DOES THE FRAME SIZE OF FREE-RANGING BEEF CATTLE INFLUENCE THEIR DIET?

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ABSTRACT

A trial to examine, amongst other issues, the long-term effect of the frame size of free-ranging beef cattle on animal and veld performance, was launched in the camelthorn savanna of eastern Namibia in 1987. As from 2001, this trial also served to elucidate the effect of frame size on the diet selected by cattle.

The two cattle frame sizes involved were the small-framed Sanga purebreed and the relatively large-framed Afrikaner x Simmental crossbreed. Their diet selection was observed directly, by bite-counting during three hot-wet, two cold-dry and one hot-dry seasons as from 2001.

Twenty-four cows were selected at random from each frame size treatment, soon after they had been introduced to a new plot, and observed for an uninterrupted period of 10 minutes/cow. Observations were repeated on two mornings and two afternoons. During observation, all bites taken by the cow were counted separately per forage species, all species utilized were identified, as were the parts or organs taken, and the dietary abundance of each species was calculated.

Immediately before grazing of the treatment plot commenced, its botanical composition was determined along its diagonal transect by systematic step-point sampling, and the botanical abundance of all plants was calculated. The dietary preference for every forage species was calculated by comparing its dietary to its botanical abundance. Herbaceous samples were taken at random from clipped herbaceous yield, collected from 40 x 1m^2 quadrats clipped on the diagonal transect and presumed to represent the nutrients on offer in the plot. Immediately after a diet selection observation was completed, all utilized forage plants were sampled by hand-plucking, in a manner imitating the observed selectivity of the cattle. These samples were presumed to represent the nutrient content of the selected diet and compared to the randomly collected samples.

Both cattle frame size treatments consumed grasses preferentially. Four perennial grass species (*Schmidtia pappophoroides, Anthephora pubescens, Eragrostis lehmanniana/E. trichophora* and *Melinis repens repens*) contributed 65.0% of the diet. These grasses were subsequently identified as the principal forage species of cattle in eastern Namibia, provided that they still occur in abundance in the veld. They were also preferred forage species of the cattle of both frame sizes, as indicated by their high preference ratio. Dicotyledonous forbs and woody plants were consumed more frequently during the drier seasons, but still substantially less frequently than grasses.

The cattle of both frame sizes utilized the same forage species, but to a different extent. The small-framed cattle selected fewer of the highly desirable grasses and more of the less desirable grasses. They also selected more forbs than the large-framed cattle, resulting in a more nutritious diet. However, both cattle frame size treatments managed to select a diet more nutritious than the average that was on offer, although it appeared not to meet the protein requirements of lactating cows that are mated in summer. The difference between random and imitated samples was even greater in the drier than in the wet seasons, although it appeared not to meet the protein and energy requirements of dry, pregnant cows in the drier seasons.

It is concluded that both cattle frame sizes selected a more nutritious diet than the average that was on offer, but since the diet of the small-framed cattle had an even larger variety, they were better able to exploit the available forage resource, especially during the cold-dry and hot-dry seasons.

INTRODUCTION

Overgrazing, amongst other factors, is causing rapid degradation of southern African savannas by beef cattle. Productivity per unit area of savanna is declining, resulting in declining animal production, or escalating feed supplementation to maintain animal productivity. Therefore, ranchers are increasingly advised to make use of small-framed, adapted cattle types rather than large-framed, exotic cattle types. It is claimed that under adverse conditions the former will maintain a higher productivity than the latter (Els *et al.*, 1999). However, which of the offered vegetation is actually utilized by free-ranging beef cattle, how nutritious is the fodder on offer and the diet selected from it and do different cattle types interact differently with the natural vegetation? This trial sought to answer these questions by determining the diet of two different frame sizes of cattle, how season influences diet selection, the nutritive value of the selected diet compared to the vegetation on offer and whether the nutrient content of the diet meets animal requirements.

