CATTLE PRODUCTION FROM HIGH INPUT INTRODUCED PASTURES ON THE MARRAKAI LAND SYSTEM, N.T.

T. H. McCosker

Mount Bundey Station, Adelaide River, N.T.
Current address: Resource Consulting Services, GPO Box 4168, Darwin, N.T. 5794.

ABSTRACT

A single paddock observation trial was sown on a 15 ha cleared site on a commercial cattle property to determine the growth rate of young cattle grazing a high input pasture containing a mixture of grasses and legumes using high fertilizer rates. The pasture, established in 1979–80, was stocked in 1980–81, resown in 1981–82 with more robust species, burnt out in 1982 and restocked in 1983–84. Cattle were weighed regularly and pasture DM yields recorded at the end of each wet season.

The originally sown "improved" grasses, Panicum maximum *(common guinea),* Brachiaria decumbens *cv. Basilisk and* Chloris gayana *cv. Callide (Rhodes grass), did not persist beyond the second wet season, allowing the pasture to become dominated by the legume calopo.* Andropogon gayanus *cv. Kent and* Setaria sphacelata *cv. Kazungula, which were subsequently oversown on lithosol and yellow earth soils respectively in 1981–82, were more productive than the grasses used in the first sowing. Of the legumes sown,* Calopogonium mucunoides *(calopo), and the* Stylosanthes *cultivars Verano and Seca persisted but* Macrotyloma axillare *cv. Archer and* Stylosanthes guianensis *cv. Cook did not. "Dry season" average animal liveweight gain ranged from 0.22 kg/hd.day in 1980 to -0.19 kg/hd.day in 1984. "Green season" growth rates were 0.42 and 0.49 kg/hd.day and "monsoon season" growth was 0.78 and 0.68 kg/hd.day in 1981 and 1984 respectively. When the pasture was grass dominant and grazed at a higher stocking rate, it produced higher liveweight gains during the pre- and post-monsoonal "transiton periods" than it did when legume dominant.*

INTRODUCTION

Improved pastures based on annual legumes oversown into native pastures have a history of commercial failure in the Northern Territory (McCosker and Emerson 1982). An alternative role for legumes is combined with improved grasses into a cleared, fertilized, high input pasture system (Rickert and Winter 1980; McCosker *et al.* 1982). Commercially viable "upland" (off the floodplain) pastures based on introduced grasses were not well known in the Marrakai land system in 1979. Therefore to test their potential for animal production, an area of high input pasture was established at an early stage in a beef cattle production research programme undertaken on "Mt. Bundey" station in the Adelaide River district of the Northern Territory.

The initial objective was to determine the maximum animal production from this type of pasture in a tropical, monsoon environment. High fertilizer inputs, a complex mixture of species, and animal supplements were used, regardless of cost, in an attempt to maximize animal growth rate. However, because of the rapid failure of many of the originally sown species, the primary objective was not achieved. The site was subsequently resown with more robust grasses (McCosker 1987) and this paper reports the relative performance of cattle on legume-dominated and introduced grass-dominant pastures at different points in time.

MATERIALS AND METHODS

Location

The experiment was conducted at "Mount Bundey" station, 125 km south-east of Darwin in the Northern Territory (13°15'S, 131°7'E). "Mt. Bundey" is in the Marrakai land system (Christian and Stewart 1953) which represents some 7000 km^2. Soils are chemically and physically poor with a low water holding capacity (Day *et al.* 1983). The climate is monsoonal with an annual average rainfall of 1365 mm, about 80% of which falls from December to March.

Soil types

A single 15 ha paddock was used. Seven hectares of yellow earth and 5 ha of lithosol soils were cleared at the start of the 1979–80 wet season. Three hectares of moderate density *Eucalyptus alba* were left for shade. This yellow earth area had an understorey of *Themeda triandra* (kangaroo grass) and *Sorghum plumosum* (plume sorghum). The lithosol was a shallow skeletal soil with 30 to 100% surface gravel. The yellow earth was an imperfectly drained, sandy loam of moderate depth. Both soil types have $<$ 5% slope (Forster and Fogarty 1975).

