

## Grazing impacts on rangeland condition in semi-arid south-western Africa

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**Introduction** The savannah biome, consisting of a dense herbaceous layer and a relatively open woody layer in competitive balance, constitutes 64% of the land surface of Namibia, an arid country in south-western Africa, and is used mainly for extensive cattle and sheep ranching. About half of the savannah area is affected by dense to moderately dense bush-thickening, resulting in a ten-fold decrease in the rangeland's grass-based carrying capacity and a concomitant loss in meat production of about US\$115 million per year (De Klerk, 2004). Bush-encroached areas typically have densities > 2 000 bushes/ha with > 90% belonging to a single species. High grazing pressure by specialist grazers, such as domestic cattle, is often blamed for rangeland degradation. There is an urgent need to understand the dynamics of bush encroachment and devise grazing strategies to contain it.

**Materials and methods** Observations on diet selection of free-ranging beef cattle in a semi-arid savannah of central Namibia quantified dietary preferences and diet composition of cattle exposed to a three-fold increase in the stocking rate (SR) from 1 large stock unit (LSU)/30 ha to 1 LSU/10 ha (Rothauge, 2005). The diet selection study was supported by detailed botanical surveys determining the canopy cover of the soil and botanical composition of the rangeland in the treatment plots, average size, 142 ( $\pm 28.9$ ) ha, by systematic point sampling, as well as by clipping herbaceous yield in quadrats before each observation of diet selection. Yield and density of grass tufts was determined by counting the clipped tufts per species. Abundance data was subjected to an arcsine transformation. All data were pooled for the SR treatments, cattle type (CT) and season. Observed rangeland condition was the result of 17 consecutive years of imposition of the treatments.

**Results and discussion** Stocking rate had a much bigger impact on rangeland condition than season or CT. The increase in SR caused the canopy cover of the soil to decrease by 9% ( $P < 0.01$ ), total herbaceous yield to decrease by 17% ( $P < 0.05$ ), density and yield of tufts of grass species preferred by cattle to decrease by 36% and 97%, respectively (both  $P < 0.01$ ), and a concomitant increase in the density of grass species not preferred by cattle by 250%, while their tuft yield declined by 71% although the grass sward was still dominated by perennial grasses at both SRs. Species compositional changes in grasses could not be detected by the traditional method of clipping all grasses irrespective of cattle's dietary preference for different species. Even a decline of 17% in herbaceous yield might not be apparent without a long-term data set for comparison, due to highly variable annual rainfall. Simultaneously, the increase in SR caused six known invasive species of woody plants to become 85% more abundant ( $P < 0.01$ ), while the abundance of woody species unlikely to become invasive ( $n=4$ ) increased by only 2% ( $P > 0.05$ ). Overall abundance of woody species increased by 39% ( $P < 0.05$ ), to 17%. In contrast to grasses, woody plants became perceptibly denser although still far from forming a dense stand dominated by only one species. Many woody species were still struggling for supremacy in the rangeland of the treatment plots. Predictably, beef production of cattle in the treatment plots declined by 8% per cow, but increased by 241% per hectare with the three-fold increase in SR. Annual calving rate (calves born/cows mated) decreased by 2% ( $P < 0.05$ ) and the inter-calving period increased by 3% ( $P < 0.01$ ).

**Conclusions and recommendations** A three-fold increase in the stocking rate of beef cattle had, after 17 years, not caused typical bush encroachment, although rangeland condition had clearly deteriorated in terms of soil cover, abundance of preferred forages and woody plants. Many of the initial changes, especially in species composition, are not readily visible unless monitored intensively and compared to a long-term data set. Ranchers are thus seduced into stocking up their cattle because beef production per unit area is still increasing, albeit at a slower rate, in accordance with the model of Jones & Sandland (1974). The bush encroachment so typical of large parts of Namibia must have been caused by stocking rates in excess of 1 LSU/10 ha.

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