Factors affecting cattle performance on Coastcross 2 at different stocking and fertilizer rates

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The performance of young cattle, grazing Coastcross 2 (a cynodon hybrid) was studied at two sites in the Eastern Cape (Republic of South Africa). The rainfall and the fertilization rates at the two sites differed. Three stocking rates were applied at each site. Average daily gains are related asymptotically to fodder availability (kg/$W^{0.9}$), and to time of year and the occurrence of rainfall.

Die prestasies van jong beeste wat Coastcross 2 ('n cynodon baster) bewei het is by twee terreine in die Oos-Kaap bestudeer. Die reënval en bemestingspeile het by die terreine verskil. Drie veeladings is by elke terrein toegepas. Gemiddelde daaglikse toenames is gekorreleer met die voerbeskikbaarheid (kg/$W^{0.9}$), tyd van die jaar en die voorkoms van reën.

Introduction

Coastcross 2 is a cynodon hybrid which constitutes 8 000 ha of the 36 000 ha of cultivated pastures in the Bathurst (Eastern Cape, Republic of South Africa) area. It has the local reputation of being more drought tolerant than *Pennisetum clandestinum* (kikuyu grass), an important advantage in the area. In view of the popularity of this grass among farmers, and the absence of locally generated research results to guide advisers, it was decided to study the performance of young cattle grazing Coastcross 2. In the course of the investigation, the effect of herbage availability, time of year and minor rainfall events on herbage quality and their influence on animal performance became apparent.

Procedure

The trial was conducted at two sites, the Bathurst Research Station (33°30'S; 26°50'E) (1986–1994) and on the farm Boslaagte (33°45'S; 25°55'E) (1990–1994). Both sites are frost free, but Bathurst (714 mm rainfall per year) receives considerably more rainfall than Boslaagte (474 mm). At both sites there were three stocking rates, and the animals were rotated through six paddocks at weekly intervals. Grazing season started late in October, after the pasture growth had commenced. Animals of a treatment were removed from treatments when they had lost weight on two consecutive weeks during autumn.

At Bathurst, the trial was conducted on a soil of the Hutton form, Stella family (Soil Classification Work Group, 1991). The soils were deep (1 m) and the slope gentle (0–2%). Available moisture (10–100 kPa) was 135 mm per m of soil depth.

Coastcross 2 Bermuda grass was established during 1984 and fertilized at the rate of 300 kg/ha N (as limestone ammonium nitrate, LAN) (applied in three equal dressings during spring and early summer) and 21 kg/ha P (as single superphosphate) during spring. No potassium (K) was applied to the soil as K levels were greater than 150 mg/kg. The areas under the treatments were 0.48 ha, 1.02 ha and 1.98 ha, and four animals with initial weight varying between years from 190–330 kg per cell. Usually young Bonsmara oxen were used but Nguni oxen and Bonsmara heifers were also used.

At Boslaagte, the soils were shallow on a calcareous substrate with slopes of 5–15%. An established Coastcross 2 pasture was used and fertilized with 160 kg/ha N (as LAN) and 10.5 kg/ha P as single superphosphate. The N was applied in two equal dressings, in spring and early summer. The areas under the three treatments were 1.59 ha, 2.12 ha and 3.18 ha, respectively. Four (1990) or five (1991–1993) animals were used per treatment and their initial weights varied between years from 180–370 kg.

When the animals were moved into and out of a paddock, they were weighed (unfasted). Herbage was sampled by harvesting 20 quadrates (0.3 m x 0.5 m per paddock with a cutting height of 2.5 cm) and drying the samples in a forced-draught oven at 70°C to determine standing crop, herbage quality (crude protein and crude fibre, AOAC 1984).

Rainfall and evaporation at the Bathurst Research Station and rainfall at the Boslaagte homestead were measured daily. Rainfall was accumulated for periods of a week, and rainfall in excess of the weekly evaporation (45 mm) was ignored.

Animal weight was raised to the power of 0.9 (Meissner & Paulsmeier, 1995). Average daily weight gains (ADG) were related to the mean standing crop on entry into a paddock.

Regression analyses were used to relate within-season animal weight gains (during subjectively selected periods of similar performance) to the weekly rainfall, the herbage availability per day on entering the paddock (i.e. standing crop divided by the stocking rate and the number of days of occupation), mean weeks after October 1 during the period, initial animal weight of the period. The term 'daily allocation of herbage' as used in this work is probably not correct as the animals were not allocated fresh herbage on a daily basis. It is used here to relate the available forage to the expected daily requirements.

