PASTURE IMPROVEMENT IN THE ESKDALE DISTRICT OF SOUTH EASTERN QUEENSLAND

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SUMMARY

This paper deals with pasture improvement studies on a solodic soil derived from granodiorite in a 35 in. rainfall area. It includes studies on species adaptation and fertilizer requirements aimed at improved pastures for beef production.

Out of 18 grasses and 17 legumes tested for species adaptation a mixture of Rhodes grass (*Chloris gayana* Kunth), Siratro (*Phaseolus atropurpureus* DC) and Hunter River lucerne (*Medicago sativa* L.) was selected for further work. Lucerne could be established by lime pelleting of the seed.

Fertilizer requirements were determined from glasshouse and field work which showed phosphorus and sulphur deficiencies. As a result a fertilizer programme of 2 cwt an acre of superphosphate at the time of sowing and 1 cwt an acre in subsequent years is recommended for this soil type.

A 20 acre paddock of the above mixture was established three years after the commencement of the work. Its grazing history during the first year and the legume yields over two seasons is presented. The combination of Siratro and lucerne has been successful in providing complementary growth curves. Siratro had its best growth during summer, but contributed little during winter and spring. Lucerne on the other hand had its best growth during spring thus narrowing the gap of low pasture yield and quality normally associated with tropical pastures in southern Queensland. The cost of establishing such a pasture on cleared and fenced land was estimated at about $20 an acre.

INTRODUCTION

The Eskdale district is situated between the towns of Esk and Crow's Nest, Queensland, and is part of the spear-grass region which was described by Shaw and Bisset (1955) and by 't Mannetje (1965). Prominent indigenous species in the unimproved pastures of this district are black speargrass (*Heteropogon contortus* (L.) Beauv.) and Tambookie grass (*Hyparrhenia filipendula* (Hochst.) Stapf). Dry matter production and feeding value of these species are generally low.

The work described in this paper was carried out at "Eskdale-West", which since November 1965 has been known as "Robyn-dale", a beef cattle property of 4,600 acres. The average rainfall is 35 inches a year, of which about two thirds falls during the summer months; light frosts are common from May to September. The soils on the property are coarse textured solodics derived from granodiorite. Analytical data for soil from 0 to 6 inches from two locations on the property are shown in Table 1.

These figures represent a slightly acid soil with low phosphorus and nitrogen contents, a low total exchange capacity with a particularly low calcium level, but a very high level of total potassium.

This paper deals with the initial pasture improvement studies, i.e. species testing and fertilizer requirements. The problem of lucerne nodulation on slightly acid granitic soils is discussed and an illustration of pasture utilization is presented.

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TABLE 1.

Chemical analysis of soil (0-6") at two sites at "Eskdale-West", corresponding with experimental sites.

	Site 1	Site 2
pH (1:5, soil:water)	6.2	6.4
Available P	5 ppm	16 ppm
Total P	0.013%	0.014%
Total K	3.5%	—
Total N	0.068%	0.075%
Exchangeable Cations:		
Ca	1.6 m—equiv.%	—
Mg	0.6 "	—
K	0.38 "	—
Na	0.04 "	—

SPECIES TESTING

An experiment was planted in February 1961 which contained two plots (25 × 40 sq links) in randomised blocks of each of 18 grasses and of each of 17 legumes (see Tables 2 and 3) which were subjected to intermittent heavy grazing. The grass plots were oversown with a mixture of *Phaseolus atropurpureus* C.P.I. 18556, phasey bean (*P. lathyroides*) and centro (*Centrosema pubescens*), and the legume plots were oversown with commercial Rhodes grass (*Chloris gayana*). The area received 2½ cwt an acre of Mo-superphosphate and 1 cwt an acre of muriate of potash at planting time and 1 cwt an acre of superphosphate in each subsequent year. (This experiment was established before the fertilizer requirements of this soil had been worked out; it was subsequently found that molybdenum and potassium were not needed for this soil). The legumes were inoculated with the appropriate *Rhizobium* strains insofar as they were known.

The main purpose of the trial was to investigate the persistence of the species in grass-legume mixtures under intermittent grazing. Tables 2 and 3 show the complete list of species used with the seeding rates and notes on their persistence and productivity.