Species sown

The initial sowing into a ploughed, fine tilth seedbed was a mixture of the grasses: *Chloris gayana* cv. Callide (2 kg/ha), *Brachiaria decumbens* cv. Basilisk (1 kg/ha), *Panicum maximum* (common guinea) (3 kg/ha), and legumes: *Stylosanthes hamata* cv. Verano (5 kg/ha), *S. guianensis* cv. Cook (5 kg/ha), *S. scabra* cv. Seca (5 kg/ha), *Calopogonium mucunoides* (calopo) (5 kg/ha) and *Macroptillium axillare* cv. Archer (10 kg/ha). The yellow earth area was sown on November 26 to 27, 1979, and the lithosol area on January 22 to 23, 1980. The seed was broadcast and covered by harrows. Legumes were inoculated with appropriate *Rhizobium* prior to sowing. *S. humilis* (Townsville stylo) and *Alysicarpis vaginalis* (buffalo clover) re-established in subsequent years from soil seed reserves.

In December 1981, the yellow earth was re-sown to *Setaria sphacelata* cv. Kazungula (4 kg/ha) using a seed drill, and 3.5 ha of the lithosol area was re-sown to *Andropogon gayanus* cv. Kent (1 kg/ha) in rows 1.8 m apart. The site was completely burnt by a wildfire in May 1982. The remaining 1.5 ha of the lithosol area was re-sown in January 1983 to Kent and a mixture of stylos (predominantly Verano and Graham) which were broadcast at 1 and 8 kg/ha respectively.

Fertilizer

Establishment fertilizer consisting of 520 kg/ha single superphosphate (SSP), 100 kg/ha muriate of potash, 11 kg/ha zinc sulphate, 11 kg/ha copper sulphate, and 0.4 kg/ha sodium molybdate, was applied on November 21, 1979. The sown area was topdressed with urea at 100 kg/ha on February 28, 1980, SSP at 167 kg/ha on September 23, 1980 and 100 kg/ha on November 21, 1983, and 100 kg/ha potassium oxide on December 1, 1983.

Establishment counts

Seedlings were counted in thirty 0.5 $\times$ 0.5 m quadrats on the yellow earth on January 2, 1980, and on the lithosol on February 25, 1980.

Pasture yield

Pasture yield and botanical composition was estimated by the SVET technique (O'Rourke *et al.* 1984). Four observers each estimated twenty 0.5 $\times$ 0.5 m quadrats in May 1980, April 1981, and May 1984. In April 1983, 3 observers each estimated 30 quadrats.

Cattle

The site was initially stocked by ten 18-month old Brahman cross steers on May 16, 1980. Monthly, fasted liveweight measurements commenced on June 26, 1980 when the average liveweight was 226 $\pm$ 34 kg (SD). The same draft of animals remained until May 25, 1981. The steers were sprayed with Nexagon S to control buffalo flies and ticks at each weighing, and were drenched with Albendazole on June

26 and October 24, 1980. Faecal samples were taken *per rectum* from the same 3 animals at each weighing. Individual samples were oven dried at 95°C for 24 hours prior to analysis for nitrogen (Kjeldahl technique). Mineral supplements (Rumevite Fermafos) were available throughout the period and the cattle also had access to a non-protein nitrogen supplement (Rumevite Proteinfos) in the 1980 dry season.

The paddock was destocked from May 1981 to June 1983 to allow the establishment of replacement grasses and as a result of the fire in 1982. The second draft of animals consisted of 12 Brahman-cross weaner heifers whose average unfasted weight was 179 ± 14 kg at restocking on June 28, 1983. They were weighed 6-weekly (unfasted) until October 18, 1984. An additional 6 heifers from the same weaner draft were added on December 21, 1983. Animals had access to salt during the dry season and a mineral supplement (ICI Ultraphos) during the wet season. Block consumption was low (< 50 g/head.day) in both seasons. Liveweight changes were statistically analysed by Students t-test.

