Herders' Forage-Livestock Decision Behavior in Northern Grassland regions of China

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Introduction

China has approximately 393 million hectares of grasslands, accounting for 41.7% of the national land area. However, 90% of useable grasslands are degraded because of human and natural reasons. Overgrazing was the dominant factor affecting grassland condition. In order to control the grassland degradation problems, the government has proposed the 'forage-livestock balance' policy in 2002. A series of ecological policies were (Hou *et al*., 2013) and outcomes have been described as a "partial improvement amidst overall deterioration". Reasons for apparent failure of the policy have been the subject of much discussion over the years. However, there has been a lack of research on the role of herder decision making behavior regarding the balance between animals and grass. Under the Household Responsibility System, the herders are directly responsible for managing these vast and important lands for China, and their decisions have both direct and indirect impact on the balance between animal needs and forage supply. Self-reliant herders are the main livestock producers in the Chinese northern grassland regions. Those herders breed animals mainly based on their own available rangelands, and buy forage and fodder only for winter use. They often consider they have lived in pastoral areas for generations, and have their understanding of the rangeland carrying capacity, thus always breed livestock number that they think are reasonable. As a result, overgrazing is universal. A better understanding of the effect herders' behavior has on the grassland condition and the details of decision making and their stock-breeding practices is urgently needed to develop more effective policies and programs to alleviate the degradation of grassland.

Materials and Methods

Study area: Xinbaerhu Left Banner, Xilinhot and Sunite Right Banner were selected as the study area. Three counties were distributed in meadow steppe, typical steppe and desert steppe, respectively. The households own livestock and hold rangeland right through contracts since the 1980s. Livestock production from grazing native vegetation is the primary income of households. Natural grazing all year is the cheapest and most important source of livestock feed in these regions.

Table 1: Background information of study sites

Site	Rangeland type	Rangeland (ha)	Usable rangeland (ha)	Per capital net income (yuan)	Annual temperature(℃, 1980–2011	Annual precipitation (mm, 1980–2011)
Xinbaerhu	meadow steppe	1.94×10^6	1.79×10^6	9101	0.22	274.07
Xilinhot	typical steppe	1.49×10^6	1.38×10^6	9587	2.98	258.73
Sunite	desert steppe	2.58×10^6	2.37×10^6	5140	5.49	194.63

Household survey: A structured, close-ended household level survey was conducted in villages from these three counties during July-September 2011 and 2013 (*Sunite in 2011, Xilnhot and Xinbaerhu in 2013*). Pastoral agriculture is the primary income of households in each village. A stratified random method was used to choose the sample herder households in each of the studied counties. The survey included two topics: (1) basic demographic and socioeconomic information; (2) the details of herders' decision making and production practices.

Field experiment: The experiment was performed at a household scale. The study site was identified by conducting extensive interviews with herders and by direct field observations. These areas were mapped using ArcGIS (ver. 9.3.1), and their economic incomes and stocking rates were calculated using data from the household surveys. The pastures were classified as high economic level (HEL), middle economic level (MEL) and low economic level (LEL). The responding stocking rates were 1.50 sheep unit ha^{-1}, 0.75 sheep unit ha^{-1} and 0.50 sheep unit ha^{-1}, respectively. It is difficult to find ungrazed sites as the household rangelands and enclosures where grazing was forbidden were still used for grazing by herders. In our search for ungrazed plots, we chose grazing plots as control (CK) that had been used as winter grazing sites.

Each site had five plots. In each plot, five point samples were randomly taken at least 10 m apart. Replicate points within the plots were located in closely similar topographic position. At each plot we investigated the cover, density and height in ten quadrats (1 m×1 m). Aboveground biomass was also measured. Data were collected in August, the peak of the growing season in the study area.

Data analysis: To assess the grassland ecosystem health condition, *Costanza's* (1992) model (HI = V×O×R) was modified into

$$HI = \sqrt{V \times O \times R}$$

where HI is the health index of the rangeland, V is the vigor of the rangeland, O is the organization of the rangeland, and R is the resilience of the rangeland. Data were collected as repeated measures. The treatment effect was tested by using one-way analysis of variance (ANOVA), and the significance level for all tests was $P < 0.05$. When there were significant differences among treatments, the least significant difference (LSD) method was used to examine which treatments were different.

Results and Discussion

Table 2 showed the assessment results of herders' pastures of three counties. In Xinbaerhu and Xinlinhot, the health index was the highest in MEL, HEL second and LEL lowest; In Sunite, LEL has the highest health index, and MEL second, HEL lowest. However, the grassland health condition was similar among treatments in each county (*P>0.05*). Notably, while those pastures of all economic levels are unhealthyaccording to the method of quartering (Wang *et al., 2008*). This was directly related with the herders' long-term decisions.

Table 2: Complex ecological health index of each study site.

	Xinbaerhu	**Xilinhot**	**Sunite**
HEL	0.47	0.83	0.41
MEL	0.64	0.83	0.54
LEL	0.21	0.49	0.56

The empirical studies showed that herders' decision making were relatively steady and there was a period of 3–5years. Their making forage-livestock balance decisions often refereed to the rainfall of the year, or the yearly rainfall patterns, and herders had their own judgment about the yearly rainfall patterns for each year.

Herders always carried out the game between profits and prospect utilities. The cumulative prospect utilities were between upper and average years in Xinbaerhu and Xilinhot, while between lower and average years in Sunite. The cumulative profits were the same with the cumulative prospect utilities. Herders were characterized by bounded rationality when making decisions based on yearly precipitation patterns and didn't choose the maximum utilities or profits and such preference was stable in some periods; but herders' behavior varied in accordance with the reference standards affected by some other factors in different grassland areas.

Conclusion

Our paper analyzed the effect of those herders' long-term production decision behavior on grassland condition and the details of decision making. Result showed that their pastures' heath condition was similar among different economic levels (*P>0.05*) and importantly, the pastures are all unhealthy. Herders' production decisions had a period of 3–5years. Their decisions based on yearly rainfall patterns were a complex result of present and past practical patterns. Herders were characterized by bounded rationality when making decisions based on yearly rainfall patterns and didn't choose the maximum utilities or profits.

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