Effects of Grazing Management on Grassland Production and Animal Performance

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Abstract. Five grazing treatments with a set of design for evaluation of seasonal grazing influencing grassland conditions and animal performance have been conducted across northern and western China, in order to identify the key solutions for degradation of grazing grasslands. Here, the effects of seasonal grazing within two systems-one based on current 'survival' practices and the other taking more of a 'production' focus in Bashang grasslands were reported. The experiment involved a factorial combination of alternative practices (survival vs. production systems) in spring, summer and autumn with a layout of 15 plots and 1.5 ha per plot. Results of consecutive two years studies showed that the vegetation composition changed significantly across grazing treatments, and spring rest treatments can significantly improve grassland production but with low LWG across all grazing seasons. Animal lost live weight on all grazing treatments in autumn indicating that the quality of grassland was lower and need supplementary feed in this season. In the meantime, the average LWG is lowest across the whole grazing season in the continuous survival grazing treatments, but highest in the continuous production treatment. In conclusion, spring rest is most important for grassland quality maintenance, and the continuous production grazing is more appropriate for animal production.

Keywords: *Leymus chinensis* grassland, vegetation composition, grassland productivity, animal liveweight gain.

Introduction

Grasslands across China are acknowledged as being degraded to varying degrees having significant environmental, resource and economic impacts (Wang *et al.* 2012). The people who depend upon grassland are below the poverty line with low income. Ninety-five percent of China's poorest people lives in the more fragile ecological areas of the country. The livestock production systems on grasslands across northern and western China have many similarities, which provide the opportunity to think about the problems at a systematic level to identify general mechanisms that apply and from which better general recommendations can be made. In those systems, grassland problems are exacerbated by the severe climate; a short 3–4-month growing season over summer (annual precipitation of 150–450 mm) and then dry, cold periods from autumn through to spring. That means there are only short-periods each year when green forage is available. Current grazing practices throughout the northern and western China have traditionally been the use of herders to manage livestock under continuous grazing throughout the year (Kemp *et al.* 2011). The animals have been primarily managed for survival, which means the only time most of them achieve any growth is during the short summer period. Through autumn, winter and spring animals lose weight and in consequence their growth in summer is to a large extent compensatory gain. These practices have resulted in high animal densities with large impacts on grassland condition and subsequent degradation.

The appropriate grazing method used needs to be reconsidered in relation to the seasonal cycles of grassland growth. Here, five grazing treatments with a set of design for evaluation of seasonal grazing influencing grassland conditions and animal performance have been conducted, aiming to assess the effects of seasonal grazing on grassland conditions and animal performance.

Methods

Study area

Experiments were carried out at the Guyuan State Key Monitoring and Research Station of Grassland Ecosystem (in the south of the Inner Mongolian steppe), situated 1430 m above sea level, Hebei province, China (41°45′N, 115°39′E). The area has a semi-arid continental monsoon climate with an average annual precipitation of 430 mm, mostly occurring between July and September. The mean temperatures throughout the experimental periods were 18.1°C, 21.1°C and 16.4°C in June, July and August, respectively.

Leymus chinensis, *Artemisia scoparia* and *Carexdur iuscula* were the dominant species in the experimental area, germinating in early May and remaining green until mid-September. In addition, *Phragmites communis* and *Cleistogenes squarrosa* were in high proportion during the experimental session, and *Stipa krylovii* could be found but with a scattered distribution.

Experimental design and animal management

The five grazing treatments involved a factorial combination of alternative practices (survival vs. production systems) in spring, summer and autumn with a layout of 15 plots and 1.5 ha per plot. The detailed information about the five grazing treatments is as follows: spring rest, summer survival grazing (with about 75% aboveground biomass removed), autumn production grazing (with about 50% aboveground biomass removed) (SA1); spring rest, summer production grazing, autumn survival grazing (SA2); spring survival grazing, summer survival grazing, autumn survival grazing (SA3); spring survival grazing, summer survival grazing, autumn production grazing (SA4); spring production grazing, summer production grazing, autumn production grazing (SA5). Each treatment has 3 replicates.

