Production and management simulation of family pasture in different pastoral areas based on OMMLP model

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Abstract

Family ranch grassland livestock production optimal management model was used to simulate the grassland supply and livestock demand, family economic status under different stocking rates senarion with collection of grassland, livestock, and economics data from Wuzhumuqin Banner and Tongliao as two types of pastoral areas in Inner Mongolia Autonomous Region. The livestock is grazing all year long in Wuzhumuqin Banner, but the livestock is grazing in summer and feeding in hovel in winter in Tongliao, which we call it as semi-farming and semi-pastoral area. The results showed that summer grassland productivity could meet the energy demand of livestock. As the temperature drops in winter and spring, the energy demand of livestock increases, and there is excessive supplementary feeding suff from December to February in the whole pastoral area, and the supplementary feeding amount from January to next January in the semi-agricultural and semi-pastoral areas is not enough to meet the maintenance needs of livestock requirement. The methane emission of herds was more in summer than in winter, and the average methane emission of herds was 3.87 kg/ day and 3.28 kg/ day in the whole grazing area and semi-farming and semi-grazing area, respectively. When the stocking rate of typical households in the whole pastoral area and semi-agricultural and semi-pastoral area was adjusted to 1.34 sheep units/ha and 1.65 sheep units/ha, the corresponding net income was 198,000 RMB and 81,000 RMB, and the net income of pasture was the highest.

Introduction

China is rich in grassland resources, with natural grassland area of 2.80×10^8 ha~3.99×10^8 ha, Inner Mongolia grassland is the area with the most concentrated development of animal husbandry in China. In recent years, with the rapid development of animal husbandry, grassland degradation, pastoral poverty and other problems have restricted the development of productivity to a large extent, and had a significant impact on the production and life of local people.

A large number of studies have shown that different feeding methods will have different effects on the livestock husbandry of family pasture grassland. Therefore, this paper takes Dongwuzhumuqin Banner, a whole pastoral area dominated by "grazing+supplementary

feeding", and Zhalut Banner, a semi agricultural and semi pastoral area dominated by "grazing+shed feeding" as the research objects, and uses the grass livestock balance model and optimal management model in OMMLP model to simulate them, Analyze and compare the energy status and economic income of grass and livestock between the two, and obtain the production and management plan that can obtain the maximum economic benefits under the premise of protecting the ecological environment through model simulation.

Methods and Study Site

experimental design

The research shows that reducing the livestock carrying capacity will help the restoration of grassland ecosystem and increase the unit productivity of animals. Rational utilization of grassland is helpful to improve grassland degradation, and rational pasture management measures are also one of the ways to achieve rational utilization of grassland [11]. The stocking rates of typical herdsmen in the whole pastoral area and the semi agricultural and semi pastoral area are 1.4SE/ha and 1.8SE/ha, respectively, with a net income of 174000 yuan and 65000 yuan; When the stocking rate level is adjusted to 1.34SE/ha and 1.65SE/ha, the corresponding net income is 198000 yuan and 81000 yuan. Only by finding a reasonable level of stocking rate can we ensure the maximization of economic benefits.

Model introduction and principle

OMMLP (Optimized Management Models for Household Pasture Livestock Farm Production) is a model software system specially designed and developed for Chinese family ranching, focusing on business simulation and Optimized Production. By setting various parameters such as livestock, grassland, supplementary feeding, economy, meteorology, labor force, etc. and setting conditions, the current situation of livestock balance and the growth rate of pasture are simulated, and the optimal management plan of the pasture is obtained.

Results and Discussion

Energy status of grass and livestock in different types of family pastures in pastoral areas

Typical herdsmen in different types of family pastures in pastoral areas were simulated by using the grass livestock balance model (Fig. 1). The energy demand of livestock in the whole pastoral area increased significantly at the end of March. Since the end of September, the energy demand of livestock has increased month by month. Excessive supplementary feeding was found from December to February, and this part of supplementary feeding was invalid. The energy demand gap of livestock in semi agricultural and semi pastoral areas mainly occurred in early March and late October. The temperature began to drop and the energy demand curve rose when October entered winter. From March to April, it was the lambing period of domestic animals, and a large amount of energy was needed to maintain the demand, reaching the maximum energy demand of the year.

When the daily average temperature in winter is lower than - 5℃, the heat loss of sheep is 9MJ~17MJ every day, which is nearly twice the energy requirement in a warm environment (Zhang, X.Q. Kemp, D. Ma, et al. 2017). The livestock carrying rate of Dongwu Banner is high, while the natural grassland area of Zarut Banner is far lower than that of Dongwu Banner, and the quality of forage in cold season is low, so the contradiction between grass and livestock is

more prominent, especially for female livestock. Supplementary feeding is an important measure to ensure the normal growth of livestock. It is particularly important to determine a reasonable amount of supplementary feeding according to the demand of livestock to ensure the maintenance of livestock.