An extended period of uniform animal performance was assumed to indicate a uniform period of herbage nutrient intake. Periods of weight loss (greater than 0.3 kg/animal/day) were excluded because body reserves were catabolized, and a different set of physiological conditions prevailed to those associated with weight gain.

Results

There were 98 periods (longer than 4 weeks) of relatively uniform animal performance during the trial. Of these there were 64 with herbage quality data as the other samples were lost. The correlations between the attributes for these 64 periods are shown in Table 1. There are two groups of attributes, the one being ADG, weekly rainfall, standing crop and herbage crude protein concentration. These are generally positively correlated with each other. Weekly rainfall was highly correlated with protein content, but otherwise the correlations between variables which could be used to predict ADG were not high. The second group comprises fibre concentration, initial animal weight and weeks after October 1, and these attributes are, generally, negatively correlated with the first group. Time since October 1 has a fair correlation with fibre concentration. Although fibre concentration is significantly (negatively) correlated with ADG, protein concentration is not. The correlations of weeks since October 1 and weekly rainfall with ADG are better than those with fibre and crude protein.

The ADG of the animals during these 64 periods of uniform gain could be approximated by the equation:

$$ADG = 0.1437 + 0.8099AVA1 - 0.02055\ weeks + 0.5070RR \qquad (1)$$

$r^2 = 0.62$; $n = 64$; RMSE = 0.29 kg

where ADG = average daily gain during the period of relatively uniform gain

AVA1 = 1.124 – 1.277EXP(– 4.647 herbage available per day per $W^{0.9}$)

$r^2 = 0.38$; RMSE = 0.37

Weeks = mean number of weeks since October 1 during period of uniform gain

$r^2 = 0.38$

Table 1 Correlations between attributes for 64 uniform growth periods for which herbage analyses are available

	Time	Init. weight	Fibre %	Protein %	Standing crop	Allocat.	Weekly rain	ADG
Time***	1.00							
Initial animal weight	0.67	1.00						
Crude fibre content	0.52	0.53	1.00					
Crude protein content	–0.27	–0.09	0.23	1.00				
Standing crop	–0.34	–0.10	0.19	0.30 1.00				
Allocation *	–0.35	–0.30	–0.10	–0.30	0.68	1.00		
Weekly rainfall **	–0.50	–0.24	–0.11	0.76	0.33	0.08	1.00	
Average Daily Gain	–0.61	–0.40	–0.37	0.14	0.45	0.55	0.41	1.00

Correlations less than 0.25 are not significant (p = 0.05)

*Allocation = daily allocation per $W^{0.9}$

**Average weekly rainfall (to a maximum of 45 mm/week) during period of uniform animal performance

***Weeks after 1 October

RR = 0.9515 – 1.021EXP(– 0.1627Rain)
r^2 = 0.19; RMSE = 0.42
Rain = mean weekly rainfall (to a maximum of 45 mm) during period of uniform growth.

Equation 1 shows the effect of time since October 1 and herbage availability on ADG. During the first 11 weeks after October 1 the ADGs at the same availabilities are higher than later in the year (Figure 1). Initially the gains follow the equation:

ADG = 1.167 – 1.273EXP(– 8.795 herbage available per day per $W^{0.9}$) .... (2)
r^2 = 0.61; n = 30; RMSE = 0.28
Later in the season, the gains followed the equation:

ADG = 0.07829 – 0.9527AVA2 + 0.7966RR – 0.1554 weeks .... (3)
r^2 = 0.50; n = 68; RMSE 0.30

where AVA2 = 0.9059 – 1.044EXP(– 5.767 herbage available per day per $W^{0.9}$)
r^2 = 0.38; RMSE 0.33
RR = 0.5747 – 0.8368EXP(– 0.5473 mean rainfall)
r^2 = 0.07; RMSE = 0.40
Weeks = mean weeks after October 1
r^2 = 0.03

Discussion

The weight gain responses to available fodder display similar asymptotic trends to those of Hart (1972, 1978) and Hart *et al.* (1988), and are compatable with the linear response of weight gain per animal to stocking rate (animals/ha) (Jones & Sandland, 1974).

