

Study on the Grassland Ecosystem-based Adaption Management under the Land Private Use

Dan Li

Chinese Academy of Fiscal Sciences, Beijing 100142, China.

How to cite this paper: Dan Li. (2022) Study on the Grassland Ecosystem-based Adaption Management under the Land Private Use. *Journal of Humanities, Arts and Social Science*, 6(4), 567-580. DOI: 10.26855/jhass.2022.12.010

Received: October 22, 2022

Accepted: November 18, 2022

Published: December 14, 2022

***Corresponding author:** Dan Li, Chinese Academy of Fiscal Sciences, Beijing 100142, China.

Email: sweetchi0617@163.com

Abstract

Since 1984, China's government has implemented household land private use in rural areas to promote market economy, which brought a great change to the local community in terms of land management, particularly for the pastoral areas. Taking an agro-pastoral area of N County of Xinjiang as a case study, this research analyzed the interaction between the local community production rules and land private use as external rules based on Hayek's Theory of Society Order Evolution. Semi-structured household interviews were conducted at two villages in 2017 and 2018 to examine the contradiction and coordination between external land policy and community internal rules, and analyze the evolution mechanism. The results showed that the internal joint production rules of pastoral community were replaced by the external rules of land use, which led to each households manage their land independently, and consequently their traditional resource management rules were gradually terminated. Under the market mechanism, many farmers chose to raise livestock as well as farming, and they paid herders to graze their livestock on the herder's pasture. This new agro-pastoral transaction relationship led to overgrazing and pastures degradation. The pastoral community failed to develop new ecosystem-based adaption rules to cope with the shocks from both of outside policy and the market after their previous rules were broken. Although this is a negative case to analyze why a local community failed to adapt to the outside institutional and marketization change, the lessons and suggestions from this study would contribute to the further study in the ecosystem-based adaption management of natural resources.

Keywords

Land private use, Community production rules, Agro-pastoral relationship, Adaption Management

1. Introduction

Convention on Biological Diversity defined Ecosystem-based adaptation (EbA) as "Using biodiversity and ecosystem services to form holistic adaptation strategies to help individuals adapt to the negative impacts of climate change" (CBD, 2009). Adaptive management was regarded as an effective management strategy to deal with climate change and the vulnerability and uncertainty of ecosystem, such as protecting wetland ecosystems to prevent floods and protecting biodiversity to ensure food security (Reid, 2011). In view of unbalance and uncertainty features of Grassland, ecosystem-based adaption management had attracted extensive attention among scholars in the field of grassland management.

1.1 The Review of EbA Management Research

The concept of EbA management could be traced back to 1978, which emphasized ecological, economic and social values must be taken into consideration when making management decisions, in view of the inherent uncertainties of natural resources and ecological environment, and different interest groups involved (Holling, 1978). Administrators defined management objectives, designed hypothesis experiments, collected and analyzed all kinds of information in the implementation process, compared results and expected goals, and adjusted the management plan (Lee, 1993). Adaptive management was a spiral process of "learning from practice to guide practice" to promote the ecosystem sustainability (Salafsky, 2001).

EbA management had been widely used in natural resources such as fisheries, forests and water, and had become a powerful tool for governments to deal with uncertainty. The Wetland Ecological Management Project and forest Rescue Plan in the United States and the Grassland Ecosystem Change Prediction Project in Australia were constantly adjusting management strategies according to monitoring results in the long-term implementation (Johnson, 1996; Wong, 2007). In practice, decision makers found that in order to maintain the flexibility and adaptability of management, they need to learn more about dealing with uncertainty problems from community experience (Meinzen-Dick, 2010). Samoa, an island country in the South Pacific, recognized customary law and encouraged communities to apply their knowledge and experience to participate in the adaptive management of natural resources to ensure sustainable use of fishery resources (Chong, 2014). Community-based grassland resource management in Mongolia promoted knowledge and information exchange among herders, increased social capital to ensure livestock mobility and forage storage, and helped herders better cope with drought and snow disasters (Fernandez-Gimenez, 2014).

