LIVEWEIGHT GAIN FROM ROTATIONALLY AND CONTINUOUSLY GRAZED PASTURES OF NAROK SETARIA AND SAMFORD RHODESGRASS FERTILIZED WITH NITROGEN IN SOUTHEAST QUEENSLAND

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ABSTRACT

Nitrogen fertilised (336 kg/ha/yr N) pastures of Narok setaria (*Setaria sphacelata* cv. Narok) and Samford rhodesgrass (*Chloris gayana* cv. Samford) were either grazed rotationally (1 week grazing, 3 weeks rest) or continuously at 5 steers/ha over 6 years. No supplements were fed.

Narok had consistently higher total and green yield on offer than Samford rhodesgrass. Rotationally grazed pasture had consistently higher yields with higher sward heights than did continuously grazed pasture. Despite these differences, mean annual liveweight gains did not differ between grasses or between grazing management systems. The mean annual liveweight gain was 169 kg/steer or 845 kg)ha. In one year there was a significant (P<0.05) grass x grazing management interaction in which Narok gave higher gains with continuous grazing and Samford rhodesgrass better gains with rotational grazing.

RESUMEN

*Las pasturas de setaria Narok (*Setaria sphacelata *cv. Narok) y rhodes Samford (*Chloris gayana *cv. Samford) fertilizadas con nitrógeno (336 kg/ha/año) fueron pastoreadas rotacionalmente (1 semana de ocupación y 3 semanas de descanso) o continuamente con 5 novillos/ha durante 6 años. Suplementaciones no fueron dadas. Narok consistentemente produjo mayor rendimiento de MS total que rhodes Samford. Con pastoreo rotacional las pasturas consistentemente produjeron mayores rendimientos con mayores alturas de plantas que las pastoreadas continuamente. A pesar de estas diferencias, el promedio anual en las ganacias de peso vivo no fueron diferentes entre las pasturas o entre el manejo de los sistemas de pastoreo. La ganancia promedio anual en el peso vivo fue 169 kg/ novillo o 845 kg/ha. La interacción manejo del pastoreo x pastura fue significativa (P<0.05) en un año, en el cual Narok produjo mayores ganancias con pastoreo continuo y rhodes Samford mejores ganancias con pastoreo rotacional.*

INTRODUCTION

The use of nitrogen fertilizer on grass pastures for beef production in the 1100mm rainfall zone of south-east Queensland has been examined in previous studies. In one study it was concluded that it was unlikely that conservation of excess summer growth would be economic (Jones 1976). In another there was no difference between animal production from nitrogen fertilized pastures of *Setaria sphacelata* cv. Narok and *Chloris gayana* cv. Samford (Jones 1989). These experiments were continuously grazed and thus did not consider the effect of grazing management.

Animal production from pastures is a function of pasture yield and quality, the stocking rate imposed on the pasture and the grazing management used. There has been a continuing debate of the merits of various forms of grazing management, in particular, the value of rotational as opposed to continuous grazing. There appeared to be little or no advantage in using rotational as opposed to continuous grazing for beef production for tropical pastures ('t Mannetje *et al.* 1976). However, a number of the studies on more intensive pastures were conducted for relatively short periods of time.

In this study we compared beef production under continuous or rotational grazing from nitrogen fertilized pastures of a tufted grass — *Setaria sphacelata* (setaria) and a stoloniferous grass — *Chloris gayana* (rhodesgrass) over 6 years.

MATERIALS AND METHODS

The experiment was located at the CSIRO Pasture Research Station, Samford (27°22′S, 152°53′E, altitude 50m, annual rainfall 1105mm) on a level, secondary alluvial terrace on gleyed podzolic and prairie-like soils developed on South Pine River alluvium (Thompson and Murtha 1960).

The area was used previously for grazing studies. Four pastures of Samford rhodesgrass and 4 of Nandi setaria, were established on a cultivated seedbed in 1962. They were grazed continuously and fertilized annually as described by Jones (1976, 1989). The setaria paddocks were re-sown to *S. sphacelata* cv. Narok in 1969. From May 1970 to May 1974, the paddocks were grazed continuously at 5 steers/ha. During this period they were fertilized annually with 336 kg/ha N as urea, 250 kg/ha single superphosphate and 125 kg/ha KC1 (Jones 1989). During this experiment, the pastures were fertilized with 250 kg single superphosphate and 125 kg KC1 per hectare in September each year. Urea was applied in 4 equal dressings in September, December, March and May to give 336 kg/ha/yr of N.

