



# Wake up “boiling frogs”: a study on animal husbandry under climate change in Northern China

Lijuan Miao<sup>1,2</sup> · Zhanli Sun<sup>2</sup> · Xuefeng Cui<sup>3,4</sup> · Justin Veuthey<sup>5</sup>

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## Abstract

The development of animal husbandry in China is facing enormous pressure from increasing demand of meat consumption, climate change, degrading grassland, and changing national policies. This paper presents the latest findings from an anthropological field investigation interviewing local herders, traders, and local officials from farming–pastoral ecotone in Inner Mongolia and shed lights on how locals have adapted their lives to climate change and the new national husbandry policies of the twenty-first century. Based on the anthropological interviews, we discussed the future opportunities and challenges of animal husbandry development in farming–pastoral ecotone. Results suggested that national ecological conservation policies and meat price have much larger impacts on animal husbandry than climate change, as perceived by locals. Family Fencing Policy, a relatively new policy aiming to avoid overgrazing and restore vegetation, was neither well accepted nor well implemented by the local herders. This is partially explained by the poor fencing technology, insufficient support facilities, as well as the high costs and low-profit margins in the animal husbandry. We conclude by suggesting that pastoralism in Northern China may greatly benefit from the development of rural cooperatives and active participation of locals in policy designing and implementation.

**Keywords** Pastoralism · Adaptation · Climate change · Policy analysis · Inner Mongolia · China

## Introduction

Meat consumption in China has dramatically increased due to rising income and resulting dietary structure change. Now the annual meat consumption per capita reaches 45 kg. Overall, China consumes more meat than any other country per year (71 million tons)—which is twice more than that of United States of America (Larsen 2012). This huge demand for high-quality meat has laid a lot of pressure on the animal husbandry production in China. Although it owns the second largest area of pastoral land in the world (Hua and Squires 2015; Lei et al. 2011), domestic production struggles to meet the rapid growth of meat products. Animal husbandry industry has been the core economic development in Inner Mongolia (IM), a major meat production province in northern China (Liu 2013; Zhang 2013). However, its animal husbandry technology is still far behind developed countries in terms of efficiency and environmental resilience (Wang 2012; Williams 2002). In recent years, most regions in IM have had overgrazing issues and grassland degradation (Gao and Zhao 2010), while at the same time witnessed an increase in extreme climate events (e.g., dust storms,

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✉ Lijuan Miao  
miaolijuan1111@gmail.com

✉ Xuefeng Cui  
xuefeng.cui@ucd.ie

Zhanli Sun  
sun@iamo.de

Justin Veuthey  
justin.veuthey@gmail.com

- <sup>1</sup> School of Geographical Sciences, Nanjing University of Information Science and Technology, Nanjing, China
- <sup>2</sup> Department of Structural Development of Farms and Rural Areas, Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle, Germany
- <sup>3</sup> School of Mathematics and Statistics, University College Dublin, Dublin, Ireland
- <sup>4</sup> School of Systems Science, Beijing Normal University, Beijing, China
- <sup>5</sup> School of Humanitarian Studies, Royal Roads University, Victoria, Canada

drought, *dzud*) (Miao et al. 2015a). Some studies suggested that the trends of desertification under current IPCC AR5 RCP (Intergovernmental Panel on climate change, fifth Assessment Report, representative concentration pathway scenarios) scenarios over the Mongolian Plateau region get worse, as climate change and associated extreme events directly affect the process of vegetation dynamics and animal industry (Miao et al. 2015b, c).

