosting in the first winter after sowing. *Tropical Grasslands.* **3**: 57-64.

JONES, R. M. (1970)—Sulphur deficiency of dryland lucerne in the eastern Darling Downs of Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry.* **10**: 749-54.

JONES, R. M. (1972)—Methods of oversowing lucerne and medic into native pasture on non arable soils in the eastern Darling Downs of Queensland. *Tropical Grasslands.* **6**: 85-90.

JONES, R. M., ALCORN, J. L., and REES, M. C. (1969)—Death of Siratro due to violet root rot. *Tropical Grasslands.* **3**: 137-9.

JONES, R. M., and MCLEOD, M. N. (1971)—Changes in nutritive value throughout the growth cycle of snail medic (*Medicago scutellata*). *Journal of the Australian Institute of Agricultural Science.* **37**: 63-4.

LESLIE, J. K. (1965)—Factors responsible for failures in the establishment of summer grasses on the black earths of the Darling Downs, Queensland. *Queensland Journal of Agricultural and Animal Sciences.* **22**: 17-38.

MCWILLIAM, J. R., MACKAY, J. H. E., ROGERS, V. E., and SCHROEDER, H. E. (1965)—Characteristics and performance of interspecific hybrids between *Phalaris tuberosa* and *Phalaris arundinacea. Field Station Record.* **4**: 35-58.

PALTRIDGE, T. B. (1955)—Sown pastures for south-eastern Queensland. C.S.I.R.O. Bulletin No. 274.

RAWSON, J. G. (1967)—Agriculture in the South Burnett. *Queensland Agricultural Journal.* **93**: 743-53.

REES, M. C. (1972)—Winter and summer growth of pasture species in a high rainfall area of south-eastern Queensland. *Tropical Grasslands.* **6**: 45-54.

ROUND, P. (1953)—Dairy farming on the north eastern Darling Downs. *Queensland Agricultural Journal.* **76**: 311-30.

SAUNDERS, D. A. (1969)—Two new perennial grasses. *Journal of Agriculture, South Australia.* **72**: 360-2.

SAUNDERS, T. E. (1970)—Production and persistence of six lucerne cultivars at Narrabri, New South Wales. *Australian Journal of Experimental Agriculture and Animal Husbandry.* **10**: 745-8.

THOMPSON, C. H., and BECKMANN, G. G. (1959)—Soils in the Toowoomba area, Darling Downs, Queensland. C.S.I.R.O. Division of Soils. Soils and Land use Series No. 28.

YOUNG, N. D., and DALY, J. J. (1967)—A study of three important pasture mixtures in the Queensland sub-tropics; progress report 1958-63. *Queensland Journal of Agricultural and Animal Sciences.* **24**: 149-58.

(Accepted for publication January 27, 1972)