In this study, the same 8 paddocks were arranged in 2 replicate blocks of 4 paddocks. Paddocks were 0.6 ha and 0.8 ha in size in replicates I and II respectively. Paddocks in replicate I were stocked with 3, and paddocks in replicate II with 4 Belmont Red steers to give a stocking rate of 5 steers/ha for all paddocks.

One paddock of each grass in each replicate, chosen at random, was subdivided into 4 equal sized sub-paddocks which were grazed for 1 week and then rested for 3 weeks. The remaining paddocks were continuously grazed. Water was available in all paddocks and no supplements were fed.

The trial commenced April 17, 1974 and continued until May 7, 1980. Steers were changed each April or May after grazing the experiment for approximately 1 year. Mean commencing weight of the yearling steers ranged from 240 to 300 kg. Ticks were controlled by spraying with acaricide when necessary and worms were controlled by subcutaneous injections of NILVERM prior to entry into the experiment and 1 month later.

In 1974/75, an ancillary study to measure rates of biting, bite size and grazing time was carried out (Chacon, 1976). This involved additional stocking which increased overall stocking by 2% in that year.

Measurements

For the first 3 years of the experiment the steers were weighed every 28 days after an overnight fast. Subsequently, they were weighed 3 times a year.

Yield estimates of pastures were made on 3 occasions in 1974, on 4 occasions in 1975 and subsequently once in May/early June each year, at the time of peak presentation herbage. Dry matter yield and percentage green material on a dry matter basis was visually estimated on 152 0.25m^2 quadrats along randomly allocated transects for each paddock, using the BOTANAL package (Tothill *et al.* 1978). Pasture height to the top of the leaf canopy was also measured in each quadrat. Five quadrats per paddock were then estimated and cut to provide regressions for deriving the yields of the remaining quadrats.

Before the experimental stocking commenced in March 1974 the percentage composition of each component in the dominantly sown grass pastures was visually estimated in sixty 0.065m^2 quadrats in each paddock.

In October, 1978, yield and botanical composition were visually estimated (Tothill *et al.* 1978) on 80 quadrats per paddock (20 in each of the small rotation paddocks).

In June, 1974, seed head counts were made in 100 0.065m^2 quadrats per paddock (25 quadrats in each of the subdivisions).

RESULTS

Climate

Rainfall varied from 530 mm to 1303 mm over the 6 year period (Table 1). Three periods had near average rainfall, 1975/76 was above average and 2 periods were below average, with 1977/78 being well below average in each season.

TABLE 1

Seasonal rainfall at Samford for the period of the experiment and long term site means. Values in italics indicate below average rainfall.

Season	Year							Long Term Mean
	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	
Autumn	505	*138*	308	*158*	343	*150*	380	286
Winter	150	*115*	*68*	*31*	*113*	*139*		147
Spring	262	309	397	*163*	*195*	*219*		222
Summer	*255*	741	*370*	*178*	449	*314*		444
Annual	1173	1303	1140	*530*	1100	*822*		1099

Frosts occurred every winter. The number of days with grass temperatures of 0°C or below, measured at the research station up-slope from the experiment, ranged from 14 in the winter of 1976 to 40 in the winter of 1977.

Steer gains

Overall, there was no significant effect of grass or grazing management on steer liveweight gains (Table 2). In each year steers grazing Samford rhodesgrass gained more weight than those grazing Narok, but only in 1976/77 was the difference large (30 kg) and significant ($P<0.05$) (Table 2).

TABLE 2

Comparison of rotational grazing and continuous grazing at a set stocking of 5 steers/ha on LWG of steers grazing Narok setaria or Samford rhodesgrass over 6 years.

Treatment	PERIOD							
	74/75	75/76	76/77	77/78	78/79	79/80	Mean	Mean
			(kg/hd)				(kg/hd)	(kg/ha)
Setaria	175	173	183	111	175	145	161	805
Rhodes	181	181	213*	130	177	146	171	855
Rotation	177	182	204	123	182	151	170	850
Continuous	179	172	191	117	170	140	162	810
LSD ($P<0.05$)	20	35	18	47	31	16	15	75
Days	364	392	364	364	364	364		

*Differences between grasses significant at $P<0.05$

There was no significant main effect ($P<0.05$) of the 2 grazing management treatments in any year. However, in 1979/80 the interaction of species x grazing management was significant ($P<0.05$) — with Narok giving higher gains under continuous grazing (150 kg/head) than rotational grazing (140 kg/head), while Samford rhodesgrass gave higher gains with rotational grazing (160 kg/head) than continuous grazing (130 kg/head).