In addition to climate change, national policies on husbandry have made big revolutions in China. After the foundation of the People's Republic of China (1949), the land ownership transferred from nomadic tribes to farmers (1950–1958), then to the state governments. Farmers were issued the right to cultivate the land collectively under rural communes (1958–1978). Since 1979, farmland and grassland were reallocated to individual households under the so-called the Household Responsibility System (HRS) (Xu et al. 2015), under which the household owned the right to use their contracted grassland; households also had the ownership of animals. The HRS greatly stimulated farmers' enthusiasm in improving agricultural production and maximizing their wealth from the land. However, the problem of "Tragedy of the Commons" in particular in the grasslands remains due to overgrazing without sustainable planning (Gao and Zhao 2010). In recent years, the Chinese government has started paying attention to environmental protection, land sustainable management and has thus implemented a series of regulations aiming to recover natural vegetation [e.g., Grain for Green, Ecological Resettlement and Grazing Ban (GB)]. Seasonal Grazing, Rotating Grazing and Grazing Ban are three national methods to prevent the situation of overgrazing according to the *Grassland Law of the People's Republic of China*. The three policies are implemented by the local officials in different regions of IM according to the vegetation growth status. In farming–pastoral ecotone (FPE) in IM, where agriculture and animal husbandry coexist and interact, the grassland resources are even more limited and precious (Li et al. 2015); land use change is more dynamic; ecosystem is also very fragile and sensitive. GB has been initiated since 2003 by the local government to prevent grassland degradation. After that, a complementary policy, Family Fencing Policy (FFP), has been implemented for livestock management, especially in the FPE region in IM. As a new mode of grassland management, FFP is aimed to avoid the tragedy of the commons and bring ecological, economic, and social benefits to local farmers. The national government hoped that land degradation and desertification could be slowed down due to the elimination of overgrazing under the GB and FFP. Researches show that the effects of such policies are positive on the effectiveness. Some researchers pointed out that FFP could not only improve above-ground vegetation productivity but also favored forage grass functional groups and restrained the development of

noxious weed function groups (Miao et al. 2015b; Wu et al. 2009). Also, Yan's control experiment showed that live-stock weighs more in fencing than in grazing (Yan and Tang 2007). FFP will also improve sheep's productivity (e.g., weight, height, and cashmere yield) (Gao and Zhao 2010). On the other hand, according to Zhang (2013), the area of grassland degradation, including light degradation, moderate degradation and severe degradation, greatly increased in IM from the 1980s to the 2010s, while the non-degradation area declined from 67 to 22% of total grassland area during that time span. It means land degradation status in recent decades had become much worse. In addition, from 2001 to 2010, there was no obvious rising trend in the grassland net primary productivity (Mu et al. 2013).

This study is aimed to explore the impacts of national policies from farmers' perspective and identify the future challenges of the animal husbandry management in Northern China. In particular, we focus on one specific question: whether the Family Fencing Policy is a sustainable management strategy for both of the environment and the pastoralists. We investigate this question based on extensive interviews of the local herders, the local market, and local officials.

## Materials and methods

Village Maertu in Jalaïd Banner in IM (Fig. 1) was selected as the case to conduct interviews with local stakeholders between November 2015 and January 2016. Jalaïd Banner is located in the crossroads of three provinces of Inner Mongolia (Heilong Jiang, and Jilin province). It has an area of 11,837 km<sup>2</sup> and is known as the "The Barn beyond the Great Wall". Since the early 1980s, the village Maertu has become permanently settled under the guidance of the HRS policy. At the time of our research, there were over 150 households in this village and 95% of them are Mongols. Maertu is located in the transition zone between cropping agricultural area and nomadic area, so-called farming–pastoral ecotone, and is quite representative in terms of several criteria important for our research: (1) this village is a typical FPE village with large land area per capita, very traditional animal husbandry and under-developed industry; the contradiction between animal husbandry and agriculture industry is prevalent; the overgrazing problem is severe and complicated; (2) in terms of the weather condition, it is located in the arid and semi-arid eco-zone of the Koerqin region with annual precipitation varying between 156 and 824 mm; the grassland is highly sensitive to climate change (Liang and Tang 2009); (3) the household responsibility system has an important role in rural land use management, and all the local Mongolian herders have been sedentary for more than four generations. Our research reveals that pasture grazing