Of the 18 grasses nine persisted over a period of three years. Of particular interest are the *Panicum* species, which were the most productive grasses in the first two years but have since faded away completely. *Paspalum dilatatum* var *pauciciliatum*, *P. malacophyllum* and the two *P. plicatulum* cultivars showed persistence and reasonable yields in the second year but have since declined in productivity. Five grasses, Rhodes grass, pangola grass, *P. guenoarum* and the two varieties of *P. notatum*, persisted well and their yields have increased over the years. Of all species tested *P. guenoarum* had the greatest frost tolerance; even when fairly frost resistant species such as *P. notatum* had their leaves severely damaged *P. guenoarum* would hardly show "tipping" of the leaves. This species also gave earlier growth in spring than any of the others.

The number of persistent legumes was smaller than that of the grasses (see Table 3). Twelve of the seventeen legumes failed to persist which in two cases was due to failure of nodulation. *L. angolensis* had only recently been introduced and had been inoculated with the *Rhizobium* strain of *L. bainesii*. It was subsequently found (Norris, unpublished) that *L. angolensis* required another inoculant. Hunter River lucerne was inoculated with the correct Rhizobium strain, but its failure to nodulate could be attributed to lack of calcium in the rhizospere. (see below). Of the persisting legumes *L. bainesii* proved to be an unreliable legume for this district because of its great

TABLE 2.

Grasses included in initial testing experiment at "Eskdale-West" with seeding rates and notes on evaluation.

Botanical name	Common Name	C.P.I. or Cultivar	Seeding rate	Evaluation
Cenchrus ciliaris L.	Buffel grass	cv. Gayndah	4 lbs./acre	not persistent
Chloris gayana Kunth	Rhodes grass	Commercial	2 lbs./acre	productive
Digitaria decumbens Stent	Pangola grass		vegetative	productive
Panicum maximum var. *trichoglume* (K. Schum) Eyles	Green panic	c.v. Petrie	4 lbs./acre	not persistent
P. maximum Jacq.		C.P.I. 6563	4 lbs./acre	not persistent
P. coloratum L.		C.P.I. 16790	4 lbs./acre	not persistent
Paspalum commersonii Lam.	Scrobic	C.P.I. 2696	4 lbs./acre	not persistent
P. dilatatum Poir var. *dilatatum*	Paspalum	Commercial	4 lbs./acre	not persistent
P. dilatatum Poir var. *paucici-liatum* Parodi		C.P.I. 11824	4 lbs./acre	unproductive
P. malacophyllum Trin		C.P.I. 11861	4 lbs./acre	unproductive
P. plicatulum Michx var. *glabrum* Arech	Hartley plicatulum	C.P.I. 11826	4 lbs./acre	unproductive
P. plicatulum Michx	Rodd's Bay plicatulum	C.P.I. 2741	4 lbs./acre	unproductive
P. notatum Fluegge var. *saureae* Parodi	Pensacola grass	C.P.I. 21371	3 lbs./acre	productive
P. guenoarum Arech		C.P.I. 20324	4 lbs./acre	productive
P. yaguaronense Henrard		C.P.I. 11867	vegetative	not persistent
P. notatum Fluegge var. *lati-florum* Doell.	Bahia grass	C.P.I. 11863	4 lbs./acre	productive
Setaria sphacelata Stapf		C.P.I. 15899	4 lbs./acre	no germination
Sorghum almum Parodi		cv Nunbank	8 lbs./acre	not persistent

TABLE 3.

Legumes included in initial testing experiment at "Eskdale-West" with seeding rates and notes on evaluation.