During the period when steers were weighed monthly, it was observed that steers performed better under rotational grazing in the autumn/winter period. The advantage obtained during this period of feed shortage was reduced, but not eliminated, during the following period of rapid gain (687 g/d) in spring and summer (Fig. 1).

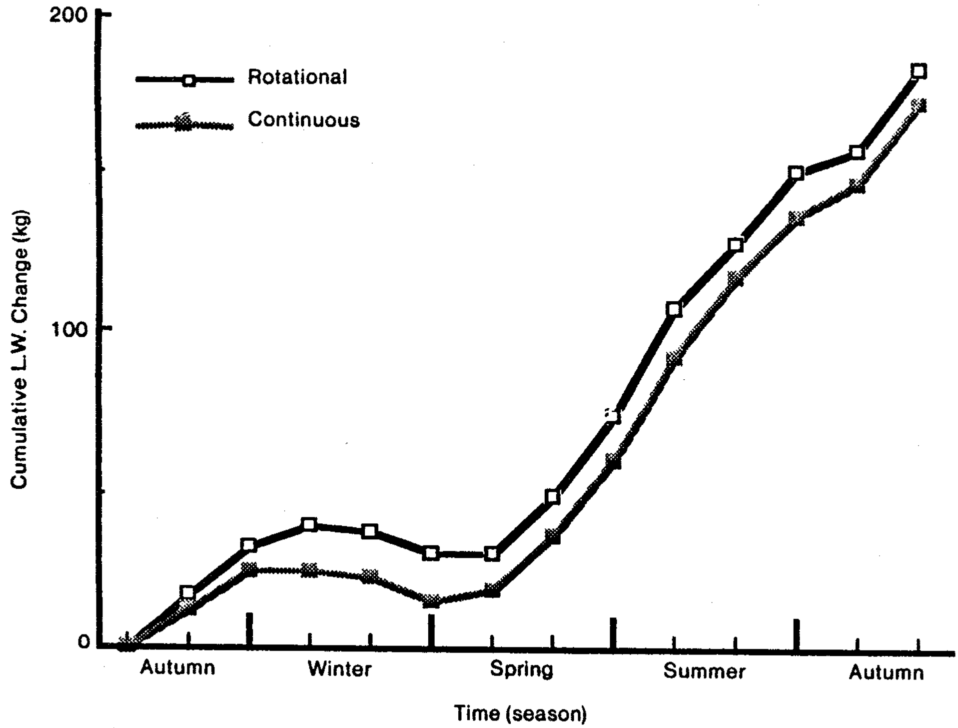

FIGURE 1

The pattern of steer liveweight gain for rotationally grazed and for continuously grazed pastures. Values are means for Narok setaria and Samford rhodesgrass pastures over the three years (1974/5 to 1976/7) when liveweight was recorded every four weeks (there were two weighings in October each year).

Pasture Yields

Presentation yields of both total DM and of green DM, were consistently higher for Narok pastures at each sampling, though differences were only significant for about half of these occasions (Table 3). Presentation yields were consistently greater on the rotationally grazed paddocks, though differences in green yield were smaller and were significant on only a few occasions (Table 3). There were no significant ($P>0.05$) interactions of grass x grazing management. Green yields in winter were depressed much more than total yields due largely to the effect of frosting (Table 3).

Sward heights were consistently taller for Narok pastures (13.1 cm ± 1.36) compared with Samford rhodesgrass (10.4 cm ± 1.47). Rotationally grazed pastures were always taller (13.2 cm ± 1.54) than those continuously grazed (10.4 cm ± 1.29), the difference being significant on 4 out of 13 sampling dates.

TABLE 3

Effect of grass species and grazing management on presentation yields of total dry matter and green herbage.