Fig. 1 Map of the study area

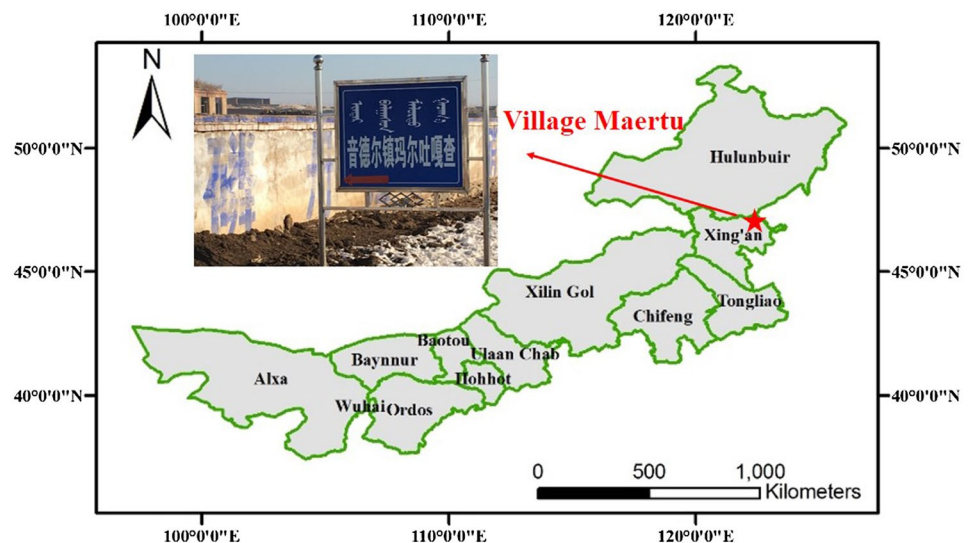


Fig. 2 Sign of the soil erosion in this village

and feedlots are the two main methods of animal husbandry management over the region. Grassland degradation, water loss, and soil erosion is extremely severe according to our field survey (for details, please see Fig. 2).

Anthropological methods were used to gain an in-depth understanding of the state of the animal husbandry development in the selected village. In an anthropological interview, we, as researchers, took a back seat and relied on informants, in this case, herders, to tell their experiences, attitudes and opinions. Although the interviews were sometimes unstructured and non-directive, such approaches had the advantage of getting a deep understanding, and the full story of the real situation. Qualitative sociological approaches were also applied, including structured interview, semi-structured interview and key-informant interview. We randomly selected 50 households as the interviewees. The questionnaire was focused on the attitudes of pastoralists, officials

and their developing willingness towards the development of animal husbandry.

## Results

### Current status of the animal husbandry and people's adaption to climate change

According to our field investigation, the average household income in 2015 was around 6000–10,000 RMB Yuan (~ 1000–1500 USD), which mostly came from the agriculture production (e.g., maize and soybean) and livestock breeding (e.g., sheep, cattle, and horses). The average household expenditure (e.g., seeds, fertilizers, forage, animals, medical expenses, and education of children) was about half of the total income. The most common livestock breeds are sheep (e.g., Mongolian sheep, fine-wool sheep, small-tailed Han sheep, and goat), cattle (e.g., Simon Dahl cattle and local cattle) and horses (e.g., English horses and local horses).

Our researches show that animal husbandry development in this village has been confronted with several challenges; climate change is not as critical as other factors—according to local herders. We find that (1) local herders thought that the most serious threats on their animal husbandry development are the increasing shortage of grass resources, due to land degradation and the large-scale grassland concessions by big cooperatives and companies; (2) the ecological subsidy is relatively low, for example, the subsidy of the Grain for Green project in Maertu, which aims to convert the cropping land to grassland (e.g., in our study area) or forest with monetary compensations to farmers, in the years 2002, 2003 and 2004 was 30, 45 and 90 RMB Yuan/Mu (1 ha = 15 Mu) respectively. Therefore, their families and animal husbandry

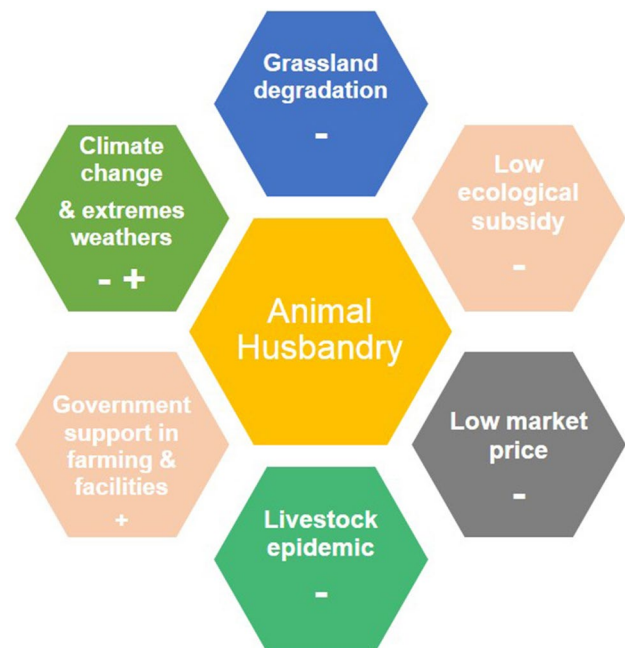
are mainly supported by the combination of the seasonal grazing and fodder (grain, crop residuals, and grazing); (3) high cost on the animal management accompanied with low market sale price. Sheep price in 2015 was the lowest among recent years: the price of the mature sheep was 3.25 RMB Yuan/kg, significantly lower than the price of 5 RMB Yuan/kg in 2014. The herders said the price of one package forage was around 4 RMB Yuan, thus if they had fed the sheep only with the packed forage, the prime cost would have been more than the revenue from selling sheep; (4) serious livestock epidemic and poor veterinary knowledge were prevalent. Foot and mouth disease, Peste des petits ruminants and Number 5 are the main animal diseases in this region. Normally, it will cost 100 and 500 RMB Yuan separately for a cattle and horse to be treated. If animals are ill, the herders only treat them with antibiotics, despite the adverse side effects and low cure rates; (5) sufficient governmental support in farming and animal husbandry facilities is important. Even though there is no tap water system, the number of wells has increased in this village, largely supported by governments, to ensure the water utilization in agriculture and animal husbandry.