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MATERIALS AND METHODS

A long-term, farm-scale systems trial to investigate the response of animal and veld to four systematically increasing stocking rates and two types of beef cattle of different frame sizes was launched at the Sandveld Research Station in eastern Namibia in 1987 (Kruger, 1998). The two types of cattle evaluated were the relatively large-framed Afrikaner x Simmental rotational crossbreed (LF) and the small-framed, purebred, indigenous Sanga (SF). Stocking rates (SR) were kept relatively constant by fixing the number of cows in a treatment and increasing the number from "low" (targeted cow mass: 15 kg/ha, equivalent to 30 ha/Large Stock Unit) to "low-medium" (25 kg cow mass/ha or 18 ha/LSU) to "medium-high" (35 kg cow mass/ha or 12.9 ha/LSU) and, ultimately, to "high" (45 kg cow mass/ha or 10 ha/LSU). Each of these 2 x 4 factorial treatments (LF at low SR, LF at low-medium SR, LF at medium-high SR and LF at high SR, repeated for SF) was allocated a grazing area of 689±4.4 ha, divided into six camps. Cow herds were rotated through these camps on a fixed cycle of 7–10 days occupation per camp during the hot-wet season and 10–14 days occupation per camp during the cold-dry and hot-dry seasons. Routine cattle management activities, such as preventive health measures, mating, weaning, replacement policy, supplementation and water provision, etc., were identical across all eight treatments.

As from 2001, this systems trial was used to determine the diet selected by cattle, how it is affected by cattle frame size and stocking rate and how the veld reacts to this treatment. Diet selection experiments were carried out during three hot-wet seasons (March–April of 2001, 2002 and 2003; HW), two cold-dry seasons (July–August of 2001 and 2002; CD) and one hot-dry season (October of 2002; HD), to accommodate the well-known effect of season on cattle diet selection and veld productivity. The diet selection trial was restricted to only one of the six available camps per treatment, to prevent differences between camps influencing the experiment. From the available six camps, the experimental plot (av. size: 142±28.9 ha) was selected for as much uniformity as possible in soil type (deep red Kalahari sands of the Hutton soil type) and vegetation type (fairly open savanna dominated by perennial grasses and the camelthorn tree, *Acacia erioloba*).

Immediately before a treatment cow herd was allowed to graze an experimental plot, the botanical composition of the plot was determined by 474±72.1 systematically placed step-points along its diagonal transect, whereafter the botanical abundance of all plant species was calculated. Herbaceous yield was determined by clipping 40 x 1 m^2 evenly spaced quadrats along the transect. At harvesting, the clipped material was sorted into 10 different fractions: the yield of six indicator grasses (*Anthephora pubescens, Aristida stipitata, Brachiaria nigropedata, Eragrostis rigidior, Schmidtia pappophoroides* and *Stipagrostis uniplumis*) and four herbaceous groups (all other perennial grasses, all annual grasses, all herbs and forbs and all herbaceous necromass). These fractions were then weighed, sampled and the samples oven-dried and analyzed to determine their nutritive value. During sampling of the clipped fractions, another sample was reconstituted from the 10 fractions, based proportionally on their mass, processed and analyzed as before and presumed to represent the nutrients on offer by all the herbaceous vegetation in the treatment plot.

During the first half of the period of occupation, while utilized plants were still clearly recognizable, six cows from each of the eight factorial treatments were selected at random and observed for an uninterrupted period of 10 minutes/cow. All bites taken were counted and all forage plants utilized were identified. The bite-counting method was originally developed for goats (Narjisse, 1991), but was found to be applicable to cattle too (Ortega *et al.*, 1995; Mofareh *et al.*, 1997). From these data, the abundance of each forage plant in the diet was calculated. Plant parts or organs utilized were also recorded. This procedure was repeated on two early mornings and two late afternoons per treatment. At these times, cattle, being crepuscular, feed most actively (Albright and Arave, 1997). For each observation, six new cows were randomly selected from the herd, enabling statistical analysis of the data by plain anova, rather than by repeated measures anova. To evaluate the effect of cattle frame size on their diet selection and the nutritive value of the diet, all 24 cows within a frame size were pooled. Similarly, all 12 cows within each of the four stocking rate treatments and all cows observed within the same season were pooled, to evaluate the effect of stocking rate and season respectively.

