Effect of grazing cycle on milk production of cows on kikuyu pasture

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Kikuyu pasture (*Pennisetum clandestinum*) was evaluated as forage for milk production during the 1985/86 and 1986/87 grazing seasons at the Bathurst Research Station in the seaboard area of the Eastern Cape. The effect of different rotational grazing cycle lengths on milk production, body weight, herbage intake, digestibility and grazing time was investigated. Pastures were stocked at two Friesian cows per ha and grazed for 1, 2 or 4-day periods of 15, 30 or 60 days rotation cycles, respectively. Data were recorded during the grazing season which lasted from December to May each year. Milk (10.9 kg) and fat-corrected milk (FCM; 10.1 kg) yields were highest ($P \leq 0.01$) with the 30-day cycle. Neither butterfat (3.55 ± 0.035%), nor protein (3.19 ± 0.022%) content of the milk was affected by rotation cycle. Milk yield patterns showed a marked autumn slump with the 15-day cycle while the other two cycles reflected a steady decline in milk production from 13.5 kg in December to 8.4 kg in May. Mean live body weight (550.7 ± 2.92 kg) did not differ between cycles but followed different patterns during the growing season. Neither organic matter (OM) intake (14.2 ± 0.188 kg), nor OM *in vitro* digestibility (56.3 ±1.07%) differed between cycles. OM digestibility decreased ($P \leq 0.01$) in all treatments from 67.6% in December to 44.7% in May. Cows in the 15-day cycle grazed longer (8.1 hours; $P \leq 0.01$) per day to compensate for the lack of DM availability. Overall, the 30-day cycle proved to be the best grazing strategy for kikuyu pasture in this investigation.

Kikoejoeweiding (*Pennisetum clandestinum*) is vir melkproduksie gedurende die weiseisoene van 1985/86 en 1986/87 by die Bathurst Proefplaas in die oostelike kusgebied geëvalueer. Die invloed van verskillende frekwensie rotasiebeweiding op aspekte van melkproduksie, liggaamsgewig, voerinname, verteerbaarheid en weidingstyd is ondersoek. Die lengte van die rotasiesiklusse van die drie behandelings was 15, 30 en 60 dae met 1, 2 en 4 dae besettings, onderskeidelik. Data is deurlopend in die weiseisoen wat vanaf Desember tot Mei strek, versamel. Melk (10.9 kg) en vet gekorrigeerde melk (VGM; 10.1 kg) opbrengste was die hoogste ($P \leq 0.01$) met die 30-dae siklus. Bottervet (3.55 ± 0.35%) en proteïeninhoud (3.19 ± 0.022%) van melk is nie deur die lengte van die siklusse beïnvloed nie. Seisoenale melkproduksietendense toon 'n duidelike herfs insinking met die 15-dae siklus terwyl die ander behandelings 'n geleidelike afname vanaf 13.5 kg melk in Desember tot 8.4 kg in Mei weerspieël. Gemiddelde liggaamsgewigte van koeie het nie tussen siklusse verskil nie (550.7 ± 2.92 kg) maar het ook verskillende tendense gedurende die weiseisoen gevolg. Beide OM-inname (14.2 ± 0.188 kg) en OM *in vitro* verteerbaarheid (56.3 ± 1.072%) het nie tussen siklusse verskil nie. OM-verteerbaarheid het in al die siklusse van 67.6% in Desember tot 44.7% in Mei afgeneem ($P \leq 0.01$). Koeie in die 15-dae siklus het langer (8.1 uur; $P \leq 0.01$) per dag gewei om te kompenseer vir die tekort aan DM-beskikbaarheid. In geheel was die 30-dae siklus die beste weidingstrategie vir kikoejoe in die suidoostelike kusgebied.

Keywords: Canopy height, dairy cows, kikuyu pasture, milk yield, rotation cycle.

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Introduction

Kikuyu (*Pennisetum clandestinum*) is a popular subtropical grass among dairy farmers in the coastal areas of the Eastern Cape because of its high dry matter (DM) yields. Its adaptability, vigour and hardiness make it tolerant of a wide variety of (sometimes harsh) management practices. However, it does not live up to expected animal performance.

