

## Changing Pastoralism and Pastoral Livelihoods Under Climate Change in Northwestern China

Shuyu Han<sup>1</sup>, Longkui Wang<sup>2\*</sup>, Katsuhito Fuyuki<sup>1</sup>, Zijun Yin<sup>1</sup>

<sup>1</sup> Graduate School of Agricultural Science, Tohoku University, Sendai 9808572, Japan

<sup>2</sup> School of Agricultural Economics and Management, Lanzhou University of Finance and Economics, Lanzhou 730101, China

\* Corresponding author e-mail: wlk@lzufe.edu.cn

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**Abstract:** The livelihood of pastoralists is strongly influenced and partially determined by regulatory grazing limitations and global climate change. It was assumed that the challenges associated with the latter factor would invariably obligate and motivate herders to practice sustainable animal husbandry. However, the former factor also incentivizing adaptive changes in the agricultural practices of herders and pastoralists as well. The present study investigated changes in the management practices that rural pastoralists have made to ensure the sustainable maintenance of their livelihood in the face of strict public policy and climate risks. Surveys were conducted in two pastoral counties of northwestern China in a region subjected to frequent annual drought events and low wintertime temperatures. This region has already undergone numerous institutional changes within the last few decades. The results of the field research indicated that farmers in both counties have modified their livelihood patterns and nomadic practices in response to regulatory and climate change. Five new adaptive livelihood patterns were identified among the agricultural workers in the study area. The novel adaptive farming practices assumed by herders were intended to cope with the tension between the requirement for environmental protection and the need for socioeconomic development. The specificity of this research helps clarify how local communities change their livelihood patterns in response to ecosystem degradation and policy modifications resulting from climate change, and enrich the understanding of the actions for dealing with climate change under the individual perspective.

**Keywords:** Climate Change; Northwest China Pastoralism; Pastoral Livelihoods

### 1. Introduction

Pastoralism is one of the oldest and potentially most sustainable systems worldwide (Uddin and Kibreab 2020). Over the millennia, pastoralists have earned their living by changing their nomadic practices and adaptive strategies in response to demographic, economic, political, and climatic challenges (Dong 2016). In recent decades, climate change and increasing demand for livestock products have made it increasingly difficult for farmer household to maintain their traditional ways and means of livelihood (Ikegami 2019). Climate change poses threats to pasture sustainability and animal health. Pasture is vulnerable to frequent extreme weather events such as drought and heavy storms. Rising temperatures and/or increasing severity and frequency of extreme weather events

may also directly and indirectly affect animal health (Bett, Kiunga et al. 2017). Ongoing urbanization, improvement of the standard of living, and dietary changes have led to rapid increases in meat demand and consumption in China (Godfray, Aveyard et al. 2018). In pastoral areas, market pressure accelerates marketization which, in turn, has a negative impact on grassland ecosystems. Pastoral areas and pastoralists worldwide have been subjected to extensive institutional changes in response to climate change.

China has the world's second-largest pastureland area. Chinese pastoralists are also facing unprecedented challenges from growing climate uncertainty and the rapid expansion of meat consumption. Though grassland is vital to the livelihood of local farmers, it is being degraded by overgrazing, soil erosion, and weed encroachment (Fayiah, Dong et al. 2020). Grassland degradation in China is closely related to political movements (Li, Wu et al. 2018). It is widely believed that accelerated land degradation in China is the consequence of the rural reforms of the 1970s (Bryan, Gao et al. 2018). The household contract responsibility system was created by Chinese farmers during the rural reforms period and liberated agricultural productivity, incentivized production by farmers, and promoted the development of the agricultural economy. During the same period, the household contract responsibility system was implemented in pasture areas and distributed animals to individual households. This system also facilitated the economic development of pastoral areas. However, the livestock and grassland contract systems did not proceed simultaneously. Hence, grasslands became public goods and were overgrazed. Thus, the grassland ecosystem was degraded in part because of the conflict between public grassland and private livestock ownership. At the end of the 1990s, the State implemented the householder pastoral land contract system in pastoral areas. Application of this new policy alleviated grassland degradation to a certain extent. However, it also disrupted local traditional land management systems and livelihood patterns. Moreover, household enclosures are important degradation drivers (Cao, Yeh et al. 2013). Herders owned both the livestock and the right to use pastoral lands. Therefore, animal production from grassland was essentially a family business. However, the lack of regulations and lax supervision resulted in overexploitation, overgrazing, and ultimately the most severe grassland degradation in the history of China (Churiya 2020). The Grassland Law was passed in 2002. The Chinese government formulated policies for pastoral land protection and grazing industry development in all pastoral regions (Bryan, Gao et al. 2018). These regulations included grazing prohibition, grazing rest, and forage-livestock balance. As these measures were restrictive, the government subsidized the herders. The policies nonetheless influenced traditional grazing patterns and livelihood. Hence, it is crucial to identify the changes in the livelihood patterns of the local community and determine whether they could foster sustainable development in the future.