Methane emissions from livestock herds in different pastoral areas

Methane emission of typical herdsmen in different types of family pastures in pastoral areas was simulated using the grass livestock balance model (Fig. 2). Methane emission in the whole pastoral area reached the maximum in August, 5.5 kg/d. The average methane emission of livestock is 3.87 kg/d. In the semi agricultural and semi pastoral areas, there were two significant increases throughout the year. Methane emission reached the maximum in August, 4.89 kg/d. The average methane emission of livestock is 3.28 kg/d.

Seasonal changes will cause changes in microbial species and relative abundance in rumen of grazing livestock, and indirectly affect livestock itself through environmental and forage factors, thus affecting animal production (Guo, P. 2021). In different pastoral areas, with the increase of temperature in spring, the number of livestock and methane emissions increased as the number of female lambing increased; In summer, the forage supply is sufficient, the weight of livestock increases rapidly, and the methane emission also increases.

Simulation of economic income and expenditure of family ranches in different pastoral areas

The optimal management model is used to analyze the economic benefits of the whole pastoral area and the semi agricultural and semi pastoral area under different stocking levels (Fig. 3). The total income and total expenditure both increase with the increase of the stocking rate, and the net income shows a trend of increasing first and then decreasing. Before reaching the threshold, the net income level of expanding the production scale rises, while if it exceeds the threshold value and continues to be put into production, the grassland production efficiency will be low, the ecological environment will deteriorate, and it is not conducive to the long-term development of grassland animal husbandry.

The research shows that reducing the livestock carrying capacity will help the restoration of grassland ecosystem and increase the unit productivity of animals. Rational utilization of grassland is helpful to improve grassland degradation, and rational pasture management measures are also one of the ways to achieve rational utilization of grassland (Li, Z.G. Ma, L.et al. 2021). The stocking rates of typical herdsmen in the whole pastoral area and the semi agricultural and semi pastoral area are 1.4SE/ha and 1.8SE/ha, respectively, with a net income of 174000 yuan and 65000 yuan; When the stocking rate level is adjusted to 1.34SE/ha and 1.65SE/ha, the corresponding net income is 198000 yuan and 81000 yuan. Only by finding a reasonable level of stocking rate can we ensure the maximization of economic benefits.

Conclusions

.In summer, the grassland productivity is high and the energy supply of pasture is sufficient to meet the energy demand of livestock; The temperature drops in winter and spring, and the energy demand of livestock increases. Overfeeding occurs in the whole pastoral area from December to February of the next year, while the supplementary feeding amount in the semi agricultural and semi pastoral areas from November to January of the next year is insufficient to provide the maintenance demand of livestock. Methane emission from livestock is more in

summer and less in winter. When the livestock carrying rate of typical herdsmen in the whole pastoral area and the semi agricultural and semi pastoral area is adjusted to 1.34SE/ha and 1.65SE/ha, the corresponding net income is 198000 yuan and 81000 yuan. At this time, the net income of family pasture is the highest.

Acknowledgements

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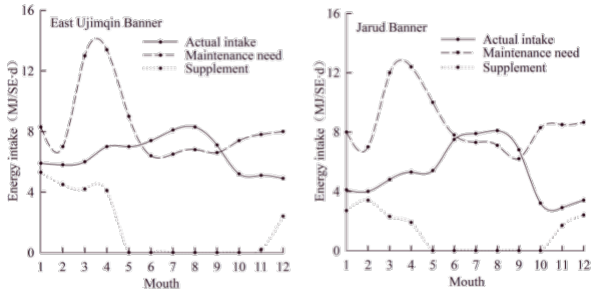

Fig. 1 Simulation of energy status of grass and livestock in family pastures of different pastoral areas

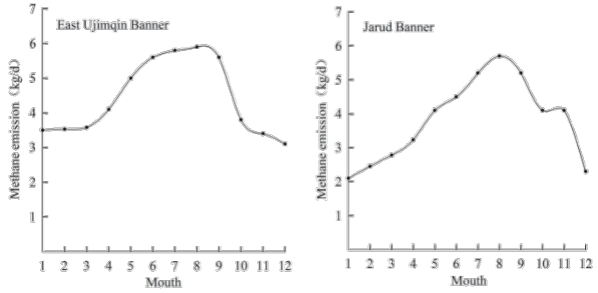

Fig. 2 Methane emission from livestock herds in different pastoral areas

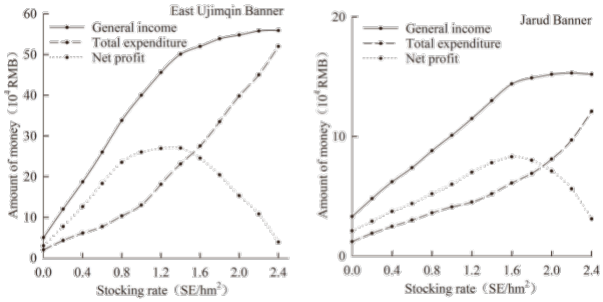

Fig. 3 The model simulates the economic income and expenditure of family ranches in different pastoral areas