Factors, such as canopy height, forage availability, sward structure and maturity, all affect the utilization of the pasture by grazing animals. Recommendations on the utilization of kikuyu pasture are based mainly on interactions between these factors, since recommended rotational grazing cycles vary from 15 to 60 days (Daines, 1980; I'Ons, 1976). Animal output, on the other hand, is the result of a complex series of interactions between the pasture and the animal. Pasture intake and animal production are related to herbage availability, herbage allowance, availability of legumes, canopy structure and grazing behaviour ('t Mannetje & Ebersohn, 1980). The quality of the feed has an effect on both the intake and output per animal (Minson *et al.*, 1976), but animal production also depends on the quantity of feed on offer. The latter primarily determines carrying capacity. Crampton *et al.* (1960), Montgomery & Baumgardt (1965) and Bath (1985) indicated that voluntary feed intake is the main factor determining the availability of nutrients for milk production. Thus availability becomes a prime determinant of volume output per unit area.

The time spent grazing reflects the ease with which herbage can be harvested and is influenced by both quality and accessibility of the feed (Minson *et al.*, 1976). Sward structure is a major factor influencing the herbage intake and grazing behaviour of animals. Subtropical pastures are grazed for longer periods than temperate pastures to obtain similar intakes, even when large quantities of herbage are available for grazing (Stobbs & Hutton, 1974). Stobbs (1975) also indicated that grazing management strategies could play an important role in maintaining swards in the best condition for optimum harvest efficiency and animal intake. The present investigation was thus conducted to determine the most suitable compromise between availability and quality of kikuyu pasture. The effect of pasture availability, as represented by the regrowth period and canopy height, sward structure and maturity of the sward on grazing behaviour, as well as the production response of dairy cows, were monitored for two grazing seasons.

Materials and Methods

The trial was conducted at the Bathurst Experimental Station (33°30′ South latitude, 26°50′ East longitude) at an altitude of 180 m. The experimental site receives a mean annual rainfall of 670 mm with 60% of the precipitation during summer. The driest summer period occurs between January and March. The research station is situated in the frost-free seaboard of the Eastern Cape Region. Fifteen hectares of well-established dry land kikuyu were allocated to the trial and grazed during the summer months (December – May). Pastures were mowed during August to remove any residual growth from the previous season. Top dressings of single super-phosphate and muriate of potash were applied annually in August to correct any deficiency as determined by soil analysis and to maintain levels of 40 mg/kg P and 117 mg/kg K. Three dressings of 100 kg N/ha were given annually in August, November and February in the form of limestone ammonium nitrate.

Three rotational grazing treatments with cycles of 15, 30 and 60 days and 1, 2 and 4 days of grazing, respectively, were applied. Five hectares of pasture were allocated per treatment and divided into 15 × 0.33-ha paddocks. Friesian cows were blocked for lactation number and stage of lactation before they were randomly assigned to the respective treatments. Each treatment consisted of 10 cows of which a minimum of six and a maximum of eight were lactating. Dry cows were included in the treatments to maintain the normal herd structure and a constant stocking rate of two Friesian cows (550 kg live weight) per ha.

The respective treatments were set up by beef cattle grazing in the appropriate rotational cycles from August to November. During this period, dairy cows were adapted to kikuyu grazing in adjacent paddocks. No concentrates or licks were fed to limit any additional effects. Cows were milked twice daily. Individual milk yield was recorded daily and samples were taken fortnightly for analysis using infra-red light photometry (Milco scan 104, Type 19900; A.O.A.C., 1980). The milk was analysed for protein, butterfat, lactose and solids-non-fat (SNF). Data were recorded from December throughout the growing season until the end of May (1985/86 and 1986/87). Three oesophageally fistulated cows were used to collect selected pasture samples for five consecutive days each month from each of the treatments. This material was used for herbage analysis (A.O.A.C., 1980) and *in vitro* digestibility tests (Engels & Van der Merwe, 1967). Herbage intake was estimated monthly using chromic oxide as a faecal output marker (Kotb & Luckey, 1972). Chromic oxide in faeces samples was determined by atomic absorption spectrophotometry (Williams *et al.*, 1962). Intake estimates coincided with the monthly sampling of oesophageal fistula material. Six lactating cows in each treatment were used for estimates of OM-intake.

The live weight of the cows was recorded fortnightly after milking and without prior fasting. Vibracorders (Stobbs, 1970) were fitted to three cows per treatment to record both the length and time spent grazing. The recordings were done for periods of four days at fortnightly intervals.

