Effect of short duration high density grazing on South African mesic grassland

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Introduction

- Short duration high density grazing (HDG) is currently gaining popularity
- HDG is achieved by concentrating large animal numbers of livestock in small areas for short periods of time creating “herd effect”
- The use of fire under HDG is discouraged

Introduction cont.

- HDG contended benefits:
  - Increases livestock production by increasing production of key foraging species
  - Improves biodiversity
  - “Hoof action” breaks soil crusts, improves infiltration
  - Large deposits of dung and urine increases soil nutrients

Introduction cont.

- However there is no evidence to support these claims in the South African mesic grasslands

Aim

- To assess the effect of short duration, high density stocking of cattle on soil physical and chemical properties and plant species composition of mesic grassland


Objectives

To determine the impact of HDG and LDG on:

- Soil physical (compaction) and chemical (pH, available phosphorus, total nitrogen and total carbon) properties,
- Plant species composition,
- Forb composition defined by functional traits

Materials & methods

- Study areas were located outside Cedarville and Kokstad, South Africa

Image from: http://flamesonmytank.co.za/TourReports/Transkei1.htm

Materials & methods cont.

- Dominated by perennial grasses, such as *Themeda trianda* and *Tristachya leucothrix* with patches of bush clumps with *Leucosidea sericea*
- Mean annual precipitation is 780 mm
- Soils are mainly clay-loam textured and derived from mudstone and sandstone

Materials & methods cont.

- Fence-line contrast between two properties, one was a short duration rotational system at a high density (HDG) and the other a rotational grazing system at a much lower density (LDG)

Materials & methods cont.

Table 1: Details of grazing systems at Kokstad and Cedarville

	Kokstad		Cedarville	
Grazing system name	HDG	LDG	HDG	LDG
Total size of grazing area (ha)	250	280	540	530
Mean herd size (AU)*	218	100	400	225
Number of paddocks	16	4	15	5
Mean paddock size (ha)	15	70	50	100
Mean period of occupation (days)	7	40	7	160
Mean period of absence (days)	120	120	70	120
Stocking density (AU ha^{-1})	15	1	8	2
Total frequency grazed per annum	2-3	2-3	2-3	2

*One AU is defined as equivalent to one cow, weighing 450 kg which gains 0.5 kg per day on forage with a digestible energy percentage of 55% (Trollope et al. 1990).

Materials & methods cont.

Soil physical and chemical properties

- Soil compaction measured with dynamic cone

- Soil samples collected from surface down to 10 cm depth & analysed for:

1. Soil pH & available P using Hunter method;
2. Total C & total N by Dumas combustion using a CNS analyser.

Materials & methods cont.

Plant sp comp and forbs functional traits

- 20 paired 10 x 10m plots along the fence at 10m at each site
- In each plot 50 x 50 cm was randomly placed 20 times
- Each species and its abundance recorded
- Above-ground growth habits of forb species were identified based on competitive ability with a grass sward for light

Materials & methods cont.

