VELD CONDITION IS AFFECTED BY THE FRAME SIZE AND STOCKING RATE OF FREE-RANGING BEEF CATTLE

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ABSTRACT

A trial to examine the long-term effects of stocking rate and frame size of free-ranging beef cattle on animal and veld performance, was launched in the camelthorn tree savanna of eastern Namibia in 1987. As from 2001, this trial also served to elucidate how diet selection by cattle of various frame sizes and at different stocking rates affect veld condition. 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.

Two different cattle frame sizes were employed, viz. the relatively large-framed Afrikaner x Simmental crossbreed and the small-framed, purebred Sanga. Veld condition was determined along the diagonal transect of treatment plots by measuring separately the canopy cover of the soil, the relative botanical abundance of different plant species, total herbaceous yield and the yield, tuft yield and tuft density of six ecological indicator grasses *(Anthephora pubescens, Aristida stipitata, Brachiaria nigropedata, Eragrostis rigidior, Schmidtia pappophoroides* and *Stipagrostis uniplumis)*. Yield was determined before and after grazing, in an attempt to quantify the dry matter removed per indicator grass as a result of grazing. The nutritive value of the removed matter was estimated by analyzing samples obtained by hand-plucking indicator grasses in a manner imitating the diet selection pattern observed in the cattle.

Results indicated clear-cut compositional changes occurring in the grass sward, primarily in response to the systematically increasing stocking rate, but in some instances also in reaction to the different cattle frame sizes utilizing the plots. These compositional changes were obscured in the total herbaceous yield. In general, the abundance, tuft yield and tuft density of preferred grass species declined in response to increasing stocking rate, but this was compensated for by flourishing less- or non-preferred grasses. Different indicator grasses had different thresholds of sensitivity towards grazing, with *B. nigropedata* and *A. pubescens* being most and *A. stipitata, S. uniplumis and E. rigidior* being least susceptible to severe defoliation (in ascending order of sensitivity). It appeared that *S. pappophoroides*, in particular, is a good indicator of the reaction of natural vegetation to defoliation by cattle, and can be used to track deteriorating veld condition better.

INTRODUCTION

Veld condition is a broad term that describes the general well-being or health of the natural vegetation (veld) in southern Africa in relation to its long-term potential for livestock production (Tainton, 1999). It encompasses a multitude of components that can be used to determine whether condition is improving or deteriorating. In the present study, components investigated included the veld's botanical composition and species diversity, the productivity of its herbaceous components, the vitality and density of individual grass tufts and the canopy cover of the soil. In a highly variable climate such as that of semi-arid savannas, veld condition is not static and, from a managerial perspective, it is often more useful to know in which direction veld condition is changing, i.e. its trend, than to know the absolute condition. This implies that veld condition has to be monitored over time to determine the trend of its change (Heady and Child, 1994).

Furthermore, veld condition is an inherently subjective term, since "optimum" condition depends very much on the type of utilization, or production system, that is practised. It is generally agreed that one of the most assured ways of inducing savanna veld deterioration is to overstock it with grazing livestock (Tainton, *et al.*, 1999). This was clearly demonstrated by a long-term, farm-scale systems trial started at the Sandveld Research Station in eastern Namibia in 1987, in the central Kalahari camelthorn savanna, which trial investigated the effect on veld condition of four systematically increasing stocking rates of beef cattle, as well as two cattle frame sizes (Kruger, 1998). Since 2001, changes in veld condition in this trial have been related to the dietary selection patterns of free-ranging beef cattle, on which this article will report.

