STOCKING RATE OF FREE-RANGING BEEF CATTLE AFFECTS THEIR DIET SELECTION

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ABSTRACT

A trial to examine, amongst other issues, the long-term effect of the stocking rate 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 served to elucidate the effect of stocking rate on the diet selected by cattle. Four relatively constant stocking rates were achieved by fixing the number of cows in a treatment herd to realize a "low", "low-medium", "medium-high" and "high" stocking rate.

Diet selection by cows was observed directly, by bite- counting during three hot-wet, two cold-dry and one hot-dry seasons as from 2001. Twelve cows were selected at random from each stocking rate treatment, shortly 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 bite-counting, all plants utilized (and their parts or organs) were identified and the dietary abundance of each forage plant calculated.

Shortly before grazing of the 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. Dietary preference for plants was determined by comparing dietary to botanical abundance. Herbaceous samples, presumed to represent the nutrients on offer in the herbaceous vegetation in the plot, were taken at random from clipped herbaceous yield. Shortly after diet selection observations had been 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 random samples.

Cattle in all four stocking rate treatments selected grasses preferentially, which, therefore, dominated their diet. However, with an increase in stocking rate, selection of grasses declined from 86.2% to 82.2%, but that of woody plants increased from 6.4% to 12.8%, while that of dicotyledonous plants changed little from about 5.0%. The shift in dietary composition and preference was exacerbated by season and occasionally by cattle frame size too. Within the grasses, increasing stocking rate changed species selection: the combined dietary abundance of the principal forages, *Schmidtia pappophoroides, Anthephora pubescens* and *Eragrostis lehmanniana/E. trichophora,* all perennial grasses, decreased systematically from 74.3% at the lowest stocking rate to 41.6% at the highest stocking rate, as heavily utilized species started to fade from the grass sward. However, at each stocking rate, the cattle managed to select a diet with a more favourable nutritive value than the average that was on offer in the herbaceous bouquet, but this capability was reduced with increased stocking rate.

It is concluded that cattle can pursue their full dietary preferences only at low stocking rates. As stocking rate increases, they are forced to select other plant species and/or plant parts, eventually resulting in a diminished nutrient content of the diet. In this way, overstocking leads to reduced animal performance.

INTRODUCTION

Southern African savannas utilized by beef cattle are rapidly degrading, mainly due to over-utilization. The depredatory effect of overgrazing, brought about by, amongst other factors, too high stocking rates relative to the carrying capacity of the natural vegetation, is well known and documented. Ranchers are advised as a matter of routine to decrease their stocking rate in order to ensure sustainability of production, but short-term financial objectives entice them to apply heavy stocking rates in an attempt to remain economically profitable (Aucamp, 1990). Few studies have investigated the shift in dietary preference of beef cattle as competition between individual cows intensifies as the stocking rate increases. Consequently, this trial sought to determine the composition as well as the nutritive value of the diet of cattle at different stocking rates, how the diet changes with increasing stocking rate and the effect of these changes on animal and veld condition.

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MATERIALS AND METHODS

Refer to previous article on "Does the frame size of free-ranging cattle influence their diet?"

RESULTS AND DISCUSSION

Results from the long-term systems trial at Sandveld Research Station indicate clearly that individual animal production parameters, such as the calving rate of cows or the amount of weaned mass produced per 100 kg cow mass,

decline consistently as stocking rate increases. However, the decline in individual productivity is compensated for by an increase in system productivity as measured by the quantity of weaned mass produced per hectare, since there are more animals per hectare at the higher stocking rates (Els, 2002). These tendencies were confirmed by the present study ($P < 0.01$, $R^2 = 0.19$ for calving rate) (Figure 1a), but are compounded by the effect of cattle frame size ($P < 0.05$, $R^2 = 0.75$) (Figure 1b), as it appears that with large-framed animals an inflection point in system productivity is already reached at a stocking rate of about 35 kg cow mass/ha, whereas the productivity of small-framed animal systems seems to keep on increasing linearly with the stocking rates applied in this study.