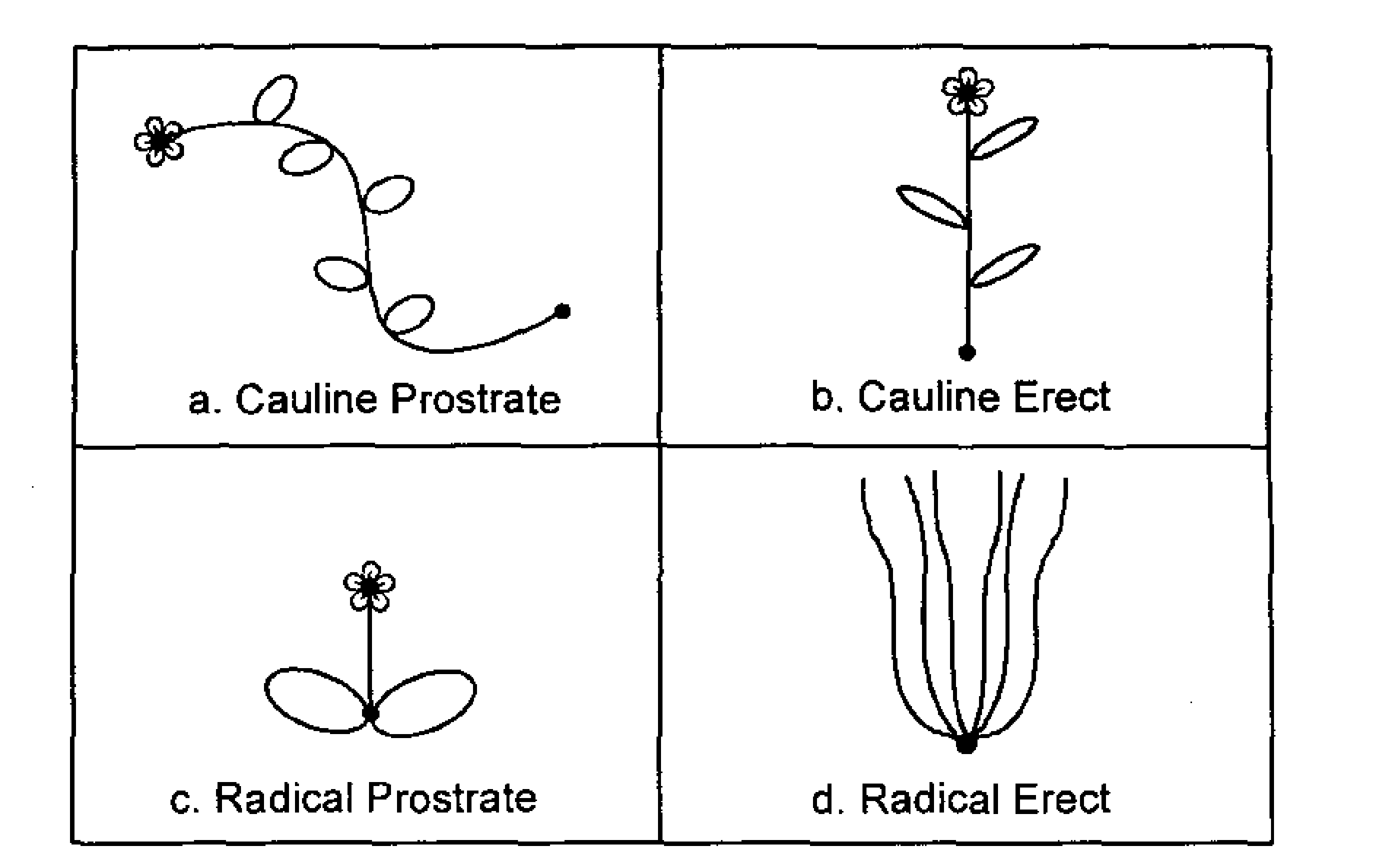


Figure 1: Illustration of the four forb above-ground growth forms examined in this study

Materials & methods cont.

Data analyses

- A paired t-test on SPSS version 23
- Partial redundancy analysis (pRDA) using CANOCO 4.5 package on the species data

Results & Discussion

Soil physical and chemical properties

Table 2: Paired samples Test of soil chemical properties between HDG and LDG

Table 2a. Kokstad

	HDG	LDG	t	df	p
Soil compaction (J m^{-1})	686.00 ± 32.667	473.70 ± 62.594	3.03	19	**0.014**
Soil N (%)	0.31 ± 0.042	0.31 ± 0.029	0.39	9	0.708
Soil C (%)	4.45 ± 0.478	4.43 ± 0.264	0.13	9	0.902
P (mg L^{-1})	5.90 ± 1.972	5.40 ± 1.020	0.71	9	0.495
Soil pH (KCl)	4.70 ± 0.184	4.60 ± 0.123	0.16	9	0.879

Table 2b. Cedarville

	HDG	LDG	t	df	p
Soil compaction (J m^{-1})	369.18 ± 19.844	300.10 ± 21.454	2.10	19	**0.049**
Soil N (%)	0.21 ± 0.006	0.21 ± 0.007	0.34	9	0.742
Soil C (%)	2.87 ± 0.736	2.90 ± 0.639	0.43	9	0.680
P (mg L^{-1})	6.40 ± 0.476	6.10 ± 0.504	0.56	9	0.591
Soil pH (KCl)	5.09 ± 0.045	5.00 ± 0.054	1.61	9	0.142