The difference in trends of ADG relative to herbage availability observed in the present trial is possibly due to compensatory growth (Elliot & O'Donovan, 1969), but more probably related to the quality of

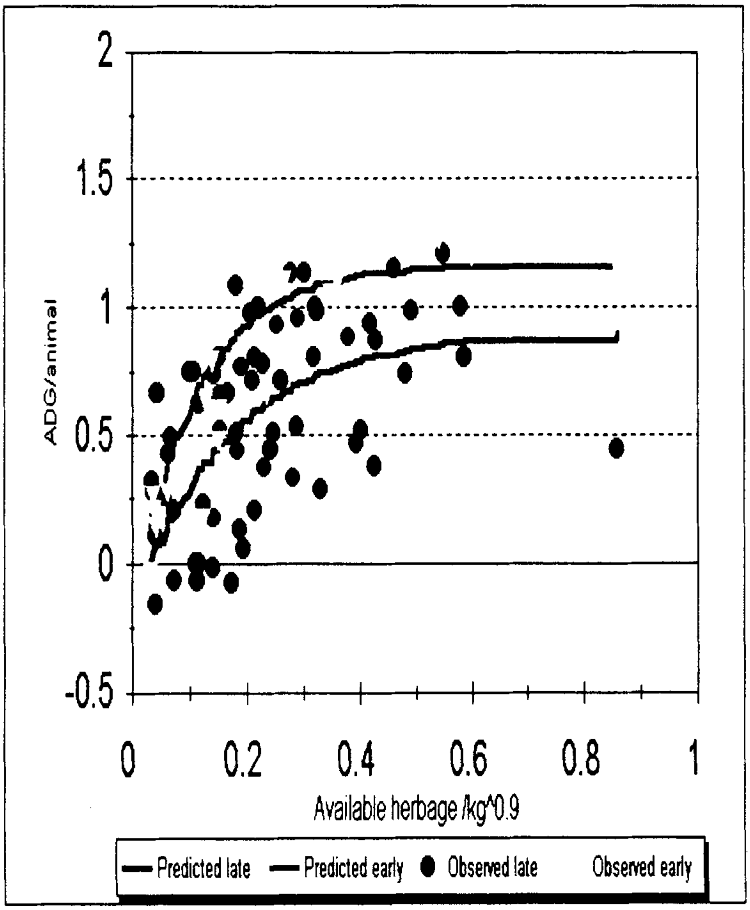

Figure 1 Effect of herbage availability and season on animal performance.

the available herbage. During the first 11 weeks after October 1 the quality is higher, and intake and ADGs can be expected to be higher than later in the season. Later in the season, when quality is lower, factors which improve herbage quality such as rain, can be expected to increase gains. The fact that the effect of rainfall is asymptotic with near maximum responses at about 5 mm of rain per week (much less than the evaporation loss of 45 mm/week in mid-summer), and that rainfall is not correlated with the daily allocation, indicates that its major effect in this instance is on the protein concentration of the grass. Eventually, herbage quality declines to the level where animal weight gains are poorly correlated with herbage availability.

Early in the season, maximum ADG is 1.17 kg, and near maximum (0.9 maximum ADG) is 1.05 kg. 'Most profitable' ADG (in this case 70% maximum ADG , Le Roux *et al.*, 1999) (0.82 kg) is achieved with a daily allocation of 0.15 kg available forage/$W^{0.9}$. Later in the season, the required allocation would be 0.21 kg/$W^{0.9}$. For a 180-kg animal early in the season, allowances of 16 kg/d, and for a 250 kg steer later in the season, allowances of 30 kg/d would be required for 'most profitable' growth, in a weekly rotational system.

Meissner & Paulsmeier (1995) quote daily intakes of 32 to 42 g/kg $W^{0.9}$ for *Cynodon* sp. forages. The present results show that, for near optimum weight gains per animal, under grazing conditions, 275 to 420 g/kg $W^{0.9}$ should be on offer in the grazed situation (i.e. the allowance should exceed the requirements by at least a factor of 8) with occupation periods of a week. This is similar to the 19% utilisation recorded on 'controlled pastures' by Campbell (1966). Greenhalgh *et al.* (1966) found that on strip-grazed pasture (mainly ryegrass and cocksfoot), dairy cows were able to consume adequate forage if the daily allowance exceeded their requirements by 50%. The present results support the conclusion that with long occupation periods and continuous grazing, herbage utilisation is less efficient than strip-grazed pastures.

Conclusions

Forage availability played the major role in determining ADG per animal. Animal performance (ADG and ADG relative to available forage) declined with time, and was probably related to a decrease in protein concentration and an increase in fibre concentration herbage on offer. Relatively small amounts of rainfall during the later periods of the year increased the protein concentration of the herbage and animal performance.

For near-optimum ADG on relatively low quality pastures, with periods of occupation of a week, fodder availability must exceed requirements by a factor of at least 8. This is in accordance with results from other subtropical and temperate pastures using prolonged periods of occupation but not in accordance with results of strip-grazed temperate pastures.

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