Differences in measured variables were tested for significance by analysis of variance and detected by least significant difference (*LSD*) using a mixed model least squares and maximum likelihood computer program (Harvey, 1977).

Results

The regrowth period of the different rotational grazing cycles resulted in average canopy heights of 85, 150 and 300 mm for the 15, 30 and 60-day cycles, respectively. The effects of grazing cycle on milk yield, composition and body weight are presented in Table 1. The differences between seasons should

Table 1 The effect of grazing cycle on milk yield, milk composition and body weight off kikuyu pasture

Rotation cycle	Season	Milk (kg)	FCM[1] (kg)	BF (%)	Protein (%)	Lactose (%)	SNF[2] (%)	Live-weight (kg)
15 Days	1985	8.2	7.8[a]	3.6	3.1	4.3	8.0[a]	508[a]
	1986	10.4	9.3	3.5	3.4	4.4	8.4	564
	Ave.	9.5[a]	8.7[a]	3.7	3.2	4.3	8.2[a]	541
30 Days	1985	9.0[b]	8.4[b]	3.7	3.2	4. 5[b]	8.4[b]	544[b]
	1986	11.1	10.1	3.5	3.2	4.4	8.4	554
	Ave.	10.9[b]	10.1[b]	3.6	3.2	4.4	8.3[b]	558
60 Days	1985	8.0[c]	7.3[c]	3.4	3.1	4.2[c]	7.7[c]	543[c]
	1986	10.6	9.9	3.6	3.2	4.5	8.5	571
	Ave.	8.9[c]	8.3[c]	3.4	3.2	4.3	8.1[c]	554
LSD	1985	b > c *	b > a*c**	–	–	b > c*	b > a,c**	b,c > a**
$*P \leq 0.05$	1986	–	–	–	–	–	–	–
$**P \leq 0.01$	Ave.	b > a,c**	b > a*c**	–	–	–	–	–

[1] FCM = 0,4M + 15 (M × %BF)
[2] SNF = Solids-non-fat

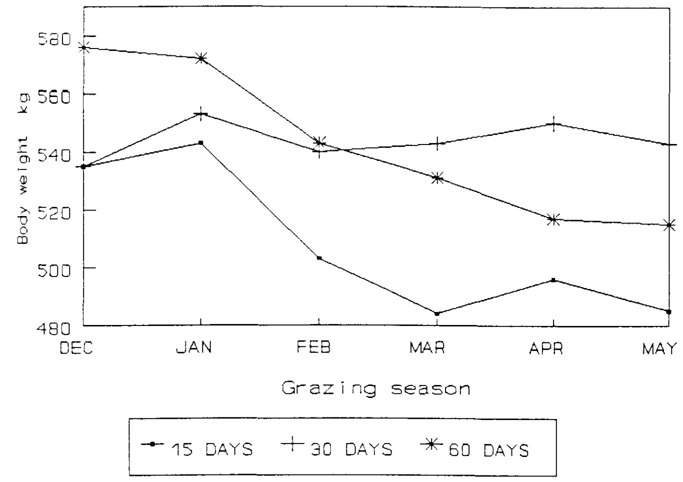

Figure 1 Effect of grazing cycle on body weight of cows on kikuyu pasture.

be judged against the background of the prevailing rainfall distribution patterns during the growing season. In each month from December to May 1986/87 at least 50 mm of rain were recorded, resulting in the pastures being more productive during that season than in the previous seasons. Total yield of milk/cow/day was also higher ($P \leq 0.01$) within each of the three cycles during 1986/87 compared with the previous season. During 1985/86 fat-corrected milk (FCM) yield was higher in the 30-day system (8.4 kg) than in the 15-day (7.8 kg ; $P \leq 0.05$) and 60-day systems (7.3 kg; $P \leq 0.01$). This was in contrast to the 1986/87 season when no significant difference in FCM yield between cycles occurred (9.79 ± 0.273 kg). The mean daily FCM yield for the two seasons was higher in the 30-day (10.1 kg) than in the 15-day (8.7 kg; $P \leq 0.05$) or 60-day (8.3 kg; $P \leq 0.01$) rotational cycles.