The present study explored the changes in local livelihood patterns based on case studies conducted in certain pastoral counties of northwestern China. The grasslands of China are located mainly in the arid/semiarid northwestern region of the nation. These areas are surrounded by the Qilian Mountains which block atmospheric circulation and are remote from the oceans. They are dry and highly sensitive to climate change. In addition, it has been subjected to numerous policy changes over the past few decades. The specificity of this research helps clarify how local communities change their

livelihood patterns in response to ecosystem degradation and policy modifications resulting from climate change. Moreover, this study not only corroborate some of the results found in the existing literature but also enrich the understanding of the actions for dealing with climate change under the individual perspective.

The present study systematically chronicled the changes in pastoralism and pastoral livelihoods that occurred in response to climate change and the institutional and socioeconomic alterations that have transpired in northwestern China. The aim of this study was to attempt to answer the following questions: (i) What are the livelihood strategies adopted by herder households under climate and institutional change? (ii) How do local institutions influence these adaptive strategies? (iii) Will these strategies help pastoralists practice sustainable development?

## 2. Materials and Methods

### 2.1 Study area

This study was conducted in Sunan Yugur Autonomous County in Gansu Province and Qilian County in Qinghai Province, China (Fig. 1). Both counties depend on local natural resource availability. Sunan Yugur Autonomous County is part of Zhangye City in Gansu Province and is located at 37°28'-39°04' N and 97°20'-102°13' E in the middle of the Hexi Corridor and the northern foot of the Qilian Mountains. The total area of Sunan County is ~23,887 km<sup>2</sup>, of which the majority is in the Qilian Mountains. Its average elevation is ~3,200 m. The climate in Sunan County is mainly semiarid montane and the average temperature is 4 °C. The second research site was Qilian County in Qinghai Province situated in the hinterland of the middle section of the Qilian Mountains. Its average elevation is 3,169 m and its area is ~13,886 km<sup>2</sup>. It has a typical humid plateau continental climate with wide temperature differences between summer and winter.

In Sunan County, three townships (four villages) including Dahe Township (one village), Kangle Township (one village) and Mati Township (two villages) were surveyed. In Qilian County, two townships (four villages) including Yeniugou Township (three villages) and Yanglong Township (one Village) were surveyed. Both study areas were highly dependent on local livestock production. Climate change has degraded the local grassland ecosystem. The balance between grassland and livestock, the implementation of grazing restrictions, and climate issues have somewhat affected herder breeding patterns in both counties. Meteorological data for Sunan and Qilian Counties for the past 40 years were analyzed. Both counties have experienced sustained increases in average temperature over that time. The average temperature over the past decade was markedly higher than that of the 1980s. There were no remarkable changes in precipitation for either county over the past 40 years. However, in Sunan County, summertime rainfall was lower in the last decade than it was in the 1990s. In Qilian County, the average precipitation from May to July was higher over the past decade than it was over the past 40 years.

The research sites were selected on the basis of their pasture characteristics (size, quality, and type), location properties, and institutions (land property rights, grazing prohibition, and environmental protection). The counties had similar biophysical settings

and contrasting pastoral management practices. They closely bordered each other and were adjacent to the Qilian Mountains.