Botanical name	Common Name	C.P.I. or Cultivar	Seeding rate	Evaluation
Centrosema pubescens Benth.	Centro	Commercial	6 lbs./acre	not persistent
Desmodium uncinatum (Jacq.) D.C.	Silverleaf desmodium	C.P.I. 8990	4 lbs./acre	not persistent
D. intortum Urb.	Greenleaf desmodium	C.P.I. 18009	4 lbs./acre	not persistent
Dolichos axillaris E. Mey		C.P.I. 17814	4 lbs./acre	unproductive
D. baumanii Harms.		C.P.I. 24972	4 lbs./acre	not persistent
Glycine javanica L.	Glycine	cv. Kairi	4 lbs./acre	not persistent
Lotononis bainesii Baker	Lotononis	C.P.I. 16833	1 lb./acre	unproductive
L. angolensis Welw. ex Baker		C.P.I. 26293	1 lb./acre	not nodulated
Medicago sativa L.	Lucerne	cv. Hunter River	2 lb./acre	not nodulated
**Phaseolus atropurpureus* D.C.	Siratro	cv. Siratro	*0.7 lb./acre	productive
P. atropurpureus D.C.	Atro	C.P.I. 16879	4 lbs./acre	productive
P. atropurpureus D.C.	Atro	C.P.I. 18556	4 lbs./acre	productive
P. lathyroides L.	Phasey bean	Commercial	4 lbs./acre	not persistent
Stylosanthes humilis H.B.K.	Townsville lucerne	Commercial	4 lbs./acre	not persistent
Vigna marina Merr.		C.P.I. 21347	4 lbs./acre	not persistent
Teramnus uncinatus Sw.		C.P.I. 22620	4 lbs./acre	not persistent
Leucaena leucocephala (Lam.) De Wit	Leucaena	cv. Peru	4 lbs./acre	not persistent

*Siratro was sown at this low rate because of lack of seed.

variation in yield. It showed up particularly well during periods of good spring rainfall, but it declined markedly during summer and in dry periods. However, it was the only one of the persisting legumes in this experiment which showed good frost tolerance. Green leaf desmodium was promising until 1964, when it practically disappeared during a period of dry weather in summer. After a similar period in 1965 this legume did not recover. *Dolichos axillaris* grew well in the first two years, but cattle refused to eat it on most occasions, and in later years it declined in density. Townsville lucerne, which is well known for its success in northern speargrass pastures (Shaw 1961), established well and regenerated in the first few seasons, but it gradually declined in stand and individual plants did not grow vigorously.

Of the legumes used to oversow the grass plots only *P. atropurpureus* C.P.I. 18556 persisted; the Rhodes grass used to oversow the legume plots only persisted where the legumes grew well. In the other plots, where the legumes failed, Rhodes grass was finally replaced by native species.

In February, 1964 17 treatments of this experiment were sampled for dry matter yields and nitrogen yields (see Table 4).

TABLE 4.

Dry matter yields of grasses and legumes, N % of grasses and total N yield in a species testing experiment at "Eskdale-West."

Treatment			dry matter yield and composition					N % Grass	N yield
			grass	%	leg.	%	Total		
			lb./ac.		lb./ac.		lb./ac.		lb./ac.
1.	P. notatum C.P.I. 11863	oversown with P. atropurpureus C.P.I. 18556	209	34	397	66	606	1.15	11.4
2.	P. notatum C.P.I. 21371		424	40	645	60	1069	0.94	18.6
3.	P. dilatatum C.P.I. 11824		243	47	419	63	662	0.93	11.8
4.	P. guenoarum C.P.I. 20324		562	71	226	29	788	0.87	10.0
5.	P. plicatulum C.P.I. 11826		237	22	854	78	1091	1.00	21.8
6.	P. plicatulum C.P.I. 2741		187	27	513	73	700	0.95	13.4
7.	Pangola grass		1808	93	132	7	1940	0.62	14.2
8.	P. coloratum C.P.I. 16790		77	24	243	76	320	0.74	6.1
9.	Rhodes grass		1339	64	739	36	2078	0.71	28.4
10.	Rhodes grass, no legume		529		—		529	0.70	3.7
11.	Silverleaf desmodium	oversown with Rhodes grass	463	99	6	1	468	0.82	3.9
12.	Lotononis		491	30	1135	70	1626	1.00	28.2
13.	Townsville lucerne		397	83	83	17	480	0.78	5.8
14.	Siratro*		375	43	496*	57	871	0.90	16.4*
15.	P. atropurpureus C.P.I. 16879		739	43	987	57	1725	0.86	30.4
16.	D. baumanii		529	97	17	3	546	0.77	4.7
17.	D. axillaris		678	70	287	30	965	0.68	10.8
	Least signif. difference	5%	373		481		648		
	,,	1%	560		709		938		
	,,	0.1%	815		1020		1335		

*Siratro was sown at 0.7 lb. an acre in comparison to 4 lb. an acre of the other *P. atropurpureus* treatments. This was the only seed available at the time.