Neither season nor cycle significantly influenced the butterfat (BF; 3.55 ± 0.035%) or protein (3.19 ± 0.22%) content of the milk. Significant seasonal and treatment differences did occur in respect of lactose and SNF. The lactose content of the milk was higher (4.5%) for the 30-day ($P \leq 0.05$) than for the 60-day (4.2%) cycle during the 1985/86 season. Within seasons, SNF was higher ($P \leq 0.01$; 8.4%) during the 30-day than during either the 15 or 60-day cycles (8.0 and 7.7%). A similar tendency occurred with mean values for all seasons but no significant difference in SNF content was recorded during the 1986/87 season (8.35 ± 0.47%).

With the unfavourable rainfall distribution during 1985/86, the mean live weight of the cows was higher ($P \leq 0.01$) with the taller sward of the 30-day (544 kg) and 60-day (543 kg) grazing cycles compared with the shorter sward of the 15-day (508 kg) grazing cycle. This tendency was not repeated in the following season (568.6 ± 4.34 kg) nor in the mean values for all the seasons (550.7 ± 2.92 kg). However, tendencies in mean live weight values (both seasons) were dissimilar during the grazing season, as illustrated in Figure 1. The 30-day cycle tended to maintain body weight (544 ± 2.97 kg) whereas a distinct ($P \leq 0.05$) decrease in body weight occurred in both the 15 and 60-day cycles (49.0 and 59.0 kg, respectively).

Table 2 Effect of grazing cycle on milk and FCM yield during the growing season on kikuyu pasture

Treatment		Daily milk yield (kg/day)				Daily FCM yield (kg/dag)			
		15 days	30 days	60 days	Average	15 days	30 days	60 days	Average
December	1985	10.5	11.8	13.2	11.8	10.3	10.8	12.4	11.2
	1986	13.0	16.3	16.3	15.2	11.6	14.7	14.5	13.6
	Ave.	11.5	14.6	14.3	13.5	10.6	13.0	13.1	12.3
January	1985	8.1	9.4	9.5	9.0	8.1	9.4	8.8	8.8
	1986	12.0	13.3	11.3	12.2	11.2	12.0	10.5	11.2
	Ave.	10.2	12.3	9.9	10.8	9.8	11.6	9.1	10.2
February	1985	9.0	9.8	7.2	8.7	8.4	8.9	6.4	7.9
	1986	9.2	9.1	9.6	9.3	8.3	8.3	9.1	8.6
	Ave.	9.1	10.5	8.2	9.3	8.5	9.5	7.5	8.5
March	1985	5.5	6.8	5.5	6.0	4.9	6.1	5.1	5.4
	1986	8.4	10.3	9.4	9.3	7.5	10.1	9.7	9.0
	Ave.	6.9	9.6	6.9	7.8	6.2	9.2	6.7	7.5
April	1985	7.2	6.4	6.3	6.6	6.9	6.5	5.9	6.4
	1986	11.0	10.2	8.6	9.9	9.8	9.0	8.2	9.0
	Ave.	9.9	9.2	7.1	8.7	9.0	8.7	6.8	8.1
May	1985	9.1	9.8	5.9	8.3	8.1	8.8	5.2	7.4
	1986	8.5	7.2	8.3	8.0	7.5	6.6	8.0	7.3
	Ave.	9.2	9.1	6.8	8.4	8.2	8.3	6.3	7.6
LSD $P \leq 0.05$		1.914			1.06	1.93			1.01
$P \leq 0.01$		2.70			1.50	2.73			1.44
±*SE*		0.835			0.456	0.750			0.437

Table 3 Effect of grazing cycle on the time (hours per day) dairy cows spent grazing during the growing season

Month	15 Days	30 Days	60 Days	Average
January	7.8	4.8	5.2	5.9
February	8.9	6.6	6.0	7.1
March	7.9	5.9	5.4	6.4
April	7.8	7.9	6.1	7.3
Average	8.1	6.3	5.7	6.7
LSD	Table	Treatments		Months
$P \leq 0.05$		0.67		
$P \leq 0.01$	NS	0.95		NS
$\pm SE$	0.58	0.29		0.33

Milk and FCM yields per month in the grazing season are listed in Table 2. Average daily milk yield within treatments varied ($P \leq 0.01$) considerably between consecutive months of the growing season, but followed a distinct pattern. The influence of the autumn slump during March (Table 2) is particularly evident in the 15-day rotation cycle. At commencement of the growing season, (November/December) the 60-day system tended to produce the highest milk yields (13.2 kg). In the period December to March, the highest yields were obtained with the 30-day system (Table 2). From April to May, the 15-day cycle tended to outyield the other cycles. Mean FCM yields declined with all treatments throughout the grazing season but the 30-day cycle was the most consistent.