At the start of experiment, 198 Mongolia sheep were selected from the main flock on the basis of uniformity of live weight (43 kg ± 3.7), and randomly divided in five groups. All sheep had been grazing on plots from June 15 to September 15, 2011and June 18 to September 18, 2012 and were housed feeding through other periods. Sheep shelter was established in each plot for rest. Water and salt were available all the time and no supplement was added during grazing. Animals received an anthelminthic drench before the start of the experiment.

Grassland condition and animal performance

The herbage biomass of different treatments was determined at the end of spring, summer and autumn, respectively. The materials within a 0.5 m×0.5 m quadrat were cut to ground level using a hedge-trimmer at 9 random locations across each plot. The herbage harvested from each quadrat were dissected into different species groups of grass, sedge and forb, then oven dried to constant weight to determine dry matter (DM) content and dry-weight proportion.

The live weight changes of the sheep in terms of daily live weight gain in each treatment were obtained by weighing each sheep at the start and end of each grazing time. The formula used was as below:

$$daily\ liveweight\ gain(g/d) = \frac{\mathrm{m1} - \mathrm{m2}}{\mathrm{d}}$$

Where, m1 and m2 were the live weight at the end and beginning of grazing season, and d was the grazing days.

Statistical analysis

Analysis of variance were carried out, using SAS 8.2 (proc ANOVA) to test the effect of grazing treatment, season and their interaction on grassland production and LWG per sheep, and year was treated as the repeated measures. Multiple comparisons of means were done by Duncan-test.

Results and Discussions

Vegetation composition

Grazing treatments had significantly effected on the vegetation composition (Fig. 1). The spring rest treatments SA1 and SA2 had obviously higher proportion

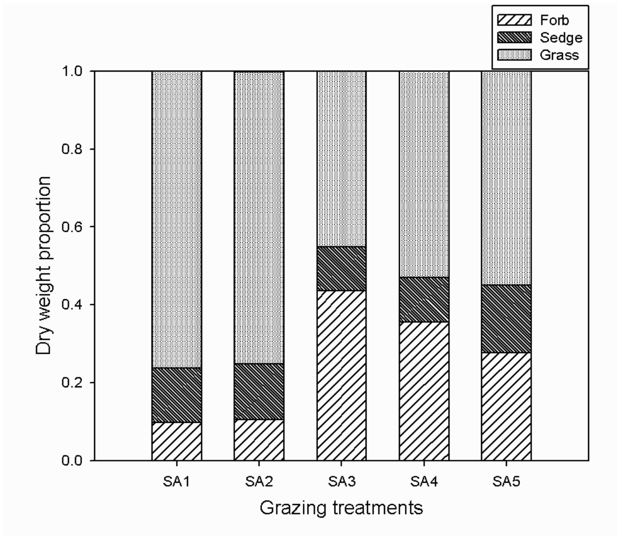

Figure 1. Average vegetation composition of five grazing treatments throughout whole grazing seasons in 2011-2012

of grass, and lower proportion of forb than rest of treatments. The continuously survival grazing treatment SA3 exhibited the lowest grass proportion and highest forb proportion. Compared to the SA5, the SA4 had a similar grass proportion but higher forb proportion. The proportion of sedge did not change much across all treatments.

Grassland production

There was significant difference on grassland production between grazing treatments (P<0.05; Table 1). Across all the grazing seasons, grassland production on the spring rest treatments SA1 and SA2 were significantly higher than those on SA3 and SA5 (P<0.05). SA4 had a similar grassland production to SA3 (P>0.05), but significantly lower than SA5 (P<0.05). Grassland production varied across season (P<0.05) with highest production in summer, but no difference between spring and autumn (P>0.05).

