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Impact of high-density grazing compared to conventional grazing on the woody vegetation of the Kalahari Savannah of South Africa

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Abstract

Kalahari Savanah rangeland of Southern Africa is known for well-balanced herbaceous and woody layers. Historic use of conventional grazing, with long grazing periods and insufficient rest periods, caused bush encroachment. High density grazing might prevent bush encroachment. Two grazing approaches were compared to quantify their impact on tree density. The conventional grazing (CG) approach consisted of four camps. Cattle grazed each camp for 14 days, at a grazing pressure of 0.5 large stock units (LSU) per hectare (ha), followed by 42 days of rest. This equates to a stocking rate of 8 ha per LSU. For the high-density (HD) approach, camps were grazed one to two days, at 27.5 LSU/ha, with rest periods of 120 days. Which equates to a stocking rate of 4 ha per LSU. Surveys were done along a 100m x 2.5m belt transect (four replicates, three distances from watering point), using the Biomass Estimates from Canopy Volume model (BECVOL). This method measures woody species richness, total tree density (plants ha^{-1}), total dry matter production estimates (kg DM ha^{-1}) and Total Evapotranspiration Tree Equivalents (ETTE ha^{-1}). Tree density was lower at HD (780 plants ha^{-1}) compared to CG (1 077 plants ha^{-1}), ($P > 0.05$). Evapotranspiration tree equivalents was significantly ($P < 0.05$) lower at HD (1 605 ETTE ha^{-1}) than at CG (2 295 ETTE ha^{-1}). Total woody biomass production was almost similar for CG (2 730 kg DM ha^{-1}) and HD (2 790 kg DM ha^{-1}). Seedling density was significantly ($P < 0.05$) higher at CG (1 303 plants ha^{-1}) than at HD (684 plants ha^{-1}). High-density grazing generally had a far less negative impact on tree density than conventional grazing. It can therefore be concluded that a HD grazing approach could contribute positively towards ecosystem health in the Kalahari Savannah of South Africa.

Introduction

Pristine Kalahari Savanah rangeland of Southern Africa is known for well-balanced herbaceous (grass) and woody (tree and shrub) layers (Mucina and Rutherford, 2006). Historic application of continuous grazing and later conventional rotational grazing systems, with long grazing periods and insufficient rest periods, has caused bush encroachment (Smit 2004, Ward 2005, Bond & Midgley 2012, Belayneh and Tessema 2017). High density grazing, which entails higher densities of grazing livestock for shorter periods, followed by longer resting periods, proofed to enhance general ecosystem health (Chaplot et al. 2016; Malan 2022; Malan and Paulse 2023). This method of grazing forms part of regenerative grazing which has the benefit, amongst others, of preventing bush encroachment (Teague and Barnes 2017; Franke and Kotze 2022, Gebremedhn et al 2023). The objective of this study was to compare the tree densities of two adjacent farms, one under conventional grazing and the other under high density grazing.

Methods

The study area is situated within the Kalahari bushveld bioregion (SVk 1, Mafikeng bushveld), (Mucina and Rutherford, 2006), with a long-term grazing capacity of 8 ha LSU^{-1} (hectare per Large Stock Unit) as indicated in the Long term Grazing Capacity Provincial Maps (2018). This region is characterized by a well-developed grass layer consisting of species such as *Stipagrotis uniplumis, Eragrostis lehmanniana, Schmidtia pappophoroides* and *Schmidtia kalihariensis* (Mucina and Rutherford, 2006; Sandhage-Hofmann et al. 2015). The dominating trees and shrubs are: *Dichrostachys cinerea, Grewia flava, Grewia retinervis, Tarchonanthus camphoratus, Vachellia erioloba, Vachellia hebeclada,* and *Ziziphus mucronata* (Mucina and Rutherford, 2006). The aim was to compare the vegetation dynamics of two adjacent, commercial cattle farms, who were grazed at different grazing approaches over a 20-year period. Two grazing approaches were compared to quantify their impact on the density of woody vegetation. The conventional grazing (CG) approach (normal stocking rate of 8 ha/LSU per year) consisted of four camps, 62 ha each. Cattle (Brahman cross breeds, mean cow weight 550kg, weaning rate 95% at 260kg) grazed each camp for 14 days, at a low stocking density of 0.5 large stock units (LSU) per hectare (ha), followed by 42 days rest. For the high-density (HD) approach (double the stocking rate at 4 ha/LSU per year) camps (10 ha each) were grazed (with Bovelder cross breed cattle, mean cow weight 470kg, weaning rate 98% at 230kg) one to two days at a high stocking density of 27.5 LSU/ha, with rest periods of 120 days.