Rainfall

Rainfall is shown in Table 1. Establishment rainfall on the yellow earth was adequate during November and December 1979. Heavy rain in January and February 1980 created poor conditions for establishment on the lithosol due to waterlogging. Good April rain shortened both the 1980 and 1983 dry seasons. There was a heavy, unseasonal fall of rain in August 1980.

TABLE 1

Rainfall for the experimental site.

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May to Aug	TOTAL
Adelaide River					(mm)					
Long Term Average	19	44	101	224	309	310	258	57	43	1365
1979/80	0	68	50	231	584	262	185	136	33	1549
1980/81	0	18	100	197	268	395	222	13	0	1213
1981/82	94	16	105	386	342	174	188	0	0	1305
1982/83	0	0	27	100	250	229	390	38	0	1034
1983/84	0	54	164	66	591	310	179	32	3	1399

Pasture growth is divided into the "monsoon season" (January–March inclusive) of heavy reliable rainfall, and the pre-wet (first rain—early January) and post-wet (April–June) "transition" periods. The "green season" as defined by McCown (1980–81) comprises the monsoon season and both transition periods.

RESULTS

Establishment

Callide, Archer and calopo established with 9.7, 7.1, and 5.8 seedlings/m^2. Basilisk and common guinea had poorer establishment with 2.4 and 2.1 seedlings/m^2 respectively. The *Stylosanthes* spp. could not be differentiated as seedlings and had a group count of 29 seedlings/m^2. There were no large differences in establishment between soil types.

Dry matter yields

Yield data from 4 annual harvests on each soil type are presented in Table 2. Total grass yields were low in the first grazing period (1980–81), both before and after grazing, but were better in the second period (1983–84). In both periods, yield on the yellow earth fell more under grazing than it did on the lithosol. Total legume yield increased during both grazing periods on the yellow earth but only increased in 1981 on the lithosol.

TABLE 2

Dry matter yields at the end of the wet season for each soil type.

Species	Lithosol				Yellow earth			
	1st Period		2nd Period		1st Period		2nd Period	
	1980	1981	1983	1984	1980	1981	1983	1984
			(kg/ha)					
Chloris gayana cv. Callide	1080	510	0	0	1650	310	0	0
Brachiaria decumbens cv. Basilisk	130	520	0	0	520	30	490	80
Panicum maximum (common guinea)	280	210	450	70	210	0	60	70
Andropogon gayanus cv. Kent	na	na	3100	3010	na	na	na	50
Setaria sphacelata cv. Kazungula	na	na	na	0	na	na	4150	2870
Native grass	1790	630	560	270	2530	90	790	110
Total grass	3280	1870	4110	3350	4910	430	5490	3180
Calopogonium mucunoides (calopo)	500	1510	0	180	2220	4530	1420	4840
Stylosanthes hamata cv. Verano	430	320	1370	430	1050	60	370	300
Stylosanthes scabra cv. Seca	110	40	20	20	60	20	0	0
Stylosanthes guianensis cv. Cook	190	1110	20	560	320	180	0	0
Macrotyloma axillare cv. Archer	210	0	0	0	60	0	0	0
Naturalized legume	tr.	50	290	140	tr.	0	tr.	10
Total legume	1440	3030	1700	1330	3710	4790	1790	5150
Total yield	4720	4900	5810	4680	8620	5220	7280	8330

tr. = trace na = not applicable

By the end of the first grazing period, yield of Callide, Basilisk, common guinea and native grass declined, particularly on yellow earth. The very large decline in native grass is particularly noteworthy. It recovered slightly during the destocked years but yield was low again in 1984. Kent and Kazungula had good establishment yields on lithosol and yellow earth soils respectively in the second period. Grazing had little effect on Kent but yield of Kazungula dropped slightly. The resilience of Kent and Kazungula, despite a fire and heavier stocking rate, relative to the other introduced grasses, was a notable feature. Native grass yield on the uncleared area was not measured, but observations showed it to be dominated by *Themeda triandra*. It was heavily grazed during the first period and but less severely in the second period.