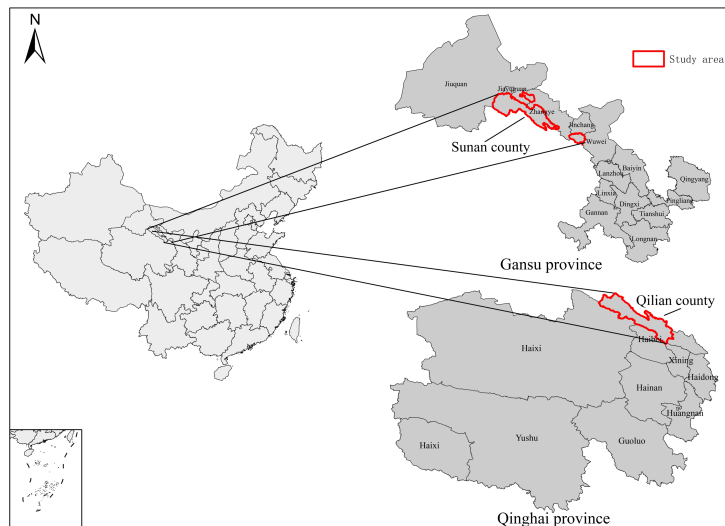


Figure 1. Research site map.

## 2.2 Data

The findings reported in the present article were based on data collected during field trips over 1 month in Spring 2021. The first field trip was a one-week pre-survey while the following 3 weeks were devoted to in-depth interviews. The main data collection methods comprised open, semi-structured interviews and the data were qualitative. All respondents provided informed consent to be interviewed. In 2020, a questionnaire was designed to determine the new livelihood patterns adopted by local pastoralists. The respondents were asked questions pertaining to demography, internet access, insurance, loans, cooperation, and leadership. Thirty herder households were interviewed and 28 valid questionnaires (16 from Sunan and 12 from Qilian) were obtained.

## 3. Results

Drought has had a severe negative impact on pastoral areas. Though the respondents ascribed drought only to recent climate change, in fact the climate has been shifting for the past 200 years. Since the dissolution of rural collective economic organizations in the 1980s, institutionalized pastoral areas have undergone tremendous change as well. Hence, the dual pressure arising from environmental degradation and policy interventions in the pastoral area merits consideration.

The present study explored the changes in herder livelihood resulting from (a) grassland usage restrictions in response to climate change-driven degradation, (b) livestock overload and increasing demand for livestock production, and (c) environmental protection policies that severely restricts grassland use. The grazing management patterns

were grouped into five categories, namely, (1) grassland transfer, (2) wasteland reclamation and artificial grass planting, (3) farmland rental for grazing, (4) breeding community formation, and (5) land stock cooperative establishment.

### 3.1 Grassland transfer

Certain herders in both counties adopted grassland transfer to alleviate the land use pressure caused by public policy. This strategy is implemented in other pastoral areas such as Tibet and Inner Mongolia (Zhang, Meng et al. 2010, Li 2012, Du, Liu et al. 2017). In grassland transfer, the contracting party transfers the grassland contracting rights to a third party engaged in animal husbandry by renting, transferring, subcontracting, swapping, and buying shares during the contract validity period.

Grassland transfer is performed mainly because herders differ in terms of their production and management capabilities. Some pastures are underutilized and could, therefore, be exploited by other herders. Grassland transfer may be transacted in the form of lease transfer or subcontracting. The rental price varies with grassland productivity. In general, households with less grassland and overloaded livestock opt for this strategy to alleviate the stress of land use limitation. An interviewee in Qilian County stated that...

*“...the rental of pastureland is 80 ¥/acre/yr. As I have a small pastureland (152 acres), the annual rent is 12,160 ¥, which is much higher than the cost of using the same 152 acres to feed sheep.”*

This situation encourages certain owners of small pastures to rent grassland as it could generate passive income. However, it also causes certain problems. (1) Short-term leases severely damage grassland by promoting retailer immigration and use of the grassland for short-term animal breeding. The operator cares only about the immediate benefits, the leased grassland is severely overloaded, and land degradation is accelerated. (2) Oral contracts are illegal as they are technically beyond government control.

### 3.2 Wasteland reclamation and artificial grass planting

Wasteland reclamation and artificial grass planting are practiced in response to grassland environmental policies that restrict grazing land and severe degradation of natural grasslands that results in low yields of poor-quality grass. Natural pastures can no longer meet the current livestock production demand. Artificial grass planting has played significant roles in mitigating grassland degradation in the Qilian Mountains and reducing the tension between grazing restrictions and livestock increase. In both study areas, the three main artificial grass planting methods were cropland, grassland, and wasteland planting. In cropland planting, oats, alfalfa, and green corn are raised to ensure sufficient winter forage. In grassland planting, wheat awn, triticale, and Elymus are cultivated for summer grazing. In Bianma Village of Qilian County, wasteland was artificially transformed into grassland and the grass was piled in haystacks and sold to nearby herders.