In terms of total yield of dry matter the best treatments at that time were Rhodes grass + *P. atropurpureus* C.P.I. 18556, Pangola grass + *P. atropurpureus* C.P.I. 18556, *P. atropurpureus* C.P.I. 16879 + Rhodes grass, and lotononis + Rhodes grass. The dry matter yields of these treatments were significantly higher than those of most other treatments (see L.S.D. in Table 3). All these treatments except the one with Pangola grass had the highest N-yields. Despite the very low seeding rate of Siratro its total dry matter and N-yield were still fairly good. In fact only the treatments listed above had significantly better dry matter yields than the Siratro treatment. The percentage composition in treatments 1-9 (see Table 2) reflects the compatibility of these grasses with *P. atropurpureus*. In the Pangola grass treatment the legume component was very small, which explains the low N% of the grass and the relatively low N yield of this treatment in comparison with the other high yielding treatments.

Of the grasses tested in this experiment (treatments 1-9) the yield of Pangola grass was significantly higher ($P = 0.001$) than the yield of any of the other grasses and the same applies to that of Rhodes grass except in comparison with *P. guenoarum* from which it differed significantly at $P = 0.01$. *P. guenoarum* yielded significantly higher ($P = 0.05$) than Rodd's Bay plicatulum and *P. coloratum*, but was not significantly different from any of the other grasses.

Of the legumes (treatments 9 and 11-17) lotononis yielded significantly higher ($P = 0.05$) than all other legumes except *P. atropurpureus* C.P.I. 18556 and C.P.I. 16879. The latter, in turn, were significantly different ($P = 0.05$) from the other legumes except for *D. axillaris* and Siratro which were not significantly different from C.P.I. 18556.

On the basis of persistence, availability of seed, ease of establishment and yielding ability (dry matter and N) Rhodes grass and Siratro were the most suitable species on which to base further pasture investigations.

FERTILIZER REQUIREMENTS

The fertilizer requirements of the soil at the experimental site was studied in the glasshouse and in the field. A glasshouse pot experiment, conducted by Mr. I. F. Fergus (Personal Communication) of the C.S.I.R.O. Division of Soils, indicated deficiencies of phosphorus (P) and sulphur (S) with a possibility of molybdenum (Mo) deficiency.

In February 1962 a field fertilizer experiment was commenced using a mixture of Rhodes grass and Siratro, which incorporated levels of P equivalent to 0, 2, 4, and 12 cwt of superphosphate an acre, together with S (0, $\frac{1}{4}$ cwt an acre) and Mo (0, 6 oz an acre) treatments. There were strong responses to P and S by both the legume and the grass but no responses to Mo. Total yield responses are shown in Fig. 1. They were obtained three months after establishment.

The yields were more than twice as high at the P level of 2 cwt an acre of superphosphate than without added P, both with and without S (significant at $P = 0.001$). The yields increased slightly with more applied P, but these differences were just not significant from the level of 2 cwt. S had a significant effect at all levels of P. It appears from these results, that the use of 2 cwt an acre of superphosphate, which contains S, at planting time would be adequate.

It was shown in subsequent years in the same experiment that superphosphate has to be re-applied to maintain good pasture yields, because the effect of 2 cwt an acre applied at planting had largely disappeared after two years. Although no conclusive data are available on the maintenance requirement for improved pasture on this soil, 1 cwt an acre has been applied each year and this has maintained good growth and sufficient P and N levels in the plants.