Calopo yield substantially increased on the yellow earth soil during both grazing periods. Observations indicated that animals actively avoided calopo until the onset of flowering in March. It was then grazed until dew caused moulding of the senesced

TABLE 3

Cattle liveweight change for two periods and defined seasons.

Season	*1st Period* (1980/81) ADG (kg/hd/day)	SE	Season	*2nd Period* (1983/84) ADG (kg/hd/day)	SE
Dry Season 26/6/80 to 24/10/80	0.22	0.02	Dry Season 28/6/83 to 26/10/83	−0.04	0.02
			20/6/84 to 12/9/84	−0.19	0.02
Green Season 18/10/80 to 24/5/81	0.42	0.05	Green Season 27/10/83 to 19/6/84	0.49	0.02
			:incl replacements	0.47	0.01
Whole Year 26/6/80 to 24/5/81	0.35	0.04	Whole Year 28/6/83 to 19/6/84	0.31	0.01
Monsoon Season 30/12/80 to 9/4/81	0.78	0.04	Monsoon Season 3/1/84 to 19/4/84	0.68	0.02

ADG=Averge daily gain

material during May. Yield of *S. guianensis* lines on the lithosol increased slightly during both periods. The remaining introduced legumes almost disappeared under grazing.

Animal production

Animal production data are summarized in Table 3. Yearling steers gained weight during the 1980 dry season, whereas heifers lost weight in the 1983 dry season ($P < 0.01$). In the monsoon season, the steers in 1981 had a higher average daily gain (ADG) ($P < 0.05$) than the heifers in 1983, but there was no difference in the "green season" or in annual weight change ($P > 0.05$) between the 2 groups. This infers that the heifers in the second period had higher growth rates during the "transition" seasons. The higher stocking rate in the second grazing period resulted in higher production per hectare.

Faecal crude protein

Faecal crude protein was correlated ($P < 0.01$) with ADG in the month subsequent to sampling the faeces but was not correlated to ADG in the previous month ($P > 0.05$). The regression equation was:

$$y = -1.16 + 0.148\,x \qquad (R^2 = 0.75) \qquad \ldots\ldots (1)$$

where y = ADG (kg/hd.day) in the month subsequent to the faecal sample, and
x = faecal dry matter crude protein (%).

DISCUSSION

Prior to grazing in 1980, sown grass comprised 29% and sown legume 39% of total pasture yield. This had altered to 16% and 77% respectively after 1 year of grazing due to a decline in the yield of both native and improved grasses, and a large increase in that of calopo. In the second grazing period (1983–84), the proportions of sown grass and legume were 63% and 27% before grazing and 48% and 49% after grazing respectively. The botanical change in the second period was due to an increase in calopo. In both grazing periods, the change in favour of the legume was caused by active selection of grass (native or sown) and non-grazing of calopo. The selection imbalance may also have increased the competitiveness of calopo, thereby hastening grass decline. Middleton and Mellor (1982) reported a similar trend with guinea grass and *Calopogonium caeruleum* at Utchee Creek in north Queensland. In contrast, Winter *et al.* (1977a) found that stylo content of a Basilisk and common guinea pasture varied from 30 to 37% and 38 to 48% respectively at the end of the wet on Cape York Peninsula over a 3-year period.