### 3.3 Grazing land rental

Herders rent other pastures or croplands for grazing. This practice alleviates the pressure caused by land use limitations. In both counties, grassland was rented for grazing

and cropland grazing exchange (CGE) was practiced. Grassland rental for grazing enables other herders to avail themselves of unused grassland. CGE provides low-cost feed for cattle, and grazing maintains cropland health. CGE matches herders who raise livestock with farmers who produce fodder (crop residues and mulch). Livestock inclusion in crop rotation mutually benefits both crop and livestock farmers.

In both counties, the respondents stated that CGE was the main grazing pattern they used because of grassland bans and grazing rest. As available perennial grassland shrinks, herders turn to harvested cornfields for animal grazing. Farmers who have completed their autumn corn harvests maintain the straw. Between October and March, herders move sheep and cattle as far as 10 km to access cropland cornfield grazing. This method alleviates land use pressure and diversifies cropland. One cropland owner stated that...:

*“...every October, the herdsmen in Sunan County borrow grazing from my cornfields. In this way, I save the time and cost of processing corn stalks and gain extra income by renting cropland.”*

Grazing land rental alleviates land use pressure and diversifies cropland use. Nevertheless, it also has certain negative effects for herders. First, it elevates breeding costs. In both counties, herders save time by renting trucks to transport cattle and sheep to cornfields. Freight is calculated according to travel distance and livestock species. Fences and clean water supply are vital for grazing. As cornfields lack these amenities, herders must install and pay for them on their own. Borrowed house costs are also substantial for herders. Borrowed croplands are remote and herders must, therefore, borrow houses near the cornfield so they can reside with their livestock for 3-5 mo. However, the major expenses are the costs of living and transport. Cropland rental is considerably more expensive than traditional grazing. Rent is charged on the basis of cornfield area. If the cornstalks do not suffice to feed the livestock overload, then herders must purchase grass mounds to compensate for the forage shortage. Certain interviewees also indicated that the farmlands they rented have been subjected to herbicides with long residual effects. Hence, both the herders and the livestock could be exposed to these harmful chemicals (Nyanga, Johnsen et al., 2012).

### 3.4 Breeding community

Community-based breeding programs (CBBP) are low-input systems wherein farmers improve and share the genetic resources of their livestock (Mueller, Rischkowsky et al., 2015). In recent years, the breeding community has received a great deal of attention as it was regarded as a sustainable development model of small, low-cost, family-based breeding programs (Kosgey, Baker et al., 2006; Duguma, Mirkena et al., 2011; Lamuno, Sölkner et al., 2018).

The breeding community was implemented in both counties. Climate change and grazing overload have severely degraded and decertified grassland resources, reduced available per capita grassland, and restricted the development of livestock production. The survey disclosed that the government uses policies, financial support, and technological training to incentivize local herders to form or join breeding communities. In this way, the pressure of grassland usage restrictions is mitigated and livestock numbers increase.

The breeding community may help offset or avoid economic loss caused by climate change. It supplies livestock with forage and tap water and the external environment does not significantly affect them. For the foregoing reasons, the herders in the survey area were drawn to breeding communities. However, it was grazing land limitation rather than climate change that primarily motivated them to opt for the breeding community. Most interviewees claimed they selected the breeding community mainly for livelihood maintenance and income expansion. Even with state subsidies, though, advanced facilities require self-investment and are incomparable with the large-scale breeding industry. Certain interviewees also remarked that relative to traditional nomadic breeding, the breeding community produced inferior livestock quality and its associated production costs were significantly higher. Most of the locals purchased forage from remote sources to accommodate the high demand. However, the quality of this forage is inconsistent which could result in livestock disease. The herders also mentioned that animal waste could not be eliminated in a timely fashion and could, therefore, have a severe negative impact on the environment.