Surveys were done along a 100m x 2.5m belt transect (four replicates at each of three distances from watering point), using the Biomass Estimates from Canopy Volume model (BECVOL) (Smit 1996; Smit 2014). This method measures woody species richness, total tree density (plants ha^{-1}), total dry matter production estimates (kg DM ha^{-1}) and Total Evapotranspiration Tree Equivalents (ETTE ha^{-1}). The ETTE is defined by Smit (2014) as the leaf volume equivalent of a 1.5m single-stemmed tree. The SPPS statistics for windows package was used for statistical analyses (IBM, 2017)

Results

Results are summarized in Table 1. Total woody biomass production was almost similar for CG (2 730 kg DM ha^{-1}) and HD (2 790 kg DM ha^{-1}), while the other characteristics had big differences. The reason for similar biomass is due to the presence of more big trees in relation to small trees on the HD farm. This phenomenon usually corelates with a healthier savanna ecosystem (Bond and Midgley 2012; Smit 2022). Tree density was lower at HD (780 plants ha^{-1}) compared to CG (1 077 plants ha^{-1}), ($P > 0.05$). Evapotranspiration tree equivalents was significantly ($P < 0.05$) lower at HD (1 605 ETTE ha^{-1}) than at CG (2 295 ETTE ha^{-1}). The higher number of ETTE's on the CG farm is an indication of more, but smaller trees, an indication of a bush encroached area (Belayneh and Tessema 2017; Smit 2022). Similar results were found with seedling density, which was significantly ($P < 0.05$) higher at CG (1 303 plants ha^{-1}) than

at HD (684 plants ha^{-1}). The majority of the seedlings present on the CG farm was that of unwanted species like *Dichrostachys cinerea* and *Gymnosporia buxifolia*.

Table 1: Mean tree density, ETTE, total biomass production and seedling density of woody plants for two grazing approaches. (mean ± SE).

Woody layer	CG	HD
Tree density (Plants ha^{-1})	1 077 ± 42	780 ± 46
ETTE (ETTE ha^{-1})	2 295 ± 59	1 605 ± 55*
Total biomass (kg DM ha^{-1})	2 730 ± 74	2 790 ± 99
Seedling density (Plants ha^{-1})	1 303 ± 19	684 ± 15*

*P < 0.05. Total Evapotranspiration Tree Equivalents (**ETTE**), Grazing approaches [conventional grazing (**CG**), high-density grazing (**HDRa**).

Although this paper focusses on the woody layer, it is worth mentioning that CG had a lower veld condition score of 412 compared to 581 of HD, while the percentage of perennial grasses was also higher (64%) at HD than at CG (43%).

Discussion

Bush encroachment due to wrong grazing practices is a huge problem in the savanna areas of the world (Kgosikoma and Mogotsi 2023; Di Virgilio et al. 2019, Gebremedhn et al. 2023). Such grazing practices includes continuous grazing and approaches with long grazing periods and improper resting periods. High density grazing leads to a high grazing impact for a short period, followed by an extended rest (recovery) period (Chaplot et al. 2016, Franke and Kotzè 2022). This grazing approach is believed to hold many benefits by improving soil health, vegetation health and animal health (Hawkins et al. 2017; Malan 2022). In this study, high-density grazing generally had a far less negative impact on the density of woody vegetation than lower density (conventional) grazing. It can therefore be concluded that a HD grazing approach could contribute positively towards ecosystem health in the Kalahari Savannah of South Africa.

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