Dietary preference was determined by comparing the dietary abundance of a forage species to its botanical abundance. A ratio larger than 1.0 indicates a preferred forage species (Petrides, 1975).

Immediately after termination of grazing on a treatment plot, samples from every utilized forage plant species were collected, by hand-plucking, in a manner imitating the observed selection pattern of cows. These samples were immediately sealed in plastic bags to retain their field moisture content, weighed, oven-dried, ground and subjected to standard chemical analysis to determine their nutritive value. This was presumed to indicate the nutritive value of the selected diet.

Statistical analysis applied the general linear model (GLM) of the SPSS computer package. All bite and botanical frequencies were subjected to an arcsine transformation first, because relative abundance data is typically skewed, with only a few high abundances and many low abundances (Zar, 1999).

RESULTS AND DISCUSSION

Diet selection observations indicate that cattle consume grasses preferentially, with a preference rating of 1.18. In contrast, dicotyledonous forbs and woody plants were not selected as frequently as they occurred in the vegetation,

with ratings of 0.41 and 0.73 respectively. However, selection of forbs and woody plants increased significantly during the dry season at the expense of grasses (Table 1). Differences between individual cows in a treatment and between morning or afternoon observation times were not significant. Combined, four forage species, all perennial grasses, constituted 65.0% of all bites. These species, *S. pappophoroides* (33.7% of all bites), *A. pubescens* (14.5%), *Eragrostis lehmanniana/E. trichophora* (11.0%) and *M. repens repens* (5.8%) represent the principal diet components of free-ranging cattle in eastern Namibia, provided that they are still abundant in the rangeland. They are also preferred dietary components, as their preference ratios exceed 1.5.

Cattle of both frame sizes utilized the same forage species, viz. 25 of the 28 available grass species, 25 of 30 dicotyledonous forbs and 11 of 13 woody species, but utilized each forage species to a different extent (Table 1). The effect of frame size on the selected diet was not significant, although SF cattle appeared to be less dependent on grasses than LF cattle ($P > 0.05$, $R^2 = 0.82$), especially on those perceived by rangeland managers to be highly desirable for cattle ranching (*A. pubescens, B. nigropedata, Digitaria eriantha seriata, M. repens repens, S. pappophoroides*), while utilizing more of those grasses perceived to be less desirable (*E. lehmanniana/E. trichophora, E. rigidior, S. uniplumis*). Their dietary preference ratio for the desirable grasses was 8–75% lower and that for the less desirable grasses 24–66% higher than that of LF cattle. The most preferred of all grasses was *E. lehmanniana/E. trichophora* (preference rating 2.5 to 3.3), with a crude protein (CP) content of 5.8% and 48.0% digestibility (DOM) of selected organs over all seasons.

The utilization of forbs and woody species did not differ with cattle frame size ($P > 0.05$, $R^2 = 0.08$ and $P > 0.05$, $R^2 = 0.10$), but seasonal effects on utilization were significant ($P < 0.05$, $R^2 = 0.38$ and $P < 0.01$, $R^2 = 0.58$) (Table 1). SF cattle appeared to utilize browse less than LF cattle. Woody species were also significantly less abundant in the SF cattle plot. The fallen leaves of *Acacia mellifera* were the most preferred of all forage plants (preference ratio of 4.0). However, these are a seasonally limited resource and soon depleted. They supply fodder of low digestibility (36.6%) but with a high CP content (12.1%) at a time when forage CP content is generally low. Increased utilization of forbs during the dry seasons served a similar purpose, as they contained 9.6±1.65% CP with a digestibility of 51.5±10.41%, compared to that of all utilized grass organs, as a group over all seasons, of only 5.9±2.83% and 50.6±12.21% respectively.