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MATERIALS AND METHODS

Refer to previous article on "Does the frame size of free-ranging cattle influence their diet?" In addition, the following procedures relating specifically to veld condition were executed:

- during the determination of the abundance of plants along the treatment plot's diagonal transect, canopy cover of the soil was determined by classifying the exact point of impact of the falling rod either as "bare" or "covered",

depending on whether it struck, or fell under, a plant canopy or not;

- during clipping of quadrats along the transect to determine herbaceous yield, the number of tufts of the six indicator grass species clipped was also counted, to determine tuft density (in tufts/m^2) and tuft yield (in g dry matter/tuft) of these indicator grasses. As this procedure was repeated before and after grazing of the treatment plot, it was possible to calculate the amount of dry matter (DM) removed per tuft of indicator grass during the period of occupation of the plot. Theoretically, this represents the amount consumed by the cattle as well as losses caused by trampling. A small number of game animals roamed the treatment plots and, since their consumption could not be separated from that of the cattle, it was included with that of the cattle.

RESULTS AND DISCUSSION

The average canopy cover of the soil was 77.1±4.46% and was not affected by treatment. It was closely linked to seasonal rainfall, indicating that even under the trial's most severe grazing treatment, plant canopies still adequately protected the soil, provided that rainfall had been sufficient. Grasses comprised on average 71.4±5.2% of the total vegetation and did not differ between treatments ($P > 0.05$). Even at the most severe stocking rate, grasses comprised at least 69.1% of the vegetation, with more than 99% being perennial. Woody plants comprised 13.4±3.2% of the vegetation and were more abundant only at the highest stocking rate (16.8%, $P < 0.01$, $R^2 = 0.61$) and in plots occupied by large-framed cattle (14.2% vs. 12.6% in plots occupied by small-framed cattle, $P < 0.05$, $R^2 = 0.61$). This may indicate that an ecological threshold towards bush thickening was reached as a result of the most severe grazing treatment, accelerated by cattle frame size. The botanical abundance of dicotyledonous forbs did not differ between treatments. Compared to neighbouring farms, characterized by dense bush thickening, bare soil and an annual grass sward, veld in the treatment plots was still in relatively good condition.

Diet selection observations on the cattle in the treatment plots had indicated earlier that they relied heavily on certain preferred perennial grasses and selected non-preferred grasses only at the higher stocking rates. As a result, the relative abundance of the preferred grass *A. pubescens* declined rapidly with increased stocking rate. Even at the medium-high stocking rate treatment, *A. pubescens* already declined from 17.7% to less than 0.5% ($P < 0.01$, $R^2 = 0.98$). Its tuft density before grazing decreased from 1.3 tufts/m^2 at the lowest stocking rate to less than 0.01 tufts/m^2 at the highest stocking rate ($P < 0.01$, $R^2 = 0.92$). Similarly, its tuft yield before grazing declined rapidly from 15.3 g DM/tuft at the lowest stocking rate to less than 0.1 g DM/tuft at the highest stocking rate ($P < 0.01$, $R^2 = 0.78$). Cattle frame size had no effect ($P > 0.05$) on this grass.

Another preferred grass, *B. nigropedata* behaved similarly to *A. pubescens*, except that it was much less abundant, even at the lowest stocking rate (0.6% of all plants at 0.02 tufts/m^2) and disappeared from the sward after the lowest stocking rate treatment. However, it was very productive, yielding 74.2 g DM/tuft before grazing. This grass and *A. pubescens* were clearly intolerant of the level of defoliation associated with realistic, let alone high stocking rates. The cattle were observed to utilize all aboveground organs of these grasses, leaving a residual stubble of 1–5 cm high, depending on grazing pressure. It was calculated that during the period of occupation these grasses supplied the cattle with about 21.8 g and 3.9 g DM/tuft respectively. The grazing material supplied by *A. pubescens* contained more crude protein (CP; 7.5% vs. 6.0%) and was more digestible (DOM; 58.1% vs. 46.2%) than that of *B. nigropedata*, explaining the cattle's greater preference for the former.

