Rangeland forage biomass production and composition under different grazing regimes on a Namibian organic livestock farm

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Abstract

The extent and the mechanisms of rangeland vegetation responses to variations of stocking rate, stocking density, grazing intensity, grazing itineraries, and durations of grazing and rest events are insufficiently understood to provide practical decision support for livestock farmers grazing management. Different rangeland management and grazing strategies, among them Holistic Management TM are propagated, but lack scientific endorsement and have stimulated a vivid scientific debate. This paper reports preliminary results of a study on the impact of variations in stocking rate and stocking density on range forage biomass production and composition on the organic cattle and sheep farm Springbockvley in Namibia. Results indicate a tendency that grazing at both, higher stocking density (approx. factor 4) and increased stocking rate (between factor 1.2 and 2) resulted in lower yield depression following reduced rainfall. High density grazing appears to lead to lower accumulation of standing dead plant material and litter. The experiment is ongoing and data analysis is preliminary.

Introduction

Rangelands and/or grasslands cover 30-45 % of the global terrestrial surface (e.g. WRI 2000, MEA 2005, FAO 2016), with low and heterogeneous net primary production, which is the main fodder resource for low external input livestock husbandry. Across Sub-Sahara Africa, rangelands sustain 70 % of the livestock population, provide livelihoods for over 50 million inhabitants and contribute considerably to meat supply and national GDPs (Rass 2006).

Conservation areas and agriculture increasingly expand onto Africas grazing lands, accompanied by a controversy concerning productivity and environmental damage of current livestock based range management (cf. Homewood and Rodgers 1987). Since the 1990s, alternative rangeland management and grazing strategies (including Holistic Planned Grazing, Savory and Butterfield 1999) emerged. Essentially based on varying grazing and rest periods, stocking density and grazing intensity, they have shown convincing success in practical rangeland restoration, hence are also propagated in communal grazing areas, although they lack both, scientific endorsement (e.g. Briske et al. 2014), and practical decision support tools that might facilitate a wider adoption. In order to identify factors that could be incorporated in grazing decision support tools we studied range forage biomass production under different stocking rate and stocking density on a Namibian livestock farm.

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Material and methods

The study was carried out on the 9,500 ha cattle and sheep farm Springbockvley about 180 km Southeast of Windhoek. The climate is semiarid with on average 260 mm annual rainfall in a mono-modal distribution (cf. figure 1). Soils are sandy and partly limestone dominated. Main forage grasses are *Stipagrostis uniplumis*, *Schmidtia kalahariensis* and *Aristida stipitata*. Grass growth terminates in May and restarts with the onset of the rains in November.

Springbockvley is under Holistic Management since 1990 and certified organic (Namibia Organic Association NOA) since 2013. The farm is divided into 60 paddocks and was stocked with on average 890 Nguni cattle and 3,700 Damara sheep between June 2013 and May 2016 (approx. 387,600 kg livestock biomass resp. 861 livestock units LU at 450 kg LW; average stocking rate was 41 kg livestock biomass per ha). The farm is currently grazed in a full farm rotation with three herds: cows (133,000 kg livestock biomass, 296 LU), oxen (106,000 kg livestock biomass, 236 LU) and sheep plus young fattening bulls (148,000 kg livestock biomass, 329 LU). Every herd grazes every paddock on the farm about once in a year according to a grazing plan for a number of days determined each year in May after a visual biomass assessment, from which the number of allowable grazing days per paddock is derived. Grazing duration per paddock is shorter during the growing period and longer during the dry period. Paddocks are always grazed in the same sequence by all herds. This regime allows for average resting periods between 80 and 100 days between grazing events.

In addition to the current grazing regime (Control), two variations (DoubleSR, HigherSD) where applied to grazing paddocks in four replications (House, Achab, Sand, Pan) each. DoubleSR was grazing at increased stocking rate, i.e. the paddock was grazed for twice the duration foreseen in the plan. HigherSD was grazing at an increased stocking density, i.e. the paddock was subdivided with a mobile electric fence into a number of parcels equivalent to the number of grazing days foreseen in the plan. Every day a new parcel was opened for the herd to graze.

Destructive biomass assessment was done in May (end of growing period) of 2014, 2015 and 2016. A one square metre metal frame was placed every 20 m along a 200 m transect in ten replications for each of the 12 paddocks (three treatments, four replications). Aboveground plant biomass within the frame was harvested quantitatively separated by species, weighed fresh, stored in paper bags, dried at ambient temperature under shade, and weighed dry. A more detailed description of the experimental site, the grazing history, the grazing management, and the research design is provided by Rahmann et al. (2015).

Results

Rainfall and biomass data are shown in figures 1 and 2 respectively. Available biomass (i.e. annual and perennial grasses, legumes and non-legume dicotyledons) declined from 2014 through 2016 in all three treatments, corresponding to cumulative rainfall during 12 months prior to sampling. Standing dead biomass increased in the first year particularly under normal and higher density grazing but under both treatments it declined from 2015 to 2016 while it again increased under double stocking treatment. The amount of litter was constant. Perennial grasses had the largest share in available biomass (58.2-97.3% across years and treatments) followed by annual grasses, legumes and non-legume dicots. Perennials increased while all other decreased over the years irrespective of the treatment.