### *3.5 Land stock cooperatives*

Both counties had two land stock cooperative models. In the first, the animals are treated as share capital. Cattle or sheep are collected from small households and bred indoors by trained personnel. The investors (pastoralists) then share the benefits depending on the number of animals invested. This model reduces livestock mobility. Nevertheless, the investors are free to seek and procure job opportunities, secure part-time employment such as tourism and migrant work, and diversify their livelihoods through multiple income streams. In the second model, it is the grasslands that are regarded as share capital. Fragmented small grasslands are collected and amalgamated into single large grasslands upon which the animals purchased by the cooperative are grazed. This strategy also enables small households to enter the market and helps maintain the free-market system.

## **4. Discussion**

Fruitful discussions of the sustainable development of the livelihood of a pastoralist first require the conceptualization of sustainability. The concept of sustainability has three dimensions (Tessema, Ingenbleek et al., 2014), namely, (1) plant-related abiotic and biotic factors, (2) human-related factors including mobility, adaptability, indigenous knowledge, formal and informal institutions, and demographic structure, and (3) economic contribution factors. The present study explored the problems that affect herder livelihood and centralize social issues. Here, the impact of the foregoing human-related factors on sustainability is considered.

### *4.1 Mobility*

Increasing mobility and displacement distance are cultural norms and are driven according to the nutritional needs of livestock (Turner and Schlecht, 2019). Therefore, mobility has a substantial impact on the sustainable development and livelihood of herders (Oba, 2011; Scoones, 2020). Mobility creates opportunities and develops risk

management in the pastoral area (Scoones, 2020). Mobility is frequently mentioned in various studies and may have multiple meanings. It refers not only to livestock per se but also to the ecology of the vegetation they graze, the culture, mentality, and economy of the people husbanding them, and the human institutions enabling livestock and their human managers to gain access to these resources (Turner and Schlecht, 2019). Hence, mobility may not be limited to livestock movement; it may also include the patterns that indirectly increase the total distance of livestock displacement.

Field data showed that certain patterns mitigate the negative effects of restricted mobility by overcoming the limitations of grassland and spatial allocation. Grassland transfer redistributes land resources and makes unused pastures accessible to the people requiring them. This strategy reallocates grassland resources, fully exploits sparse grassland, and promotes the mobility of pastoral land management. Grazing land may be rented by expanding available pastures. In this manner, animals with sufficient pasture can be displaced. Stock cooperatives consolidate the small, fragmented grasslands owned by pastoralists into larger grassland. The cooperatives purchase reasonable numbers of livestock to graze the amalgamated grassland. In this way, livestock mobility is promoted. Artificial grass planting expands the grassland area to alleviate land use pressure caused by limited natural grassland. This strategy helps increase the number of livestock with access to sufficient grassland for grazing.

#### 4.2 Adaptation

Over the past millennia, pastoralists have adapted to shifting conditions by making various alterations. Pastoralists must be able to adapt to contend with climate, political, and cultural change (Lind, 2003; López-i-Gelats, Paco et al., 2015; Herrero, Addison et al., 2016; Ghai, 2021). However, certain strategies result in pastoralist maladaptation. Thus, while adaptation is “ideal,” it might also fail (Magnan, Schipper et al., 2016). Maladaptive adaptation strategies have been previously examined (Gray, Sundal et al., 2003; Magnan, Schipper et al., 2016). Maladaptation increases vulnerability to modifications in climate, evolutionary biology, cultural issues, and human and environmental interfaces (Magnan, Schipper et al., 2016).

A breeding community was adopted by both counties participating in this study. The respondents considered it a suitable strategy. Though it limits livestock mobility, it also mitigates the impact of climate risk, alleviates the stress of grazing bans, and increases adaptability. Indoor breeding protects animals from climate risks and attack by wild animals. More animals can be bred through breeding communities than grassland grazing. Therefore, breeding communities reduce the dependence of pastoralist on pastures.

Renting land for grazing reflects the strong adaptability of pastoralists and is a win-win strategy for farmers and pastoralists alike. In the study area, the pastoralists rented cropland for grazing. This practice alleviated grassland limitations and increased farmer income. Pastoralists implement this strategy by maximizing land resources and alleviating land restriction pressure.

The transfer of grassland rights reflects the capacity of pastoralists to utilize land rationally as well as their remarkable adaptability. Pasture tenure transactions enable pastoralists to exploit unused grassland and effectively contend with land use limitations.



Pastoralists also sell land tenure as a commodity and this practice promotes grassland resource circulation.

Stock cooperatives increases the adaptability of pastoralists by centralizing small households. This practice shares the risk among member households, thereby mitigating individual small householder risk.