Results & Discussion

Table 3: Litter and ground cover variables between HDG and LDG

Table 3a. Kokstad					
Variables	HDG	LDG	t	df	p
Litter mass (g m^{-2})	321.0 ± 14.53	186.2 ± 9.63	7.193	19	**<0.0001**
Litter depth (cm)	2.7 ± 0.19	2.5 ± 0.15	0.597	19	0.557
Litter cover (%)	40.2 ± 3.06	32.3 ± 1.45	2.482	5	0.056
Live vegetation (%)	57.0 ± 2.50	55.8 ± 1.83	0.483	5	0.649
Bare ground (%)	2.8 ± 1.01	0.8 ± 0.40	2.148	5	0.084
Table 3b. Cedarville					
Variables	HDG	LDG	t	df	p
Litter mass (g m^{-2})	79.6 ± 11.57	34.0 ± 3.94	4.295	19	< **0.0001**
Litter depth (cm)	1.6 ± 0.13	1.3 ± 0.09	1.954	19	0.066
Litter cover (%)	31.2 ± 1.78	14.5 ± 6.02	2.972	5	**0.031**
Live vegetation (%)	63.3 ± 1.38	76.2 ± 4.14	2.506	5	0.054
Bare ground (%)	5.5 ± 2.51	9.3 ± 3.16	1.635	5	0.163

Results & Discussion

Diversity indices

Table 4a. Kokstad					
Diversity indices	HDG	LDG	t	df	p
Grass J (m^{-2})	0.52 ± 0.015	0.47 ± 0.015	2.520	19	**0.021**
Grass H′ (m^{-2})	1.67 ± 0.048	1.51 ± 0.047	2.954	19	**0.008**
Grass richness (m^{-2})	2.48 ± 0.098	2.51 ± 0.088	0.224	19	0.825
Forb J (m^{-2})	0.60 ± 0.008	0.58 ± 0.013	1.029	19	0.316
Forb H′ (m^{-2})	2.59 ± 0.034	2.52 ± 0.055	1.029	19	0.316
Forb richness (m^{-2})	6.20 ± 0.220	6.41 ± 0.291	0.791	19	0.439
Table 4b. Cedarville					
Diversity indices	HDG	LDG	t	df	p
Grass J (m^{-2})	0.53 ± 0.018	0.61 ± 0.017	3.290	19	**0.004**
Grass H′ (m^{-2})	1.55 ± 0.054	1.72 ± 0.049	2.372	19	**0.028**
Grass richness (m^{-2})	2.04 ± 0.096	2.21 ± 0.069	1.437	19	0.167
Forb J (m^{-2})	0.57 ± 0.015	0.49 ± 0.040	2.088	19	**0.050**
Forb H′ (m^{-2})	2.18 ± 0.058	1.86 ± 0.152	2.008	19	0.059
Forb richness (m^{-2})	3.89 ± 0.169	3.60 ± 0.157	1.363	19	0.189