Figure 1: Rainfall on Farm Springbockvley June 2012 to May 2016

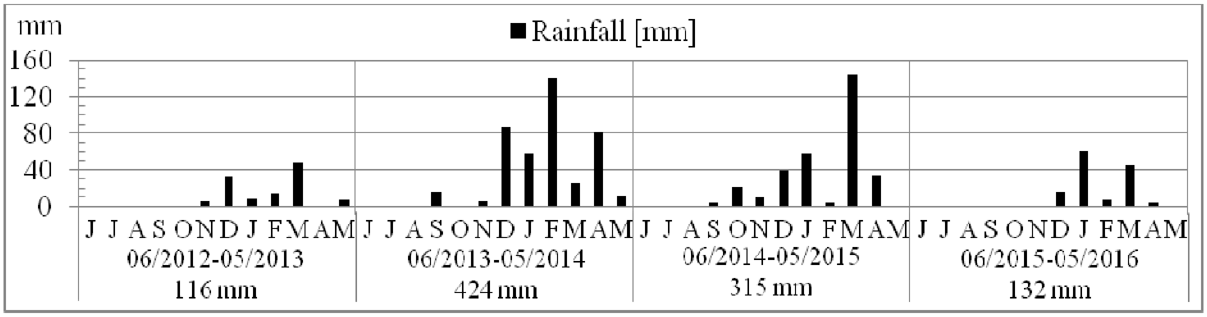

Figure 2: Available plant biomass, standing dead and litter yield [t DM/ha] under different grazing regimes on Farm Springbockvley (2014-2016)

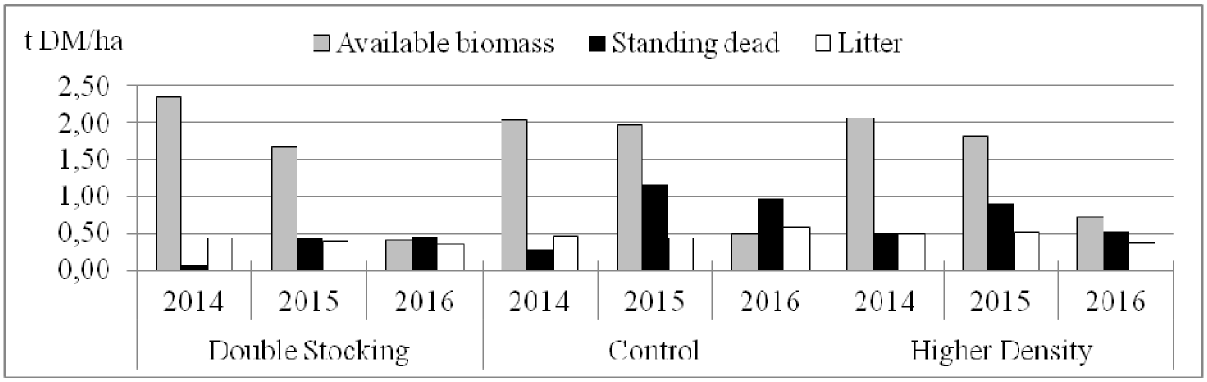

Table 1 shows aboveground forage biomass by treatment for three replications with associated cumulated stocking rate and average stocking density calculated for three grazing events prior to the respective biomass sampling.

Table 1: Aboveground plant biomass yield [t DM/ha] under three different grazing regimes at three different replications 2014-2016

		Sand DM (CSR/ASD)	Achab DM (CSR/ASD)	Pan DM (CSR/ASD)
Double SR	2014	3.39 (22/993)	1.99 (51/1236)	2.18 (37/742)
	2015	1.93 (83/1778)	2.02 (81/ 835)	1.39 (57/697)
	2016	0.55 (104/1052)	0.32 (105/974)	0.52 (57/903)
Control	2014	3.08 (38/937)	1.45 (65/1130)	1.84 (51/921)
	2015	1.93 (57/1229)	2.34 (38/780)	1.80 (30/685)
	2016	0.37 (66/951)	0.66 (56/897)	0.41 (47/843)
Higher SD	2014	3.22 (42/3814)	1.56 (63/4127)	1.36 (49/3917)
	2015	2.80 (60/4993)	1.89 (36/2813)	1.09 (33/3009)

	2016	0.74 (63/3808)	1.11 (60/3252)	0.59 (43/3604)

DM [t/ha]: dry matter aboveground plant biomass; CSR [kg LW/ha/a] = cumulated stocking rate over the period, ASD [kg LW/ha] = average stocking density

Replication House was omitted due to missing data for 2013/14 in table 1 and 2.

Table 2 presents the relative biomass production as biomass measured plus biomass hypothetically consumed at the given stocking rate multiplied by 0.03 (assuming maximum forage intake of 3% per kgLW), index figure 2013/14 = 100. Relative litter/standing dead as measured (cf. figure 2), index figure 2013/14 = 100.

Table 2: Relative biomass production and biomass reduction (2013/14 = 100) under three different grazing regimes 2014-2016

	Relative biomass production			Relative litter/standing dead		
years	DoubleSR	Control	HigherSD	DoubleSR	Control	HigherSD
2013/14	100	100	100	100	100	100
2014/15	90	96	91	238	226	155
2015/16	49	43	58	234	230	98

Discussion

As shown in table 2 results suggest that both, an increased stocking rate and density, may be beneficial for an improved production of available biomass. Higher stocking density may in addition lead to reduced accumulation of standing dead plant material and litter. The observed years vary in rainfall, which is likely the cause of reduced biomass growth over the years. Longer experiment periods are necessary to identify factors determining biomass growth and establish possible quantitative relations. Such factors could then be incorporated in grazing management decision support tools.

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