Artificial grass planting augments the adaptability of pastoralists by alleviating the land use stress caused by local government policies. Artificial grass planting furnishes extra land areas and helps local households adapt to institutional restrictions and climate change-induced grassland degradation.

#### *4.3 Indigenous knowledge*

Indigenous pastoralist knowledge is closely associated with sustainable development (Magni, 2017). Certain experts in pastoral research suggested that indigenous knowledge is crucial for pastoral area management, biodiversity, and climate change adaptation (Mapinduzi, Oba et al., 2003; Abate, 2016; Liao, Ruelle et al., 2016). The present study revealed that although public policy limits the practical application of indigenous knowledge, pastoralists nonetheless develop ways to implement indigenous knowledge and maintain sustainability. The breeding practices of pastoralists have been transmitted to the present from generations past and continue to be used in rotational grazing. As for rent land grazing, grassland transfer, stock cooperatives, and artificial grassland, the ancestral breeding practices increase pastureland size by facilitating the consolidation of fragmented grassland. Hence, large pastures realize the application of ancient indigenous grazing methods. The foregoing patterns indirectly promote indigenous knowledge. In contrast, breeding communities impede its application. The indoor environment hinders the utilization of traditional methods. Moreover, breeders do not necessarily regard climate change, terrain, or trends in grass growth.

#### *4.4 Formal and informal institutions*

Formal and informal institutions mediate livelihoods and affect sustainable development in rural areas (Scoones, 1998). They introduce measures that help herders adapt to changes imposed by public policy. In two counties, the compensation paid to households for governmental grazing bans and restrictions was applied in pastoral areas. Prior grassland compensation policies influenced the effectiveness of grassland protection measures. Because of poor compensation standards, inadequate government supervision, imperfect systems, and insufficient accountability, herders raised overload livestock which interfered with the effective use of the economic and ecological benefits of natural grassland. To compensate for losses caused by grazing bans and restrictions and protect the grasslands, the government introduced a new grassland protection subsidy. In Qilian County, previous grassland right transfers were established through verbal agreements based on geography or kinship. However, such contracts may not effectively settle disputes or resolve problems as they may be considered legally invalid or non-binding.

Informal organizations play essential roles in pastoral areas. Rural cooperatives are common in China and differ from social groups and political institutions. The stock

cooperative in Qilian County integrates the cattle and sheep in small households and amalgamates a large-scale management group. Stock cooperatives help local herders alleviate the pressure caused by grazing bans and restrictions. They also increase the access of small households to the market and mitigate individual liability by sharing risks. Establishment of a joint-stock cooperative system empowers herders to profit from strict grassland policies. It balances grass and livestock while increasing local livestock industry scale and marketization. These protective measures help ensure the rapid sustainable development of pastoral area management.

Pastoralists use their valuable experience and generationally accumulated knowledge to manage grasslands. In this manner, pastoral areas may endure for thousands of years. Sustainable development is of critical importance for pastoral regions and must be maintained through future generations. The strategies adopted by herders could mitigate the negative impact of institutional transformation. However, severely restrictive policies and growing demand for livestock production could upset this short-term balance. Certain strategies cannot achieve long-term sustainability goals. Rotational grazing cannot exist when grazing bans limit pasture area.

Rent land grazing, grassland transfer rights, and stock cooperatives are challenged by the same impediments as rotational grazing. Breeding communities could support greater numbers of animals but they are polluting, costly, and threaten long-term sustainable development. Other strategies such as tourism and part-time employment could diversify and increase herder revenue. However, loss of the younger population could shrink the demographic structure base which is the foundation of long-term sustainable development. In contrast, artificial grass planting could expand available land area and grass production, alleviate the pressure of grassland restrictions, and rationally repurpose and exploit abandoned land.