During the field work period from November 2015 to January 2016, the weather was coldest during the whole year in Maertu (from  $-20$  to  $-30$  °C), the herders said it was a bit warmer compared with previous years, with heavy snowstorm (around half-meter high above ground). Then, we conducted an interview with local farmers regarding their perceptions of how climate change and extreme weathers impact the livestock production. We find that (1) for the locals, the main channel to access to the weather information is TV, while few people make use of the smart phones, radios or computers, and none by newspapers; (2) there is a consensus on climate warming trend in recent 10 years (especially for the increasing winter temperature), and the increasing rainfalls compared to previous years; (3) in terms of the most consecutive severe droughts from 1999 to 2001, the herders remembered vividly that they suffered almost complete harvest loss, received subsidies from state government, and had to take off-farm work in a remote city. The number of the animals and animal weights were declined greatly accompanying with higher prime cost; (4) with regard to the impacts of climate trends, more than half of the interviewees thought that climate change is likely to cause the increase of the livestock diseases, such as pandemic disease, colds and infectious diseases. They also believe that climate warming will lead to increased pasture plant diseases and insect pests, serious soil erosion, and dust storms. They had no obvious feelings about the increase or decrease in the frequency of climate extremes (e.g., storms, drought or dzuds); (5) the livestock suffered from less water shortage and strong storms than previous years due to the increasing number of wells and abundant precipitation. The multiple

factors affecting the animal husbandry in the study area is listed in Fig. 3.

Family Fencing Policy is a new policy complimentary to the Grazing Ban. Meanwhile, it is negatively perceived by the locals. Animal numbers are huge in this village (over 100–300 sheep per family). Furthermore, the forage price was very high for the herders (4 RMB Yuan per package); in some parts of Inner Mongolia, for example, Xiling Gol League and Hulun Buir, the only remaining large natural grassland area in IM (Li et al. 2015; Mu et al. 2013), herders are not allowed to mow grassland for fodder. Land reclamation has totally disappeared in most part of natural grassland area in IM. Currently, the only remaining grassland in IM with high quality belongs to the government and is to be sold or to be banned from grazing (Ao and Hu 2007; Liu 2010).

Grassland resource in this village is limited and the situation got worse after some part of the grassland was sold by the local government to a dairy company named “Mengyang Company”, founded in this village 10 years ago. In the beginning, the local herders thought it was a great opportunity to develop their animal husbandry and improve their income. However, the fact is that the company took over a huge area of grassland without local herders’ agreements. As compensation, every family only received 170 RMB Yuan per mu, which was far away from their expectations. After that, the locals never trusted the



**Fig. 3** Multiple factors affecting the animal husbandry in the study area. Here, + means positive effect, – means negative effect, mainly including effects from biophysical (e.g., climate change and extremes weathers), economic (market price) and social and political (e.g., government support and policy subsidy) and the others (Livestock epidemic and grassland degradation)

government and the corporation. In this situation, grassland became even more limited and the herders have no appropriate way to deal with this difficult situation. Unlike the pastoral area, developing FFP is especially suitable for the FPE, as agricultural production in FPE could supply the forage for the animal husbandry (e.g., maize straw). Thus, it will reduce animals' grazing pressure on the grassland. However, we found that FFP in this village was difficult to implement; only some families conducted part-time fencing (just fencing in some seasons) or small-size fencing—still far from the total time fencing demanded by the Chinese government. Traditionally, Mongolian herders' livelihood relies heavily on the grassland resources. The situation cannot be easily changed, and we are skeptical that the expected situation of local government (i.e., the herders and animals are totally far away from the grassland ecosystem) will be realized in the near future. There are several reasons for the difficulties in developing FFP according to the following comments by the herders:

“Our knowledge in animal husbandry management has sustained generation to generation, and the traditional practice is difficult to change. Poor fencing technology and lack of supporting facilities are preventing us to develop the fencing in our village. This so-called family fencing just means simple walls in the backyard built by bricks or stone.” (for details, please see Fig. 4).

The cost on fencing is very high to our herders. The government won't supply any subsidy in building the modern fencing systems, even though we really want the innovation of fencing knowledge and facilities. The private sector has shown no interest to enter here and invest. For ourselves, the most important thing is that we cannot afford the advanced system.



**Fig. 4** Traditional fencing facilities in Maertu village

“The only way to sell our sheep is through the peddler and our profit margin is getting smaller and smaller. The price of the whole sheep is only 3.25 RMB Yuan per kg in 2015. We can only get around 300–500 RMB Yuan for one sheep. The price of the fresh sheep skin is just 5 RMB Yuan and nobody would like to buy it. Our children need to go to school and we need to buy machines, seeds and the fertilizers. How can we afford extra cost for building fences? The environment is none of our business.” (for details, please see Fig. 5).

### Challenges for developing the animal husbandry

The only way for the local herders to sell their animals is via peddlers (intermediate sellers). Local herders complained a lot about the low animal price and ever-increasing breeding cost. Due to the conflict between the consistent development between agriculture and animal husbandry in FPE, the local farmers tend to focus on their agriculture and just put the associating development of animal husbandry in the second place. It is not a good trend for either the development of animal husbandry nor the environment protection and sustainable development. If the price of the animals keeps declining, animal husbandry in FPE may face the danger of collapse in the near future. But this is an extreme conjecture according to the combination of current developing status and the unique form of animal husbandry management.



**Fig. 5** Trades between the herders and the peddler

According to the key-informant interview and the participant observation with the leader of the animal husbandry bureau in Hinggan League of IM, the local government has shown their willingness to make efforts to regulate the market price to a reasonable value through a variety of means (controlling the market trade and price regulating). However, the increase in livestock price may lead to the increase in livestock number and grazing intensity. Decision-making of the herders is predominately based on maximizing economic incomes; the environment protection is barely considered. Facing the dilemma, it is urgent and imminent to reform the management of animal husbandry. Over the past decades, there were no major progress in animal husbandry in majority areas of IM. For instance, traditional livestock breeding approaches, single mode of production and sales, unimproved livestock breeds and low levels of medical conditions are widely observed. At the moment, the limited grassland can barely support the livestock breeding, under the pressure from the land degradation and overgrazing. We are left to wonder how long it can survive in the future. It is an academic and social economic problem that should be investigated by the local and international scholars.

To cope with the grassland degradation and overgrazing, the Chinese government has put forward FFP and the forage planting. According to the field survey, these policies are merely lip service without real actions or additional supports. If there is no support or guidance from the government, the herders will never be able to adopt the new policy and make the necessary efforts. Therefore, the most primary task for the local government is the implementation of economic support and dissemination of advanced concept of development. Second, improving the backward animal shed, as well as the innovation of the traditional animal breeding techniques and improving the medical conditions are all necessary to move towards the advanced animal management. According to herders, lack of grazing area is the main threatening factor in developing the local husbandry. The main reason for the lack of the grazing areas is the overgrazing on shared resources (“Tragedy of the Commons”) and grassland concessions. For this reason, the government implemented Grazing Ban and Fencing Policy. However, many herders perform secretly grazing to save the costs. From this point, we could realize the insufficient management in developing animal husbandry. There is an old Chinese saying which goes “Nothing can be accomplished without norms or standards”. Therefore, strengthening the monitoring system and management system would be the most urgent thing for authorities to do.