Table 1. Effect of (a) cattle frame size, above and (b) season of the year, below, on the composition of cattle diet and treatment plot vegetation (% abundance of plant species or groups)

(a) Effect of cattle frame size (large frame, small frame)	Diet composition		P	Botanical composition		P
	LF	SF		LF	SF	
All grasses	84.4±11.83	83.4±11.84	n.s.	70.7±3.89	72.0±6.25	n.s.
S. pappophoroides	*37.2±18.69*	*30.3±17.46*	n.s.	*20.6±6.04*	*21.4±4.61*	n.s.
A. pubescens	*15.0±19.33*	*13.9±20.37*	n.s.	*5.9±6.91*	*5.9±7.82*	n.s.
E. lehmanniana	*10.3±9.43*	*11.8±11.63*	n.s.	*4.1±1.31*	*3.6±2.06*	n.s.
M. repens repens	*6.9±5.25*	*4.7±4.84*	n.s.	*3.3±2.34*	*4.0±3.46*	n.s.
All forbs	5.2±6.53	7.3±8.30	n.s.	15.1±4.93	15.5±6.02	n.s.
All woody plants	10.4±10.86	9.3±10.64	n.s.	14.2±3.18	12.6±3.09	<0.05

(b) Effect of season (hot-wet, cold-dry, hot-dry)	Diet composition			P	Botanical composition			P
	HW	CD	HD		HW	CD	HD	
All grasses	92.8±5.99	73.8±7.64	77.3±11.12	<0.01	68.9±5.10	72.4±3.71	76.5±3.47	<0.01
S. pappophoroides	*44.0±15.92*	*20.6±15.52*	*29.3±10.36*	<0.01	*21.3±5.78*	*19.9±4.59*	*22.1±5.61*	n.s.
A. pubescens	*19.0±22.26*	*9.3±15.50*	*11.3±17.52*	<0.01	*6.0±7.21*	*5.5±7.42*	*6.2±8.26*	<0.05
E. lehmanniana	*5.7±4.65*	*18.9±13.40*	*11.4±6.72*	<0.01	*3.0±1.42*	*4.4±1.53*	*5.3±1.62*	<0.01
M. repens repens	*3.4±3.75*	*8.6±5.95*	*7.5±3.47*	<0.01	*3.2±2.78*	*4.1±2.78*	*4.1±3.83*	n.s.
All forbs	3.8±3.33	10.5±10.75	5.2±5.07	<0.05	18.1±5.22	14.3±3.53	8.9±2.73	<0.01
All woody plants	3.4±5.39	15.7±12.41	17.6±6.9	<0.01	13.0±3.18	13.3±3.12	14.5±3.59	n.s.

Preliminary nutritive analysis of about half of all the imitated samples indicates that the selected diet was 11.5% more digestible than the herbaceous material as a whole, contained 12.2% more metabolizable energy (ME), 37.0% more crude fat, 38.0% more CP, 9.4% more ash and 45.9% more calcium (Ca) but 17.5% less DM, 11.0% less crude fibre (CF), 9.5% less neutral detergent fibre (NDF) and 9.1% less acid detergent fibre (ADF), with similar phosphorus (P) content. The difference in nutritive value between imitated and random samples was greater in the drier seasons than in the hot-wet season, indicating that cattle select more intensely when the vegetation is at the seasonal off-peak. Compared to LF cattle, SF cattle selected a more digestible diet (52.3% vs. 50.7%), containing more energy (7.7 vs. 7.5 MJ ME/kg and 2.4% vs. 2.1% crude fat) and CP (7.8% vs. 7.1%), but less fibre (34.0% vs. 34.7% CF, 40.4% vs. 42.2% ADF and 64.8% vs. 67.9% NDF) and Ca (0.88% vs. 1.02%), and about the same P content (0.06% vs. 0.07%) because of more intense inter- and intra-species selection. The selected diet supplied lactating cows mated in summer with adequate energy but 20% less CP than recommended (NRC, 1984), while the dry-season diet of pregnant cows contained 10% less CP and energy than recommended (NRC, 1984). Dietary P content was deficient throughout the year.

In conclusion, cattle of both frame sizes were able to select a diet with a more favourable nutritive value than the average that was on offer in the natural vegetation, by preferential selection of certain forage species over others. However, small-framed cattle were even better than large-framed cattle at exploiting the forage resource on offer, as their diet was more diversified and they were less dependent on a small number of principal forage plants, resulting in their selected diet having a more favourable nutritive value than that selected by LF cattle.

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