Grazing time (hours) was only recorded from January to April and is presented in Table 3. Time spent grazing during the different months varied considerably between treatments (4.8 to 8.9 hours/day), but differences between months were not significant (6.7 ± 0.168 h). Cows spent longer ($P \leq 0.01$) hours grazing on the 15-day cycle (8.1 h) than on the other treatments (6.3 and 5.7 h, respectively).

Grazing time (minutes) spent diurnally was measured in 4 × 6-h periods from 0:00 to 24:00 and is indicated in Table 4. The prime grazing period for all treatments was from 12:00 to 18:00 daily (157 min.). This is followed by the time slot 0:00 – 6:00 (137 min.). The other two time slots (6:00 – 12:00 and 18:00 – 24:00) represent only 18 and 8.4% of the total time spent grazing, respectively.

Estimates of mean daily herbage intake (kg) obtained during each month are shown in Table 5. Daily OM intake for all cycles followed a typical seasonal trend as it decreased ($P \leq 0.01$) from 18.1 kg/cow/day during December to 10.4 kg/day during May. Differences between treatments were not significant (14.2 ± 0.188 kg).

Table 4 Effect of the grazing cycle on the time (minutes) dairy cows spent grazing during a 24-h period

Time period	15 Days	30 Days	60 Days	Average
0:00 to 06:00	173	121	117	137
06:00 to 12:00	83	81	58	74
12:00 to 18:00	196	139	135	157
18:00 to 24:00	34	37	30	34
LSD $P \leq 0.05$	20.2			11.5
$P \leq 0.01$	24.1			16.2
$\pm SE$	8.67			4.94

Table 5 Effect of grazing cycle on daily OM intake of dairy cows on kikuyu pasture (kg)

Month	15 Days	30 Days	60 Days.	Average
December	18.6	16.8	18.8	18.1
January	14.6	16.1	11.5	14.1
February	13.3	14.9	13.0	13.7
March	13.6	14.2	14.2	14.0
April	14.6	15.1	14.4	14.7
May	9.9	10.7	10.4	10.4
Average	14.1	14.6	13.8	14.2
LSD	Treatments	Body of Table		Months
$P \leq 0.05$	0.72	1.85		0.80
$P \leq 0.01$	1.02	2.24		1.13
$\pm SE$	0.31	0.68		0.35

The mean seasonal trends in the *in vitro* OM-digestibility are shown in Table 6. A strong seasonal effect is evident with a decrease ($P \leq 0.01$) in % OM digestibility in all treatments from 67.6% in December to 44.7% in May. Treatments, however, did not differ significantly (56.3 ± 1.07%).

Discussion

Kikuyu pastures are frequently recommended for dairy cows in the coastal areas of the Eastern Cape. Marked seasonal trends in milk yield, digestibility and voluntary intake at different rotational grazing cycles and canopy heights, indicate that its role as a pasture for high animal output, could be overrated. In the present study, milk yield per cow declined between December and May by 38% (13.5 vs. 8.4 kg). This supports similar studies in Natal where Bredon & Stewart (1979) indicated that the milk potential of kikuyu pasture is

Table 6 Effect of grazing cycle of dairy cows on the *in vitro* OM digestibility (%) of kikuyu pasture during the growing season

Month	15 Days	30 Days	60 Days	Average
December	69.9	63.7	69.1	67.6
January	61.5	60.3	58.5	60.1
February	55.9	57.7	55.1	56.3
March	54.9	57.3	54.2	55.5
April	49.1	58.2	50.3	57.6
May	41.3	49.2	43.8	44.7
Average	57.2	57.2	54.5	56.3
LSD	Treatments	Body of Table		Months
$P \leq 0.05$	4.4	9.8		5.6
$P \leq 0.01$	6.3	14.1		8.1
$\pm SE$	1.84	4.11		2.37