The different starting points between government and herders make the animal husbandry development difficult. It is worth pondering “who will be the main agent for controlling the animal husbandry industry”. Years ago, the commune-based collective farming system disappeared after

the HRS reform. Now, ironically, herders think it is necessary for the development of the animal husbandry to revive the collective behaviors under communes or cooperatives. While the traditional commune system cannot meet the current demand for developing the animal husbandry in Inner Mongolia, a self-organized farmer cooperative appears to be a suitable mode. The cooperatives can help small farmers coordinate their productions, protect common resources, and integrate into the production chains by conforming to the market standard, increasing bargain power, lowering input prices. We could learn the development of farmer cooperatives from developed countries, such as Ireland and Germany.

During the past decades, not only for the FPE, but also for most other regions in IM, the development of animal husbandry has been facing a situation of disconnection between the government, the cooperatives and the herders. The key to developing a climate change-resilient animal husbandry will require strengthening the bond between these three different actors, which is a huge challenge for both the herders and the local government. The farmer cooperatives could, perhaps, provide a promising solution.

## Discussion

Ecosystem deterioration and environmental pollution are common problems threatening human welfare and sustainable development in developing countries such as China (Gavrilescu et al. 2015; Harper 2015). Facing combined natural and socioeconomic problems (e.g., land degradation and market depression) (Miao et al. 2015a), animal husbandry in Northern China must find a sustainable pathway. The Chinese government launched series of ecological conservation policies, such as GB and FFP, which are aimed to reduce animals’ pressure on grassland and to prevent overgrazing. Grassland is expected to recover following the implementation of these policies. However, our research showed that grassland degradation has not been prevented as hoped by the government. Several reasons could explain this phenomenon: (1) GB and FFP, despite being well designed, were not well implemented on the ground; (2) other factors affecting the grassland ecosystem and vegetation growth, such as drought and extreme weathers, played a critical role; (3) the one-size-fits-all approach in Fencing Policy does not work well. Some studies suggested that periodic fencing and grazing may be a better method to recover the grassland (Liu 2010).

Besides the ecological impacts, how do GB and FFP influence the development of the animal husbandry from the socioeconomic perspective in FPE in Inner Mongolia? The implementation of these policies forces the transition from traditional nomadic grazing to family fenced feeding

for local herders—which is not easy. Herders had been practicing the traditional nomadic grazing for generations. They struggled with the new production system under the Fencing Policy. The rising cost in forage, facilities and services (e.g., medical treatment, fencing training, and the sanitation system), together with the relatively low price in animal products further exacerbated the situation for herders. Furthermore, the backward fencing technology, poor facilities and the unstructured management are also barriers for the smooth transitions. The government cannot just issue the policy without giving locals the economic and technological support; local herders also need to adapt to the new production system and improve animal husbandry management. Additionally, lack of supporting industries such as the animal product processing factory, health and quarantine departments and forage processing factory also hinders the development of animal husbandry during the transition stage.

Climate change is an important influencing factor for the grassland and the sustainable development of animal husbandry in the regions. The warming trend has been widely perceived by the local herders. While the potential negative effects (e.g., animal diseases, frequent natural hazards) are recognized by local herders, they do not regard climate change as a major threat—at least compared to the price fluctuation of input and animal products. This reflects the myopic view of small local herders; also, local herders tend to focus on things they can potentially change and influence. There are no adaptation strategies of climate change on the ground in the region; they are not thought of by local herders and local governmental agencies. We call for the education of local herders to increase the awareness of the long-term adverse impacts of climate change. Adaptation strategies are necessary to avoid the fate of “boiling frogs”—a slow changing environment can be dangerous to the sustainability.

## Conclusions

Based on the methods of anthropological investigation and literature review, this study attempts to discuss the management status of animal husbandry development, particularly to analyze the influence of climate change and the national ecological policy in farming–pastoral ecotone in Inner Mongolia, China. The research results suggest that national ecological policies have been a major influencing factor on the development of the animal husbandry during the last few decades. These policies, such as Grazing Ban and Family Fencing, are well designed to improve the income of the local herders and protect the grassland from overgrazing and degradation. However, the poor implementation of these policies, partially due to lack of training and economic support, caused many social and environmental problems. Instead of

a win–win situation expected from governments, a lose–lose situation is observed on the ground where grassland is not well protected; local herders are not gaining economically from these policies. We believe the active participation of private sector, development of bottom-up farmer cooperatives, and participatory consultation during policy-making can avoid this situation. The awareness of the environmental problem and climate change is not enough; local herders need to establish the short-term and long-term linkage between their own welfare and climate change. Only then, their actions will not be passive and myopic, and relevant adaptation strategies can be developed for the sustainable development of these regions. We hope our findings can wake up local herders and governments to recognize the short-term as well as the long-term threats and take proactive measurements in dealing with threats such as the fluctuations of market and climate change. We envision that this research provides real-time scientific references to the policy-makers in China for designing and implementation of land policies.