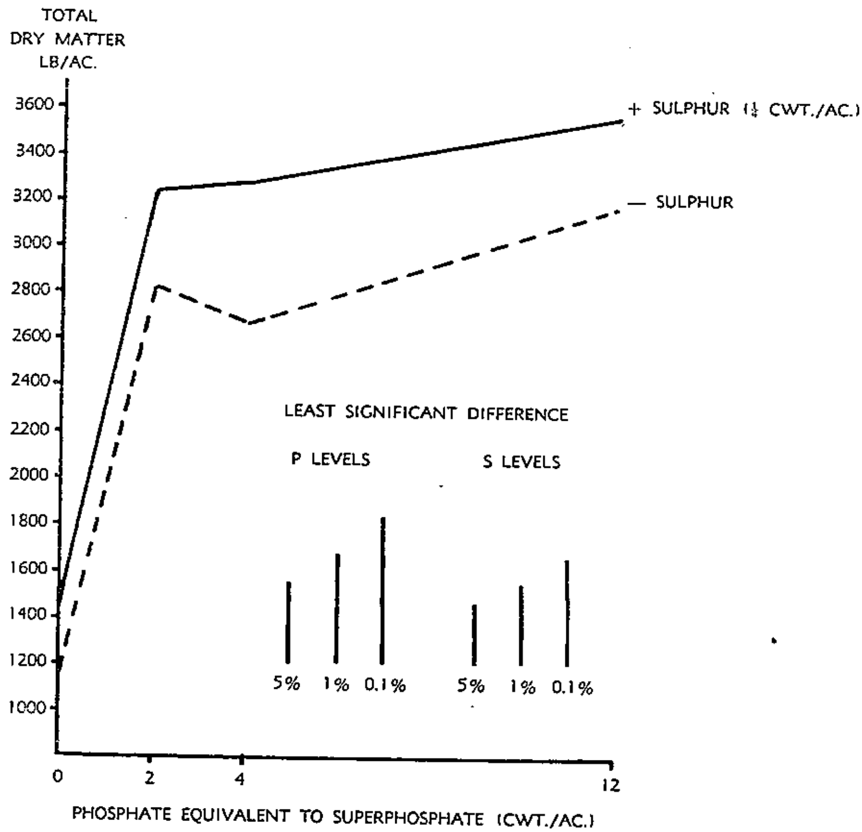

FIGURE 1.

Effects of P and S on total dry matter yield of Rhodes grass and Siratro.

SEED PELLETING OF LUCERNE

The failure of Hunter River lucerne to nodulate was investigated in a number of glasshouse and field experiments. The results of the first field experiment are sufficient to illustrate the problem and how it can be overcome. The treatments were four levels of lime (Ca CO_3) applied over the whole plot, viz. 0, 5, 10 and 20 cwt an acre and seed pelleting, which consisted of treating the seed with an adhesive to which *Rhizobium* had been added and coating it with finely ground lime (see Appendix). The amount of lime involved in the seed pelleting was about 4 lb an acre. For the other treatments the seed was inoculated with a peat culture of *Rhizobium*. An overall application of 2 cwt of superphosphate an acre was made at planting in March 1962. Six weeks and twelve weeks after planting a sampling was made by digging up plants which were examined for nodulation and their tops analysed for nitrogen.

The graphs in Fig. 2 show that the addition of lime up to 10 cwt an acre had a positive effect on nodulation and N content of the lucerne, but that at 20 cwt the lime had an adverse effect. The best results were obtained with seed pelleting. The lucerne plants in plots without lime and those with 20 cwt an acre of lime practically all died within the first year. The nodulation failure and low N content at 20 cwt of lime could be attributed to an induced boron deficiency ('t Mannetje, unpublished).