Eragrostis rigidior and *S. uniplumis* were not preferred by the cattle, so were selected more frequently only at higher stocking rates. Accordingly, their botanical abundance increased from 5.2% and 6.8% respectively at the lowest to 11.3% and 18.8% respectively at the highest stocking rate ($P_{Erig} < 0.01$, $R^2 = 0.82$, $P_{Suni} < 0.01$, $R^2 = 0.88$). Both grasses were more abundant in treatment plots occupied by small-framed cattle, than in plots occupied by large-framed cattle (11.1% vs. 9.7% and 13.6% vs. 11.4% respectively, $P < 0.01$). Their tuft density also increased due to stocking rate, from 0.4 to 1.4 tufts/m^2 ($P < 0.01$, $R^2 = 0.82$) and from 1.5 to 4.3 tufts/m^2 ($P < 0.01$, $R^2 = 0.78$) respectively. However, the abundance and tuft density of *E. rigidior* peaked at the medium-high stocking rate, whereas that of *S. uniplumis* continued to increase throughout all stocking rates, indicating that *E. rigidior*'s tolerance threshold is lower than that of *S. uniplumis*. The tuft yield of *E. rigidior* declined steadily from 29.0 g DM/tuft at the lowest to 17.7 g DM/tuft at the highest stocking rate ($P < 0.01$, $R^2 = 0.35$). The tuft yield of *S. uniplumis* held steady at around 11.7 g DM/tuft at the first three stocking rates, declining to 9.8g DM/tuft at the highest stocking rate ($P > 0.05$, $R^2 = 0.38$).

Tufts of *E. rigidior* and *S. uniplumis* were utilized very unevenly, so it was impossible to get a reliable indication of the quantity removed by the cattle during the grazing period. During summer, only their inflorescences were selected, while young or previously utilized tufts would be grazed repeatedly to ground level during the drier seasons, leaving big tufts untouched. The removed material contained 5.6% and 4.8% CP and 42.6% and 43.3% DOM, respectively. Although not preferred, these grasses can supply cattle with a lot of bulky forage during times of need, e.g. in the dry season, when more preferred forage has been depleted.

Aristida stipitata was hardly utilized at all and, for reasons of space, will not be discussed in detail. It could develop fully under all treatments, but became more abundant at higher stocking rates because of declining competition from the more preferred grasses. Large-framed cattle accelerated this trend, as they selected a small number of preferred grasses even more intensively than small-framed cattle.