Results & Discussion

Grass species composition

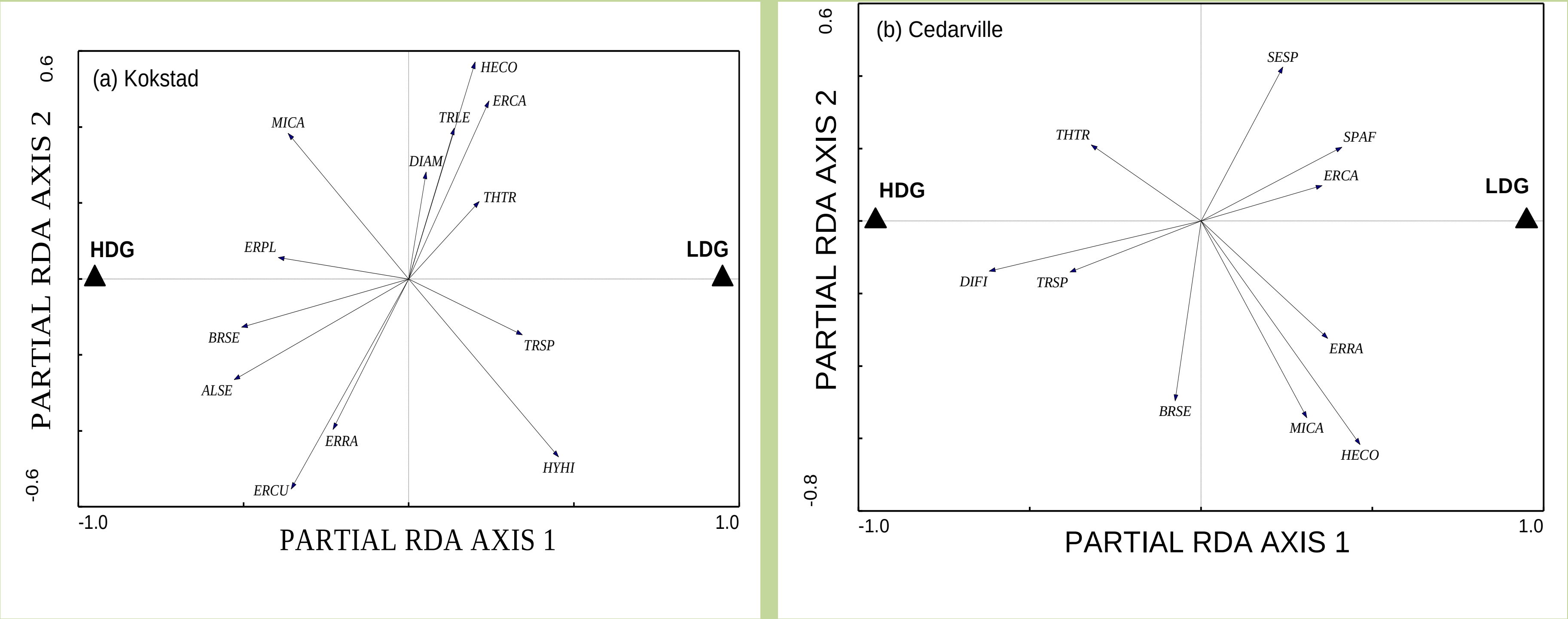


Figure 1 & 2: Plots of a partial redundancy analysis of grass species composition (%) for paired plots between HDG and LDG systems in Kokstad (*n* = 20) and Cedarville (n = 20)

Results & Discussion

Forb species composition

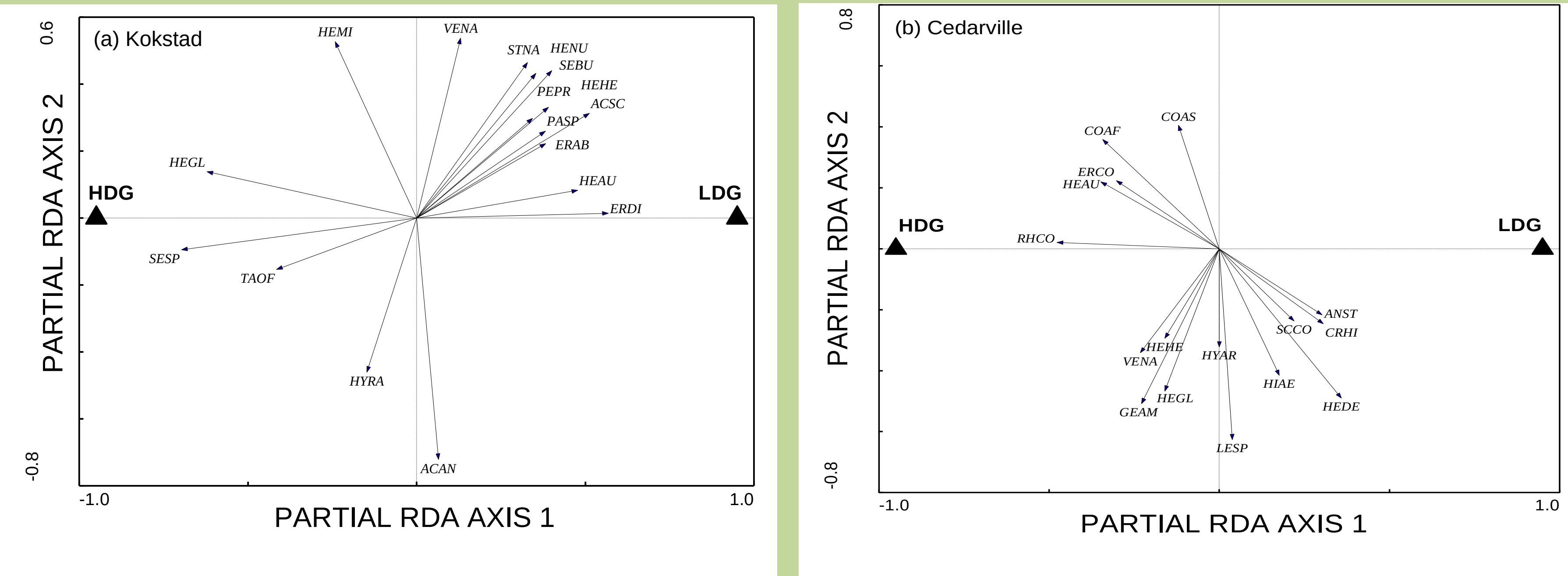
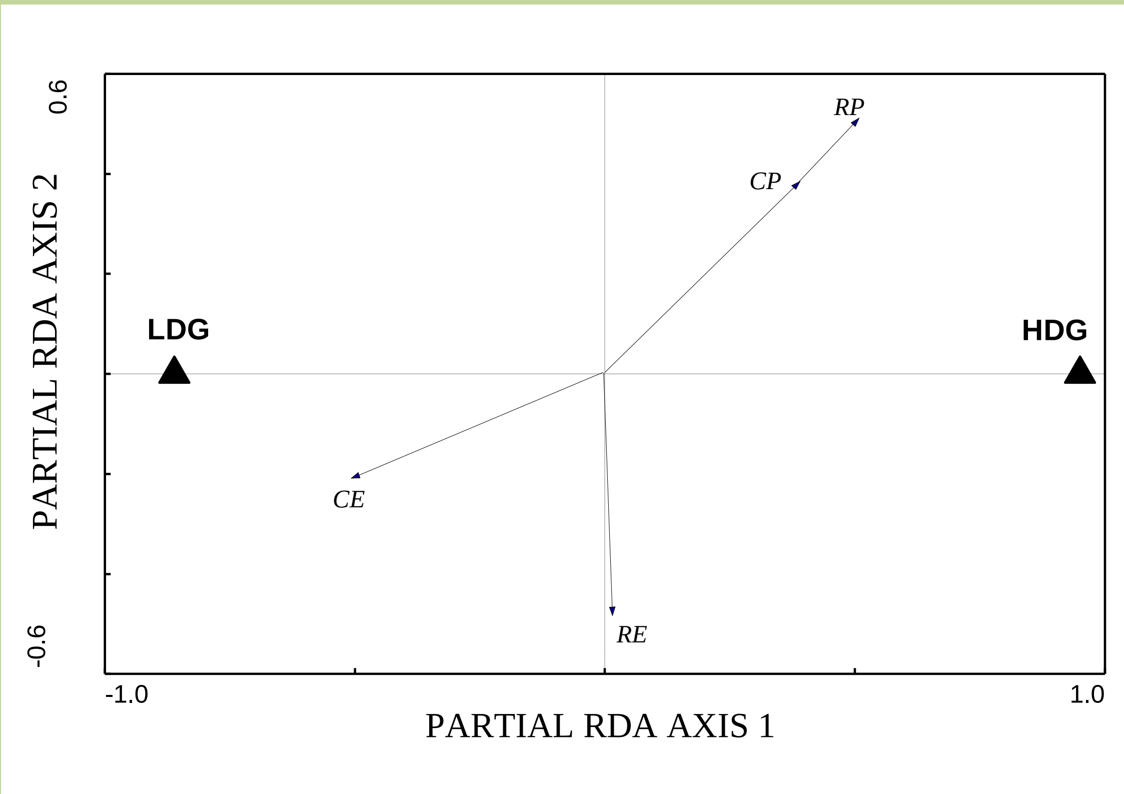