Although the two spring rest treatments had different grazing practice combination in the latter two seasons, no significant difference was observed during the whole grazing periods, and both of which showed higher grassland production than other treatments, indicating that spring rest could be a useful tool for grassland maintenance. The continuously survival grazing treatment had a lower grassland production than the continuous production grazing treatment in each season as expected. However, the similar grassland production at continuously survival grazing treatment and autumn production grazing treatment suggested that changing survival grazing to production grazing in autumn did not work too much in improving grassland quality.

Animal live weight gain

LWG per sheep at SA1 and SA2 were similar to that of SA3 (P>0.05), but significantly lower than SA5 (P<0.05). LWG per sheep at SA4 was greater than SA3 (P<0.05), but significantly lower than SA5 (P<0.05). The effect of GT on LWG per sheep differed from seasons. LWG per sheep at

Table 1. Effect of grazing treatments and grazing seasons (S) on grassland production (g/m^2) in 2011-2012.

Season	SA1	SA2	SA3	SA4	SA5	SEM	Total	GT	S	GT*S
Spring	86.6 a	85.2 a	38. 1c	35.6 c	58.9 b	4.6	60.9 B	<0.001	<0.001	<0.001
Summer	221.6 a	250.7 a	69 c	76.9 c	125.8 b	15.2	151.3 A			
Autumn	110.1 a	99.7 a	26.9 c	26.4 c	51.1 b	7.3	62.9 B			
Total	139.1 a	145.2 a	44.7 c	44.5 c	78.6 b	7.2	91.7			

Within a row (a, b, and c) or within a column (A, B, and C) means without a common superscript differ at P<0.05.

Table 2. Effect of grazing treatments and grazing seasons (S) on liveweight gain (g/d) per sheep in 2011-2012.

Season	SA1	SA2	SA3	SA4	SA5	SEM	Total	GT	S	GT*S
Spring	0	0	131.8 a	147.5 a	153.4 a	14.5	82.8 B	<0.001	<0.001	<0.001
Summer	117.1 ab	104.1 b	67.9 c	65.1 c	143.42 a	6.7	99.5 A			
Autumn	-68.3 a	-59.6 a	-114.9 b	-76.1 a	-54.5 a	7.1	-80.6 C			
Total	16.3 c	14. 8c	11.6 c	39.5 b	80.8 a	10.4	33.9			

Within a row (a, b, and c) or within a column (A, B, and C) means without a common superscript differ at P< 0.05.

SA3, SA4, SA5 were similar in spring (P>0.05). SA5 achieved the highest LWG per sheep in summer, and SA1, SA2 showed higher LWG per sheep than SA3 (P<0.05), and no difference was detected between SA3 and SA4 (P>0.05). All the sheep lost weight in autumn, with SA3 having the most live weight loss, but no difference between other treatments (P>0.05).

The two spring rest treatments did not differ in LWG per sheep. While the spring rest treatments had higher LWG per sheep in summer and lower LWG per sheep in autumn than the continuous survival grazing treatment, LWG per sheep across all grazing seasons were similar. The reason was that the spring rest treatment contributed no LWG to the total live weight per sheep in spring. LWG per sheep at the continuous survival grazing treatment and autumn production grazing treatment showed no difference in spring and summer, but in autumn production grazing treatment exhibited less LWG loss per sheep and eventually resulted in higher total LWG per sheep. The continuous production grazing treatment showed the highest LWG per sheep in spring and summer and lost the least LWG in autumn, suggesting that the continuous production grazing treatment was the most appropriate grazing regime for animal production.

Conclusion

Different grazing treatments had a big influence on the grassland vegetation composition, mainly reflecting from the changed grass and forb proportion on the grassland. Spring rest significantly increased the grassland productivity in each grazing season and was an important measure for grassland quality maintenance. But the continuous production grazing might be a more appropriate grazing regime from the perspective of animal production. However, feed supplements were needed in autumn as all sheep on all grazing treatment lost weight in autumn.

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