#### *4.5 A balance that is difficult to maintain*

The output of the case study on two natural resource-dependent pastoral counties in China did not accord with the reality that climate change is the primary reason to implement adaptive pastoral strategies. Nevertheless, this conclusion conflicts with those of certain reports addressing climate change adaptation (Herrero, Addison et al., 2016; Zhang, Cui et al., 2019). The main issue is the conflict between stable, sustainable economic development and environmental protection (Fig. 2). Policy implementation in pastoral areas is merely the tip of the regulatory trend iceberg in China. At the United Nations General Assembly, China committed to the goals of carbon neutrality by 2030 and carbon peak by 2060. Hence, the entire nation is endeavoring to balance economic development and environmental health by adjusting the economic structure, reforming the energy policy, developing the ecological industry, mitigating pollution, promoting ecological conservation, building capacity, and fostering international cooperation and public participation (Zhang and Wen, 2008). The implementation of pastoral area environmental protection policies will cause herders to leave the pasturelands and settle in planned areas. Their nomadic patterns will be transformed into intensive livestock farming. This future prospect raises the following questions: What is the future of the pastoral area, and will it disappear in the future?

Certain countries practice environmental instrumentalism, which comprises...

“...the responses of individuals and groups to environmental problems that are determined by evaluating individual or collective interests against environmental tradeoffs through cost-benefit analyses or other market-based mechanisms” (Banerjee, 2003).

The foregoing definition may cause people to consider the value of the environment. In fact, people may only reflect on this matter insofar as environmental degradation could threaten their livelihood and personal interests. The pastoral area of China has undergone severe anthropogenic degradation. Both the State and herders are aware that environmental damage is closely associated with their interests. During the survey of the present study, all respondents recognized that environmental issues are intimately tied to their livelihood. Though pastoralists are cognizant of the risks, their primary objectives are immediate benefit and livelihood security. China is imposing increasingly stringent environmental protection policies. Macro-level policies have gradually restored the ecological environment in pastoral areas while disregarding the interests of pastoralist households. Hence, the current situation is increasing the vulnerability of the pastoralist livelihood.

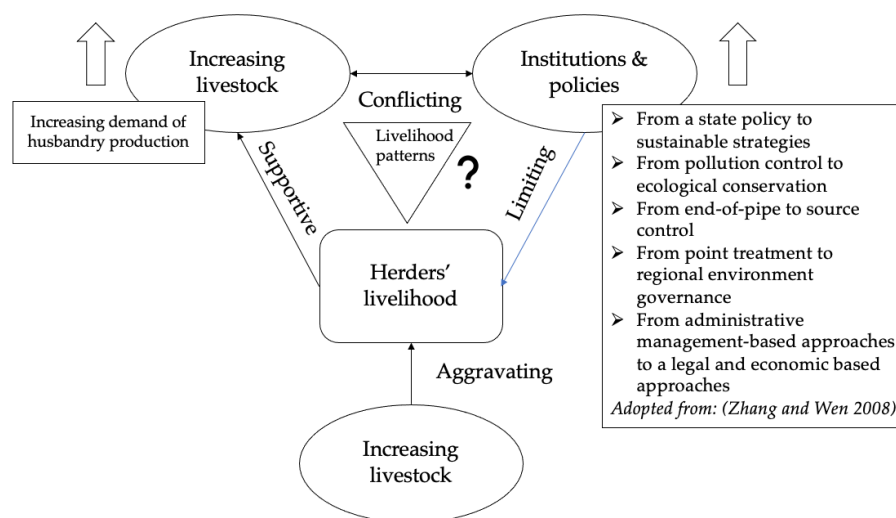


Figure 2. Current situation in the study area.

### 5. Conclusion

The pastoralists of the Qilian Mountains must contend with progressive climate change as well as increasingly severe land use restrictions. Livestock producers and pasture farmers must also adapt to the interactive effects of the foregoing changes to be able to maintain their livelihood. The present study surveyed herders and pastoralists in northwestern China to determine the strategies they have adopted to uphold the

profitability of their agricultural practices in an ecologically sustainable manner. The present study demonstrated that while certain adaptive patterns have increased sustainability to a certain extent, others may actually be decreasing it. The results of this research have indicated that it is primarily governmental grazing restrictions rather than global warming that has incentivized local and regional pastoralists and herders to devise and implement adaptive strategies for profitable yet sustainable agronomy.

The present study however, did not collect original dataset with large samples that covers a geographically distinct region. The limited numbers of our samples may mean that our analysis and conclusion are somewhat misleading. Clearly 28 households are not enough to make generalizations about pastoralists' livelihood changing under the climate change in China. Despite such limitations, from the results of those limited number of pastoralists' household, a clear pattern emerged which tells the evidence of herders still insist on exploring a ways of life in response to regulatory and climate change.

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