Liveweight gain during the 1980 dry season was higher than that in 1983. Probable causes of this difference include—(1) heavy April and August rain in 1980 resulting in an unusually short dry season, (2) supplementation of the first draft of animals with a non-protein nitrogen and mineral supplement during the dry season, (3) the use of steers rather than heifers, and (4) the inherently better performance of yearlings as opposed to weaners in this environment (McCosker *et al.* 1984). The 26 kg liveweight gain during the 1980 dry season could therefore be considered as the exception, with the 5 kg loss in 1983–84 being more the expected result. This result was similar to the small gain or loss situation reported by Winter *et al.* (1977b) at "Heathlands".

"Green season" liveweight gains per head were similar to annual average daily gains on guinea grass and *C. caeruleum* pastures on the wet tropical coast (Middleton and Mellor 1982) but slightly lower than the apparent "green season" gains at "Heathlands" (Winter *et al.* 1977b). Average daily gain over the monsoon period however, was 0.78 kg for steers and 0.68 kg for weaner heifers which is considerably higher than the average for the wet tropical coast. The "monsoon" period was unlikely to contain a component of compensatory gain as it began some 2 to 3 months after the first rain. Annual liveweight gain per head was similar to that of Winter *et al.* (1977b) who used higher stocking rates and produced a 3-year average of 155 kg/ha at 1.2 beasts/ha and a 2-year average of 237 kg/ha at 1.7 beasts/ha.

Performance during the "transitional" seasons was markedly superior in 1983–84. Transitional season growth was 42 kg/hd for the original 12 animals in 1983–84 compared to 14 kg/hd in 1980–81. Despite a similar annual liveweight gain per head (0.35 and 0.31 kg/hd.day respectively), average annual gain per hectare on improved pasture was 98 kg in 1980–81 compared to 165 kg in 1983–84 when the pasture was grass dominant and the stocking rate was higher. Middleton and Mellor (1982) also found that animal production decreased as grass content of their pasture decreased and calopo yield increased. Winter and Thompson (1977) on the other hand, considered animal production to be a function of legume (stylo) content. This difference may be due to a difference in seasonal palatability of these legumes.

The importance of an improved grass during the pre-monsoon "transition" period was also demonstrated commercially on "Mt. Bundey". In 1984, 311 steers stocked at 2.7 head/ha on *P. maximum* cv. Hamil, gained 0.43 kg/hd.day from September 19 to December 6, after 33 mm of rain on September 8. In 1978 and 1979 cattle had suffered up to 30% mortality in the same paddock on a pure calopo pasture at a lower stocking rate (McCosker *et al.* 1984).

Superior animal production from grass-dominated pastures during the transitional seasons appeared to be a function of the perennation of the grasses used. At the start of the wet season the perennial grasses responded immediately to rain while the annual legumes had to regenerate from seed. Similarly, at the end of the wet season, the grasses remained green while there was soil moisture but the legumes seeded and senesced rapidly when rain ceased. The legume leaf then quickly became mouldy and unpalatable (McCown and Wall 1981). The perennial and native grasses also responded to unseasonal rain (Gardener 1980).

Faecal crude protein was a useful predictor of growth rate in the month subsequent to sampling. Moir (1960) reported a good relationship between pasture crude protein level and faecal organic matter crude protein but did not relate it to animal production. Predicted growth from equation (1) ceased when faecal crude protein reached 7.9%, which agrees with the results of Winks *et al.* (1979) on native pasture.

CONCLUSIONS

The original objective of the experiment, which was to determine the maximum animal production from high input pasture, was not achieved due to the failure of the initially-sown grasses and to less-than-optimum plant density in the replacements. Average daily growth rates during the monsoon period appear to be higher than those attained in the wet coastal tropics but similar gains in both areas were recorded for the "green season". ADG was similar to that obtained at "Heathlands" at a comparable stocking rate. Grass vigour during the transition seasons had a large effect on annual liveweight gain per hectare. Pasture growth before and after the main monsoon period was the primary constraint to maximising annual growth rate and carrying capacity on the improved grass-based pastures of the monsoonal dry tropics.

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