	Total yield						Green herbage yield					
	Grass			Management			Grass			Management		
Date	Narok		Samford	Rotation		Continuous	Narok		Samford	Rotation		Continuous
						(kg/ha)						
22.7.74	6880	***	2670	5040	NS	4520	970	**	310	720	NS	560
6.8.74	4620	*	3260	4100	NS	3780	420	NS	450	460	NS	410
11.9.74	3220	**	1920	2700	NS	2440	1040	*	600	840	NS	800
3.3.75	2950	NS	2280	3130	*	2090	2050	*	1410	2090	**	1370
9.6.75	4430	NS	2880	4040	NS	3270	600	NS	420	540	NS	470
4.8.75	3150	**	1360	2530	NS	1990	770	**	420	660	NS	530
23.9.75	6600	***	1390	4230	**	3770	4370	***	1080	2880	NS	2560
2.6.76	2990	*	1750	3015	*	1730	2160	**	1190	2130	*	1210
18.5.77	8800	NS	7630	8700	NS	7720	4900	**	3450	4410	NS	3930
1.6.78	2214	NS	2320	2970	*	1560	1250	NS	1130	1590	*	800
3.10.78	1680	NS	1700	2010	NS	1370	1338	NS	1368	1506	NS	1287
29.5.79	5960	NS	5510	5492	NS	5980	3170	NS	2980	2930	NS	3220
8.5.80	4980	*	2950	3890	NS	4041	1610	*	870	1210	NS	1270

*, **, *** = Significant to P 0.05, 0.01 and 0.001, respectively. NS = not significant

Changes in botanical composition

All paddocks were dominated by the sown species (Narok 98%, Samford 90%) at the commencement of the management comparison in March 1974 (Jones 1989). The pastures remained sown-grass dominant throughout, although at the sampling in October 1978, which followed a drought period, there was significantly more ($P<0.05$) of the low growing *Paspalum dilatatum* with Samford rhodesgrass (15%) than with Narok setaria (1%) and under continuous grazing (12%) as compared with rotational grazing (4%). The same trends were apparent with *Cynodon dactylon* and *Digitaria didactyla*, although these were not significant.

Seed head production

Seed head formation, particularly in the Samford rhodesgrass paddocks, was greater under rotational grazing than under continuous grazing. Seed heads/m^2 under rotational and continuous grazing were: Narok 10.1 and 5.4; Samford rhodesgrass 49.5 and 9.4. Seed head numbers increased rapidly with regrowth time in the rotationally grazed paddocks. For rhodesgrass there were 7, 29, 40 and 118 seedheads/m^2 for paddock rest periods of 0, 7, 14 and 21 days. Corresponding numbers for Narok setaria were 6, 7, 9.5 and 18/m^2.

DISCUSSION

Effect of grass species on liveweight gain

Both grasses remained dominant under both grazing systems throughout the experimental period. There was greater invasion by prostrate species under continuous grazing, as noted by Tierney and Taylor (1983), but it was not large. Despite consistently higher total and green yields in paddocks of Narok, there was no year when steer gain was higher on Narok than on pastures of Samford rhodesgrass. In an earlier study (Jones 1989) where nutrient concentrations were also measured, it was concluded that there was no clear reason why steers should not have gained better on Narok than on Samford rhodesgrass. This phase of the longer term experiment has confirmed that differences between grasses in total yield and yield of green material are not necessarily associated with differences in animal production (Jones, 1989).

The liveweight gains per hectare in this experiment were lower than some obtained on wetter and less frost prone sites in coastal Queensland. On the 'Wallum' country at Beerwah, Pangola pastures fertilised with 448 kg/ha of N and stocked at 5.6 to 7.4 steers/ha have produced 1100 to 1300 kg LWG/ha (Evans 1989, Bryan and Evans 1971). However, other experiments at Beerwah gave lower animal production with only 550-880 kg/ha with 476 N/ha/year (Peake and Evans 1975, Evans and Hacker 1977). On a kraznozem soil at Wollongbar, northern New South Wales, kikuyu grass fertilised with 336 kg/ha of N gave maximum calculated gains of 911 and 1307 kg/ha when stocked at 7.6 and 9.1 weaner cattle/ha for two consecutive years (Mears and Humphreys 1974). The gains we obtained are, however, higher than those from pangola grass (533 kg/ha), signal grass (602 kg/ha) and *P. plicatulum* (273 kg/ha) fertilised with 300 kg/ha of N and stocked at 5 steers/ha at Mt. Cotton near Brisbane (Whiteman *et al.* 1985). They are also much higher than the gains from *Sorghum almum* (568 kg/ha) fertilised with 250 kg/ha of N and stocked at 4.9 steers/ha at a drier site on fertile clay soil at Gatton (Yates *et al* 1964). At this stocking rate the pasture was not considered to be stable and the lower stocking rate of 2.5 steers/ha, giving gains of 367kg/ha/yr, was deemed to be a safer option.