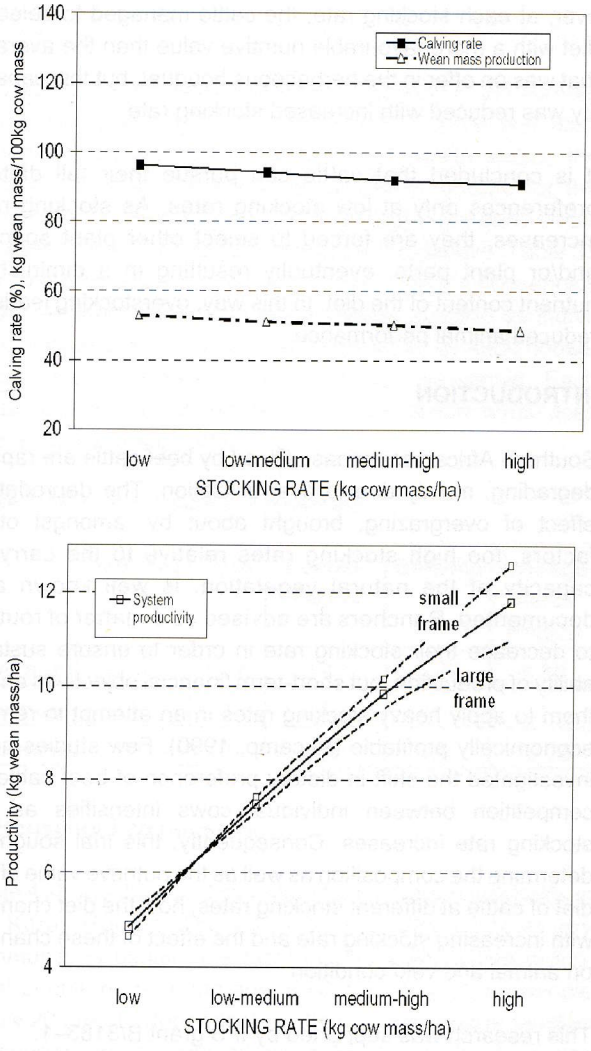

Figure 1. The effect of stocking rate on the productivity of cows (top) and the beef production system (bottom).

Diet selection observations indicate that cattle consumed grasses preferentially (83.9% of the cattle diet but only 71.4% of vegetation), but the contribution of grasses to total bites declined with an increase in stocking rate from 86.2% to 82.2% ($P > 0.05$, $R^2 = 0.87$). The reduced selection of grasses corresponded with an increased selection of woody plants, up from 6.4% to 12.8%, while dicotyledonous forbs contributed around 5.0% of bites taken at all four stocking rates. Seasonal effects on diet selection were significant ($P < 0.05$, $R^2 = 0.86$), as utilization of grasses declined from 92.8% of all bites taken in the hot-wet season to 73.8% during the cold-dry season. During the drier seasons, the utilization of forbs and woody plants increased dramatically.

Selection of different forage plant species by the cattle depended on their stocking rate ($P < 0.01$, $R^2 = 0.87$). At low stocking rates, more of the grass species considered by rangeland managers to be desirable for beef production and less of those considered to be undesirable were selected than were selected at high stocking rates. The three principal forage species, in decreasing order of importance, were *Schmidtia pappophoroides* (dietary preference ratio: 1.61), *Anthephora pubescens* (ratio: 2.48) and *Eragrostis lehmanniana/E. trichophora* (ratio: 2.88), but their combined dietary abundance decreased systematically from 74.3% at the lowest stocking rate to only 41.6% at the highest stocking rate. *Anthephora pubescens,* a grass known to be intolerant of severe defoliation, virtually disappeared from the diet of cows at the medium-high stocking rate, whereas the dietary abundance of *S. pappophoroides* increased initially before decreasing at the highest stocking rate and that of *E. lehmanniana/E. trichophora* increased consistently. Dietary abundance was strongly related to abundance of forage species in the vegetation, as *A. pubescens* declined from 17.7% of all plants in the low stocking rate plots to less than 0.5% in the medium-high stocking rate plots ($P < 0.01$). *Schmidtia pappophoroides* decreased from 23.4% to 14.7% across the four treatments ($P < 0.01$). The botanical abundance of *E. lehmanniana/E. trichophora* increased from 2.7% to 5.1% ($P < 0.01$).

Grasses that usually indicate a deteriorating veld condition increased in abundance in both the diet and the veld due to increasing stocking rate, e.g. *Aristida stipitata* (up from 0.03% to 0.5% of the diet and from 4.1% to 7.4% of the veld, respectively), *Eragrostis rigidior* (0.6% to 11.3% in diet and 5.2% to 11.3% in veld) and *Stipagrostis uniplumis* (0.9% to 19.8% in diet and 6.8% to 18.8% in veld). However, it was noticeable that at first the cattle selected only the inflorescences of these grasses, taking stems and leaves only when virtually all inflorescences had been removed. In contrast, the preferred grasses were grazed in total right from the onset of the grazing period, with only the residual stubble height varying in accordance with stocking rate, ranging from 5–8 cm at the lowest and 1–3 cm at the highest stocking rate. Large-framed cows were even more reluctant than small-framed cows to take the less preferred grasses, e.g. *S. uniplumis* contributed only 0.2% of all bites of large-framed cows at the lowest stocking rate, compared to 1.7% of the bites of their small-framed contemporaries, and 16.3% compared to 23.3% at the highest stocking rate (frame size-stocking rate interaction: $P < 0.05$).