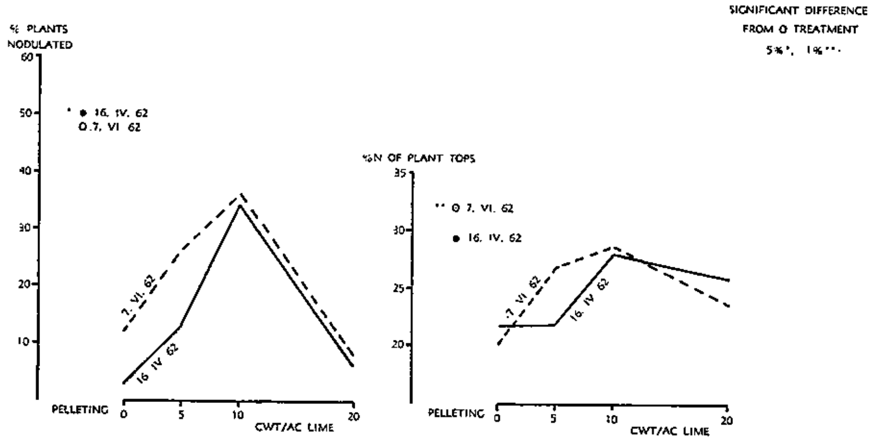

FIGURE 2.
Percentage of plants nodulated and N % of dry matter of Hunter River lucerne as affected by lime and by seed pelleting.

PASTURE PRODUCTION

In January, 1963, three years after the first experiment had been commenced at "Eskdale-West", a 20 acre paddock on a hill side, on similar soil as that of the species testing and fertilizer experiments, was sown to Rhodes grass, Hunter River lucerne and Siratro. The seeding rate for Rhodes grass was about 3 lb an acre, that for Siratro about ½ lb an acre and that for lucerne about 1 lb an acre. Siratro was sown at this low rate because seed was scarce and very expensive at the time; the present recommended seed rate for Siratro is 2 lb an acre. The lucerne seed was pelleted according to the procedure given in the appendix. The area was fertilized with 2 cwt an acre of superphosphate prior to planting. A good seed bed had been obtained by chisel-ploughing and disc-harrowing. The Siratro and lucerne seed were drilled and the area was disc-harrowed afterwards. Rhodes grass seed was broadcast and not covered. There was good germination of all species and the legumes were well nodulated.

The grazing history during the first year is shown in Fig. 3, together with the weekly rainfall.

There were three grazing periods during that year, the first when the pasture was about 10 weeks old. The grazing pressure in terms of grazing-days was equivalent to about 1 beast per 1½ acres continuous grazing for a twelve months period. The rainfall was about average for the year, although there were a few dry periods, especially between June and August. Spring rainfall was very favourable for lucerne growth. From the first frost in June top growth of Siratro was virtually absent from the pasture until October when shoots from old plants and seedlings started to appear. The same grazing pattern was maintained over the subsequent years, although at a lower stocking rate during dry periods, and in early 1967 the composition of the pasture was still comparable to that of the first year.

To illustrate the benefit of having Siratro and lucerne together in this pasture available dry matter of the two legumes over six weekly periods, using movable cages, from December 1963 till May 1965 are shown in Fig. 4, together with the rainfall and screen temperatures recorded on the property.

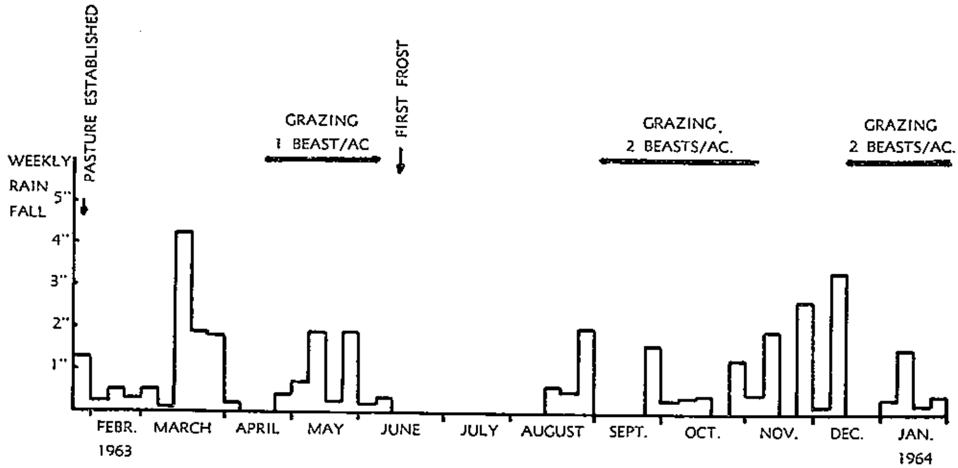

FIGURE 3.

Grazing history during the first year of a 20-acre pasture of Rhodes grass, Siratro and Hunter River lucerne, and weekly rainfall at "Eskdale-West".