The average annual gains per steer of 169 kg in this experiment were higher than those achieved on all the experiments listed above with the exception of two of the Beerwah experiments (Evans 1989, Bryan and Evans 1971).

Effect of management on liveweight gain

Pasture yields of total and green material were consistently higher with rotational grazing than with continuous grazing. However, the rotationally grazed swards were also taller with more seed heads. This marked increase of seed head numbers in rhodesgrass paddocks which established within 6 weeks of imposing the rotation treatments, continued throughout the experiment but was not subsequently measured. It would certainly have contributed to the higher stem:leaf ratio on the rotational treatments. Also it must be kept in mind that, within the rotationally grazed system, the green yield available to animals would be depressed towards the end of the week of grazing before animals were moved to the next sub-paddock. Steer gains were not significantly different on an annual basis, although higher liveweight gains were obtained with the rotational system in the cooler months, when there was little growth. This was associated with higher yields being maintained under rotational grazing, which would have rationed the amount of feed available. The 'catch-up' in liveweight gain by the continuously grazed animals in the spring could be a result of compensatory gain.

Absence of an overall significant benefit from rotational grazing may also be due to the compensating factors described by Chacon (1976). On the Narok pastures he studied, bite size was always greater for steers under rotational grazing. However, steers grazing continuously increased their grazing time in spring and autumn as compared to rotationally grazed steers. In addition, in summer, the continuously grazed pastures had higher bulk density, higher leaf density, higher green leaf and less dead material than the rotationally grazed pastures. This enabled steers to select diets marginally higher in N and *in vitro* organic matter digestibility (Chacon 1976). Further, rotationally grazed steers were consistently observed waiting at the gate on day 6 of the rotation cycle, anticipating the move to a new paddock. The differences in sward structure plus the different behaviour patterns of the rotationally grazed steers may reduce the potential benefits of the higher yields of green feed produced under rotational grazing.

It could be argued that the higher pasture production in the rotational system could have been conserved for feeding in the winter season, or that a higher stocking rate could have been carried to the advantage of the rotational system. Such claims would need to be assessed by further experimentation. However, earlier results from this site showed that benefits from conservation of excess summer feed were not great (Jones 1976). Furthermore, rotational grazing did not improve animal production during the dry 1977/78 growing season when grazing pressure was higher than usual and gains per head were only 120 kg. The small benefits of rotational grazing would not offset the additional fencing and watering costs required for this system.

The results obtained support the conclusions reached by 't Mannetje *et al.* (1976) "currently available evidence from the tropics does not indicate that any grazing management system that will provide higher animal production than continuous grazing with set stocking can readily be devised". Other recent studies with beef cows and calves (Tierney and Taylor 1983), milking cows (Chopping *et al.* 1978) or steers (Eguiarte *et al.* 1984) have also shown no significant benefits in animal production from rotational grazing, even though pasture production was higher with rotational grazing. However, we are not claiming continuous grazing is always the best grazing management. Some species, such as lucerne and leucaena grazed as hedgerows, produce and persist better with continuous grazing. Strategically timed heavy grazing or deferrment can also be a useful management tool to change botanical composition if this is deemed to be beneficial.

For the evaluation of species, the method of grazing will be of little consequence provided there is no interaction of species with the grazing management used. In this study, such an interaction occurred in only one year — 1979/80. However, this interaction of grass x management on steer gain was not paralleled by a similar interaction in terms of pasture production. Yields for the pasture sampling in May 1980 were almost identical for the two management systems (Table 3), but with Narok giving higher yields than Samford rhodesgrass under both management regimes.

Variation in animal gain from one year to another appeared to be associated with rainfall. The two years with lowest rainfall — 1977/78 and 1979/80 were those which gave the lowest animal gains (Tables 1 and 2). In years where the rainfall exceeded 1000 mm in a 12 month period, gains per steer were similar. In another experiment on animal production from nitrogen fertilized grasses at Samford, Jones and Evans (1989) found, over a different 6 year period (1981/82–1986/87), no consistent relationship between liveweight gain and rainfall. These results do not support the hypothesis that drier years are conducive to higher steer gains on N fertilised pastures in S.E. Queensland (Evans and Wilson 1984). In our experiment feed shortage in the drier years would have outweighed any advantages that the drier years may have had on feed quality.

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