Figure 1 & 2: Plots of a partial redundancy analysis of forb species composition for paired plots between HDG and LDG systems in Kokstad (*n* = 40) and Cedarville (n = 40)

Results & Discussion

Forbs functional traits



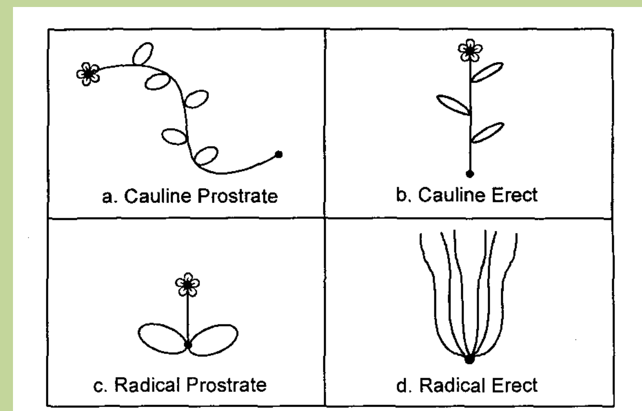


Figure 3: There was a decline of the cauline erect and an increase of the cauline prostrate and radical prostrate above-ground growth habits under HDG compared to LDG (F = 5.3, P = 0.0081)

Conclusions

- Soil compaction under HDG may lead to reduced rainfall infiltration
- Palatable grazing sensitive grass species decreased under HDG and were replaced by unpalatable species
- HDG resulted in the replacement of cauline erect forb growth form by prostrate growth form
- HDG potentially has negative impact on mesic grassland swards

Limitations of study & future direction

- Time for species turnover unknown

- Long term trials initiated at Wakefield farm

Acknowledgements

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INYUVESI YAKWAZULU-NATALI

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SAEON South African Environmental Observation Network




Thank you