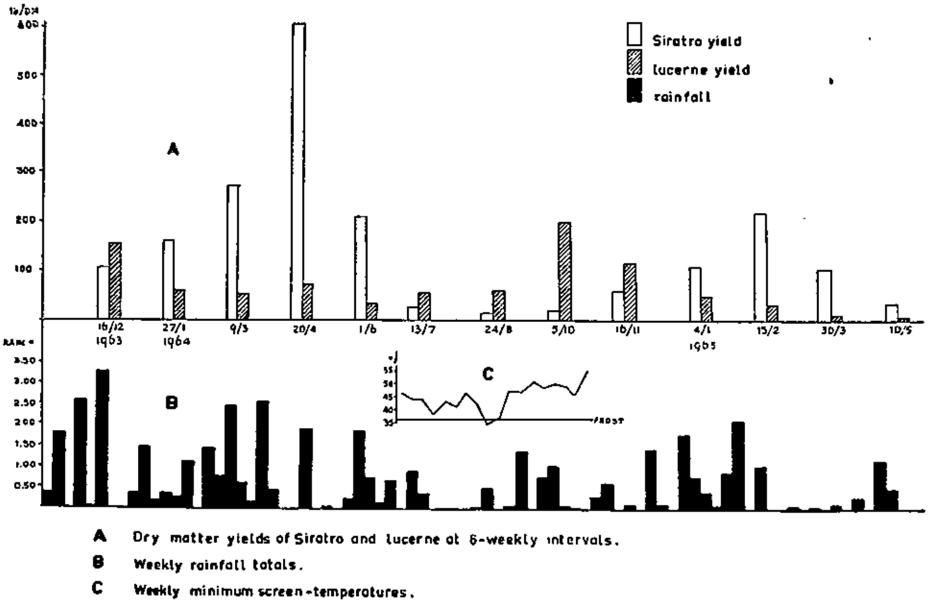

FIGURE 4.

Dry matter yields of Siratro and Hunter River lucerne with rainfall and frost data at "Eskdale-West".

Siratro had its highest production in late summer of 1964 and dropped to very low yields in winter and spring. Its yield increased again in the summer of 1965, but because of dry conditions during that period yields were lower than those in the previous summer. In contrast lucerne had a low yield during both summers but a relatively high yield in December 1963 and October-November 1964. If the mixture had contained Siratro only there would have been a period of six months in 1964 with a very small legume component. With the addition of lucerne this period was brought back to less than three months.

The pattern shown in Fig. 4 was repeated in the following season although yields were lower due to drought conditions. However, all species recovered after good rain was received in early 1967.

SEED RATES

Varying seed rates have been used in the experiments at Eskdale-West and the recommended seed rates are

Rhodes grass	3 lb/acre
Siratro	2 lb/acre
Hunter River Lucerne	4 lb/acre, to be pelleted.

GENERAL DISCUSSION

A large proportion of Queensland's beef is produced from unimproved spear grass pastures at low stocking rates. Any substantial increase in production has to come from a higher production per acre, which can be achieved only by improvement of the quantity and quality of forage, leading to higher carrying capacities and better animal performance.

Six years of pasture development studies in the Eskdale district have shown conclusively that productive pastures can be established in this area. The extent to which these findings can be applied elsewhere is not known exactly, but it is considered that most soils in the Brisbane Valley and in the South Burnett at least are suitable for the mixture of Rhodes grass, Siratro and lucerne described in this paper. Even in districts where the same species cannot be used it would be an advantage to use a mixture of a summer growing and a winter and spring growing legume, provided the species are compatible and there is normally some winter and spring rainfall. The success of the mixture is based on a greater ability of lucerne to exploit winter and spring rainfall in comparison to Siratro. For the latter temperatures are too low for active growth in this period, irrespective of rainfall.

One of the most important aspects of the work at "Eskdale-West" is the success of the lucerne. Through the use of the pelleting technique it proved possible to grow lucerne on, slightly acid, coarse sandy soils which are normally not regarded as suitable for lucerne. This technique can probably also be extended to other districts.