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## References

- Ao R, Hu E (2007) Assessment of grassland grazing system development and mode choosing in Inner Mongolia. *Inner Mong Soc Sci* 28:90–92
- Gao A, Zhao H (2010) Discussion on the impact of grazing and feeding on the production ability of the centre-half goat Gansu. *Anim Vet Sci* 4:9–13
- Gavrilescu M, Demnerova K, Aamand J, Agathos S, Fava F (2015) Emerging pollutants in the environment: present and future challenges in biomonitoring, ecological risks and bioremediation. *New Biotechnol* 32:147–156
- Harper C (2015) *Environment and society*. Routledge, Abingdon
- Hua L, Squires VR (2015) Managing China’s pastoral lands: current problems and future prospects. *Land Use Policy* 43:129–137
- Larsen J (2012) Meat Consumption in China Now Double That in the United States. Earth Policy Institute, Washington, DC
- Lei YD, Wang JA, Luo LL (2011) Drought risk assessment of China’s mid-season paddy. *Int J Disaster Risk Sci* 2:32–40. <https://doi.org/10.1007/s13753-011-0009-4>
- Li Z, Bao Y, Zhang J, Wang H, Hu Z (2015) Comparative analysis on degradation and its driving factors in Xilin Gol grassland and Hulun Buir Grassland. *J Dailian Nationalities Univ* 17:1–5
- Liang F, Tang H (2009) Impact of climate change on the agriculture and animal husbandry productivity in Wulanhaote and its strategy. *Inner Mong Sci Technol Econ* 6:60–61

- Liu R (2010) Under the Grain for green project, banning grazing, rest grazing and rotation grazing to recover the grassland ecosystem. *Inner Mong Prataculture* 22:14–17
- Liu S (2013) The advantage and measures of developing the grassland feeding animal husbandry. *Chin Agric Inf* 9:110
- Miao L, Fraser R, Sun Z, Sneath D, He B, Cui X (2015a) Climate impact on vegetation and animal husbandry on the Mongolian plateau: a comparative analysis. *Nat Hazards* 80:727–739. <https://doi.org/10.1007/s11069-015-1992-3>
- Miao L, Moore JC, Zeng F, Lei J, Ding J, He B, Cui X (2015b) Footprint of research in desertification management in China. *Land Degrad Dev* 26:450–457. <https://doi.org/10.1002/ldr.2399>
- Miao L, Ye P, He B, Chen L, Cui X (2015c) Future climate impact on the desertification in the dry land Asia using AVHRR GIMMS NDVI3g data. *Remote Sens* 7:3863–3877
- Mu S, Li J, Yang H, Gang C, Chen Y (2013) Spatio-temporal variation analysis of grassland net primary productivity and its relationship with climate over the past 10 years in Inner Mongolia. *Acta Prataculturae Sinica* 22:6–15
- Wang J (2012) Developing features of foreign animal husbandry and the choose of animal husbandry developing mode in China. *Word Agric* 10:32–35
- Williams DM (2002) Beyond great walls: environment, identity, and development on the Chinese grasslands of Inner Mongolia. Stanford University Press, Stanford
- Wu G, Du G, Liu Z, Thirgood S (2009) Effect of fencing and grazing on a Kobresia-dominated meadow in the Qinghai–Tibetan Plateau. *Plant Soil* 319:115–126
- Xu YC, Zhang YQ, Gao LP, Qiao GH, Chen JQ (2015) To fence or not to fence? Perceptions and attitudes of herders in Inner Mongolia. Build Resil Mong Rangel, Mongolia, 9–10 June 2015
- Yan Y, Tang H (2007) Effects of enclosure on typical steppe community properties in Inner Mongolia. *Acta Botanica Boreali-Occidentalia Sinica* 27:1225–1232
- Zhang L (2013) Economic status, problems and developing strategies of animal husbandry in Inner Mongolia. *Anim Husb Feed Sci* 34:78–79