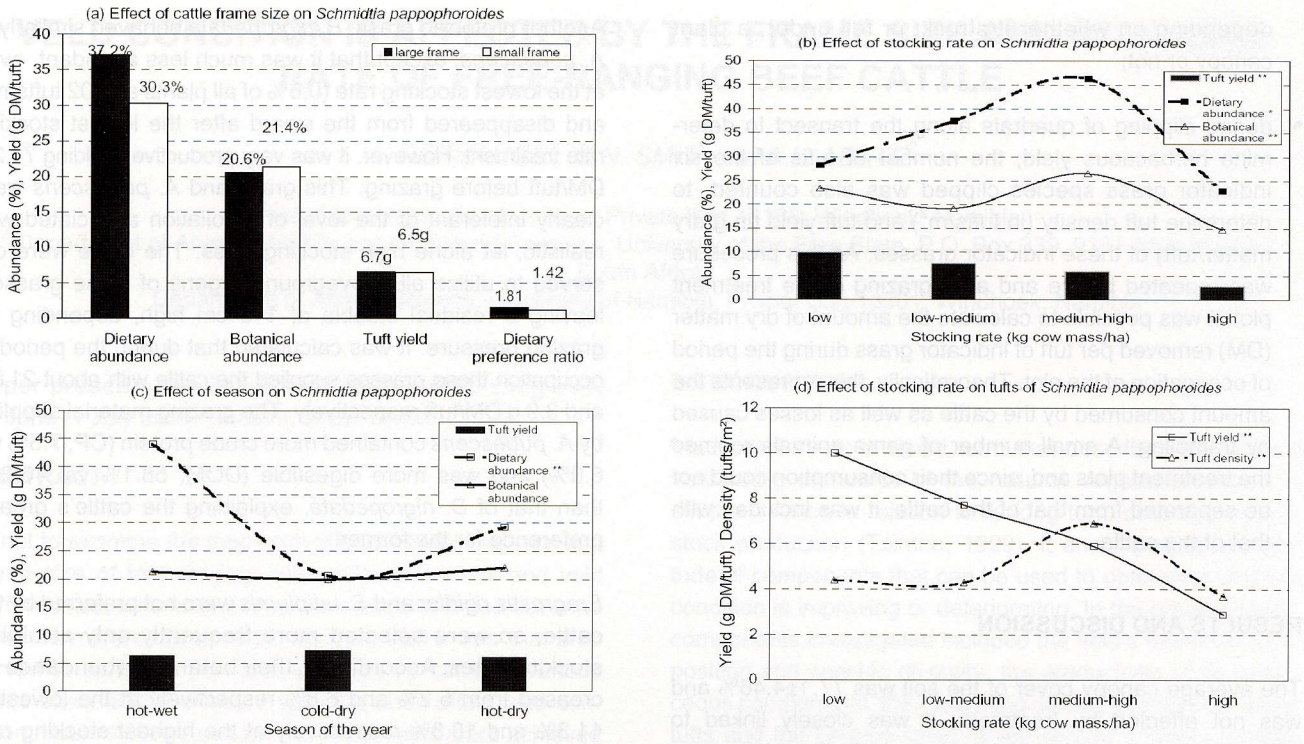

Figure 1. The effects of experimental treatments (a: cattle frame size, b and d: cattle stocking rate and c: season of the year) on the perennial indicator grass, *Schmidtia pappophoroides*. Statistical significance of treatment is indicated by * ($P < 0.05$) or ** ($P < 0.01$).

Of the six ecological indicator grasses studied individually, it appeared that *S. pappophoroides* was the most suited for beef ranching. It was preferentially selected by the cattle at all stocking rates and relatively tolerant of the associated defoliation, maintaining a noticeable presence in the grass sward even at the highest stocking rate (Figure 1). This makes it a valuable species for monitoring purposes. The cattle utilized equally all its aboveground organs containing 4.9% CP and 54.1% DOM, leaving a very short residual stubble.

The DM yield of forbs (15.0±11.0 g/m^2) did not react systematically to treatment, nor did the yield of perennial grasses other than the six ecological indicator grasses discussed above (15.2±6.7 g/m^2). The highest total herbaceous yield (188.1±41.7 g DM/m^2) was recorded at the medium-high and the lowest (153.5±40.9 g DM/m^2) at the high stocking rate ($P < 0.05$, $R^2 = 0.31$). Obviously, the increased yield of less preferred grasses masked the decreasing yield of the preferred grasses, so total herbaceous yield is not a sensitive indicator of the early stages of veld degradation, when the grass sward undergoes changes of composition and vitality.

The high proportion of necromass (grass and forb litter of the current season, on the ground and attached, but excluding decomposing matter) in the total herbaceous yield (38.8±16.4% decreasing to 26.1±17.9% at the highest stocking rate, $P > 0.05$, $R^2 = 0.22$) indicates that there was always a lot of underutilized perennial grass about at any stocking rate. At the lowest stocking rate, *S. uniplumis* and *E. rigidior* contributed most to necromass, whereas at the highest stocking rate, primarily *A. stipitata* and *Eragrostis pallens* were involved.

In conclusion, total as well as living herbaceous yield did not differ between stocking rate or cattle frame size treatments because the veld had not yet passed the threshold of degradation towards annual, bush-encroached and denuded veld. However, degradation had already started in terms of species-compositional and tuft vitality changes, especially as a result of increased stocking rate. These early degradational changes can be detected only by monitoring certain individual species. *Schmidtia pappophoroides* is particularly suited to better tracking of deteriorating veld condition, as it is simultaneously a preferred and a principal forage species of beef cattle in eastern Namibia and also relatively tolerant of defoliation at economically realistic stocking rates.

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