Adjustments to the fertilizer schedule may be necessary in areas where the soils are deficient in K, Mo, Cu or other elements. The superphosphate requirements of 2 cwt an acre at planting and of 1 cwt an acre in subsequent years is common to most areas in the speargrass region.

The failure of Townsville lucerne at "Eskdale-West" is in common with the general experience that this legume is not really suited to areas far south of the tropics, except in isolated cases. (Cassidy 1958, Fullerton 1961). At "Eskdale-West" it did not only fail in the small plots described here, but also on two occasions on a larger scale under conditions of heavy grazing and fertilization, which are generally considered as favourable for the establishment of Townsville lucerne.

However, with the recent search for ecotypes within the Australian population of Townsville lucerne (Cameron 1965) it is possible that a suitable ecotype will be found, which could have a big impact on pasture improvement in southern regions.

On most beef cattle properties there will be a problem of how to make the best use of improved pastures, because they will usually occupy a small proportion of the total acreage, certainly in the first few years of a pasture improvement scheme. Unless the area is large enough to keep a substantial proportion of the herd from an early age to the time animals are ready for marketing it would seem more profitable to use improved pasture for finishing off animals which have grown on unimproved pastures. The production of beef on the pasture described in this paper is estimated at 200-250 lb live-weight gain an acre a year in normal seasons on the basis of results at Rodd's Bay. With an estimated production figure of 50 lb live-weight gain an acre on unimproved pasture at a stocking rate of 1 beast to 6 acres in this area this represents a four to five fold increase in beef production.

TABLE 5.

Cost of establishing 40 acres of improved pasture at "Eskdale-West", on cleared and fenced land.

Labour				
Operation	Hours	Men	Cost per man/hour	Cost
Chisel-ploughing	32	1	$1.20	$38.40
Disc-harrowing	28	1	$1.20	$33.60
Fertilizing	16	2	$1.20	$38.40
Planting	28	2	$1.20	$67.20

	Total labour cost	$177.60
Materials		
Superphosphate 4 ton @ $26 plus freight	$144.00	
Siratro seed 80 lbs. @ $3.00	$240.00	
Lucerne seed 160 lbs. @ $0.50	$80.00	
Pelleting of lucerne seed	$20.00	
Rhodes grass seed 120 lbs. @ $1.00	$120.00	
	Total cost of materials	$604.00
Fuel		$10.00
Depreciation		$10.00
	Total cost	$801.60

The cost of establishing an improved pasture at the recommended seed rates is $20 an acre (see Table 5). This figure is based on an area of about 40 acres planted in December 1965 by the owner.

The estimate of the labour and fuel costs is based on the actual operations, but the cost of materials on early 1967 prices. This cost applies to land which does not require clearing or fencing and which has stock water facilities available.

ACKNOWLEDGEMENTS

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APPENDIX

Lime-pelleting of lucerne seed.

Equipment: a concrete mixer and three buckets.

Ingredients for 100 *lbs of lucerne seed:*

(1) 60-100 lbs of finely ground lime (plasterer's whiting); ordinary agricultural grade lime is not fine enough and therefore unsuitable;
(2) 5 lbs of commercial gum arabic;
(3) 1 lb of peat inoculant for lucerne;
(4) 1 gallon of rain water;

Procedure:

(a) Dissolve the gum arabic in the water; gum arabic takes time or slight heating to dissolve;
(b) divide this solution into two parts and add the peat inoculant to one of these;
(c) divide the seed into about three lots and put one lot in the concrete mixer;
(d) add one third of the gum arabic inoculant solution to the seed in the concrete mixer and turn slowly; if more adhesive is needed add some (do not overdo it) of the solution without the inoculant; turn the mixer until all the seed is evenly sticky, without great lumps of seed; the use of a clean stick is handy to break up clumps; do not use too much adhesive as this will spoil the procedure;
(e) divide the lime into three parts; add one of these to the mixer *at once;* this gives better results than a gradual adding of the lime;
(f) turn the mixer, and use a stick to break up clumps, until all the seed is evenly coated;
(g) spread the seed to dry in the shade.

This procedure is repeated for the other seed lots. The seed has to dry for at least 24 hours before handling. It may be kept in a cool place for up to one month without loss of viability of the inoculant.