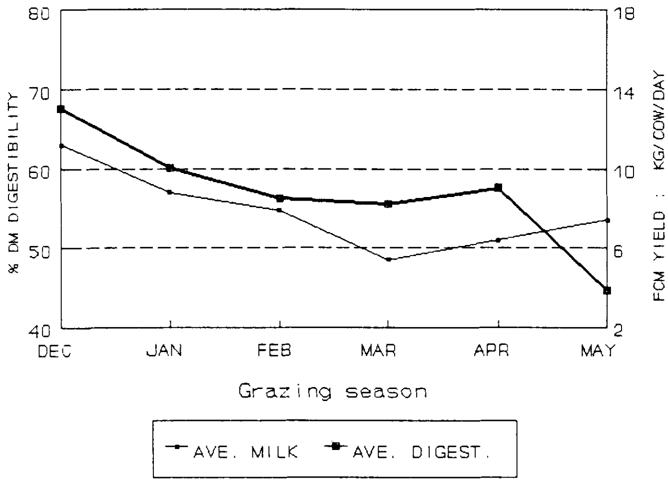

Figure 2 Effect of grazing cycle on *in vitro* digestibility and FCM yield.

about 12 kg/cow/day during spring, but declines to 5 – 8 kg/cow/day in autumn. The characteristic autumn slump in this trial and others (Bredon & Stewart, 1979; Pattinson, 1981; Dugmore & Du Toit, 1988) clearly indicates inherent weaknesses in sustaining high milk outputs throughout the season.

One inherent weakness of kikuyu pasture is the rapid decline in digestibility from December. The relationship between FCM yield and the *in vitro* OM-digestibility (%) for this trial is illustrated in Figure 2. The drop in milk yield after February, however, is well in excess of the decline in OM-digestibility. Also, the recovery in milk yield after March, is in contrast to the trend in digestibility. Mean OM intake declined in the December to May period by 43% (18.1 vs. 10.4 kg/cow/day). It leaves little doubt that a decline in digestibility (38%) is accompanied by an even more pronounced drop in voluntary intake (43%). Pattinson (1981) also found there was a decrease in DM intake on autumn-grazed kikuyu even though the latter was potentially of better quality. In contrast, Dugmore & Du Toit (1988) postulated that the autumn slump may not be due to lower digestibility *per se*, but rather to factors such as high non-protein-nitrogen content, mineral or ionic imbalances or poor grazing management, which results in moribund pasture. They recommended the use of electric fences or follower animals to prevent moribund pasture. Although an autumn slump did occur in the 15-day grazing cycle, this was not caused by moribund grass as no herbage accumulation occurred. The other two treatments did not reflect a true autumn slump, but showed a continuous decline in output after December. The fact remains, however, that kikuyu grazing would require increasing levels of concentrate feeding after December until April to maintain milk yield. The abrupt decline in milk yield in May is indicative of a lack of both available total dry matter and herbage quality. These are distinct constraints on economic milk production at this stage in the grazing season.

Cows spent 28% of their time grazing during a 24-hour period. Two very distinct grazing periods occurred between 0:00 and 06:00 (137 min.) and 12:00 and 18:00 (157 min.) which equals 73% of the total time spent grazing. Cows are usually absent from pastures for 3 – 5 hours owing to milking. Milking schedules should therefore be planned properly so as not to coincide with the prime diurnal grazing periods.

The longer time period (8.1 vs. 6.3 and 5.7 h) spent grazing with the 15-day cycle ($P \leq 0.01$) proved that this short occupation, high frequency rotation grazing cycle restricted availability. This was, however, overcome by longer periods of grazing and the same OM intakes (14.2 ± 0.188 kg/cow/day) as were consumed in other cycles. Furthermore, no significant differences in the *in vitro* OM digestibility (56.3 ± 1.072%) occurred. Therefore, the differences in animal performance between treatments cannot be ascribed to either availability (intake) or quality (digestibility). Marked differences in animal response (milk, $P \leq 0.01$; body weight $P \leq 0.01$; 1985/86) were, however, recorded between treatments. These differences cannot be accounted for with the parameters measured in this investigation. It was postulated from the results that cows on the different treatments channelled their nutrient intake differently towards an end-product. Nonetheless, the 30-day grazing cycle proved to be the best grazing strategy to apply in the lower or higher rainfall situations experienced in the south-eastern coastal area of the Eastern Cape.

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