Grasses could be sorted into three groups according to their dietary preference ratio. Those grasses that were already highly preferred by cattle at low stocking rates, where animals could develop their true dietary preferences because of low levels of competition among foraging animals, retained a high preference ratio irrespective of stocking rate, except at

the highest stocking rate, when their ratio declined simply because the grass had faded from the grass sward to a lesser or greater extent. For example, the dietary preference ratio of *A. pubescens* started off at 2.36 and rose to 3.40 before tailing off at 1.87. The second group of grasses initially had a relatively low dietary preference ratio at the lowest stocking rate, but the ratio rose quickly with an increase in the stocking rate as the more preferred grasses began fading from the sward and so were replaced by this group of grasses in the diet of the cattle. For example, the dietary preference ratio of *E. lehmanniana/E. trichophora* started off at 1.62 but rose consistently to 3.65. The third group of grasses retained a more or less similar dietary preference ratio throughout all stocking rates, either because they were too unpalatable even at high stocking rates (e.g. *A. stipitata,* ratio increased from 0.01 to 0.06), or because they were palatable and tolerant of defoliation (e.g. *S. pappophoroides,* ratio increased from 1.21 to 1.96 to 1.55). These latter grasses are of special importance to sustainable animal production in savanna ranching areas because they are both well-liked by cattle and relatively tolerant of high stocking rates.

The highest overall dietary preference ratio of 4.0 was recorded for the fallen leaves of *A. mellifera,* but they were not available throughout the year. Some leguminous dicotyledonous plants also recorded high preference ratios, but contributed very little (< 1.0%) to the cattle diets. In contrast, the average preference ratio of 2.15 of the shrubs *Grewia flava/G. flavescens/G. schinzii* is remarkable, because they contributed noticeably to cattle diets year-round (from 1.5% at the lowest to 4.3% at the highest stocking rate, $P > 0.05$, $R^2 = 0.15$) while increasing in botanical abundance due to stocking rate (from 1.0% at the lowest to 1.8% at the highest stocking rate, $P < 0.01$, $R^2 = 0.63$). The cattle took their green, attached leaves in summer, their dry, fallen leaves in winter and their buds in the hot-dry season. With a crude protein content (CP) of 15.8% in green and 8.9% in fallen leaves, they must have acted as a protein supplement (Bonsma, 1976; Fagg and Stewart, 1994).

Preliminary nutritive analysis of about half of all the imitated samples indicates that overall, cows at all stocking rates managed to select a diet with a more favourable nutritive value than the average that was on offer in the herbaceous layer. On average, the selected diet was 14.2% more digestible (DOM) than the average of the herbaceous material on offer and contained 16.9% more metabolizable energy (ME), 54.2% more CP, 43.8% more crude fat, 20.2% more ash and 80.0% more calcium (Ca), but 17.4% less dry matter, 12.3% less crude fibre (CF), 9.8% less acid detergent fibre (ADF) and 12.1% less neutral detergent fibre (NDF), while having a similar phosphorus (P) content. The difference in nutritive value between the selected diet and the average herbaceous vegetation on offer appeared to decrease as stocking rate increased, especially for the energy parameters (DOM, ME and fat content), indicating that at the highest stocking rate cows struggled to find fodder with an adequate nutrient content in the herbaceous vegetation. The nutritive value of the herbaceous layer also declined slightly with increasing stocking rate, especially in terms of its ME, CP and Ca content.

The nutritive value of grasses differed significantly ($P < 0.05$, $R^2 = 0.77$) between species, with *A. pubescens,* for example, having a much higher CP and ME content than *S. uniplumis* (7.5% vs. 4.8% and 8.4 MJ/kg vs. 6.4 MJ/kg respectively, imitated samples only). Similarly, other less desirable grasses had a lower nutritive value than most of the more desirable grasses. Less desirable grasses also become more abundant in the veld when stocking rate was increased, but the cattle remained reluctant to utilize them, taking the bulkier organs (stems) only as a last resort. For example, the dietary preference ratio of *S. uniplumis* increased from 0.14 to only 1.05 and that of *E. rigidior* from 0.12 to only 1.00 when stocking rate was increased. These factors are compounding each other, forcing a dietary shift towards the consumption of non-graminiferous vegetation at high stocking rates. In winter, the high CP content of browse and forbs (9.4±2.91% and 9.6±1.65% of selected organs respectively) compared to that of grasses (3.8±0.49% of herbaceous layer, but 5.9±2.83% of selected organs) may contribute to the observed dietary shift, even at low stocking rates.

In conclusion, only cattle kept at low stocking rates can pursue their dietary preferences fully, as they have a wide choice of diet available to them, from which they select a limited number of principal components. Nevertheless, these supply them with a diet high in nutritive value. As the cattle stocking rate increases, the herbaceous layer undergoes species-compositional and chemical-compositional changes that force cattle to utilize other forage plants not utilized before, and also other not previously ultilized organs of those plant species. This change in the selected diet diminishes its nutrient content, culminating in the well-documented decrease in the performance of cattle at high stocking rates, initially only at the level of the individual, but eventually also at the level of the production system (Jones and Sandland, 1974).

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