On the contrary, if the current management policy conflicted with the custom rules of the community, it would result in ineffective management of nature resources (Jeans, 2014). The Turkish government divided the fishing area into several regions and sold fishing rights to fishermen, which changed the traditional resource sharing management and punishment rules of fishermen communities. Although it had little impact on fishermen's economic benefits, the illegal fishing behavior increased greatly (Ertor-Akyazi, 2019). Raymond (2013) believed that the main reason for the barriers between external institutions and internal governance of communities was the lack of communication and engagement between governments and communities. Ghana's Forest Law required official permission from the government to cut down natural trees, while community management considered trees on private land belong to the landowner, others should pay landowner for the timber right. In practice, illegal felling of trees often occurred, but people followed community rules and paid fees to private landowners (P.osei-Tutu, 2015). In order to solve the problem of water distribution, Tanzanian government had established a Farmers' Water Union. If farmers want to obtain the water use license, they need to pay dues to the union. However, poor farmers in many areas, especially women, could not afford dues. So they spontaneously formed their own community water organizations. Members of this community organization and members of the Government Water Union often conflicted over water use (Sokile, 2005).

The relationship between community governance and external institutions was one of the important issues in EbA management research. Osei-tutu (2015) divided the relationship between formal institutions and community informal institutions into four categories according to the validity of institutions: 1) Complementary interaction when institutions were both effective; 2) Accommodating interaction when two institutions objectives conflicted; 3) Substitutive interaction when one institute was effective and the other was ineffective; 4) Void when both institutions were invalid, nature resource use was in a state of disorder and violations were common. However, most studies focused on describing the results after the combination of external institutions and community internal governance, while less discussion on why joint governance in practice showed different effectiveness. There were relatively few studies on the interaction between community adaptive management and external institutions.

1.2 The Influence of Land Private Use

Since the 1980s, the China's land use system in pastoral areas transitioned from collective to land private use, the Household Land Contract System was implemented in the process of distributing livestock and pasture to household. Since 1981, livestock had been distributed to households, and livestock products were owned by households, but pastures were still under collective management. In 1984, pastoral areas began to carry out Grassland Private Use policy. Private use of pasture effectively encouraged pastoralists to graze more livestock, use pasture in various forms such as leasing, raising livestock for farmers and joint operation, and generally increased the production in-

come and the living standard.

The implementation of the Land Private Use also exerted negative impacts on the pastoral society, production and grassland ecosystem (Gongbuzeren et al., 2015). Land Private Use changed the social and economic structure of pastoral areas. The function of nomadic tribal society had been weakened, especially in the organization of livestock transfer and mutual assistance between herdsmen (Cui Y, 2002). The household production mode broke down the community cooperation of pastoralists, resulting in the increase of the family livestock raising and fence construction cost, which pushed herdsmen to raise more livestock to get production income. Grassland private use led to fragmentation which caused overgrazing and trampling by livestock. Grassland fences cut the traditional transfer routes of livestock, and pastoralists could hardly adapt to the uncertainty of grassland ecosystem by livestock moving. They resisted risks and natural disasters by purchasing supplementary forage, which also caused over use of grassland (Li W, 2011; Li Y, 2014; Gongbuzeren et al., 2015). In addition, under the household production mode, pastoralists with less livestock were unable to go to distant summer pasture and winter pasture, and only stayed on spring and autumn pasture all year round, resulting in serious degradation of spring and autumn pasture due to overgrazing (Shalima Talinbayi, 2019).

After Land Private Use, farmer and pastoralist households working and living independently in Xinjiang agro-pastoral area. Farmers achieved few profit from agriculture and gradually raising animals for a living. They paid herdsmen to take their livestock grazing on the pasture in summer or rented pasture, natural grassland suffered larger grazing pressure (Li D, 2019). How do agro-pastoral communities adapt to the changes of the external Land Private Use System, and what are the livelihood and ecological outcomes? This paper will analyze whether the EbA management of agro-pastoral community under Land private use System are effective from the perspective of pastoralists livelihood, production and grassland ecology in agro-pastoral area of Xinjiang.

1.3 The Perspective of Social Evolution Theory

In order to explain the interaction between the internal community rules and the external Grassland Private Use-rules in the case, this study adopts the theoretical perspective of social evolution proposed by Hayek in 1988 (Hayek, 1988). Under the condition of limited rational constraint and knowledge decentralization, individual heterogeneity and different knowledge reserves led to different interests when people completed the social economic activities. Some people had been successful and their strategies gradually became dominant strategies, formed general rules in society and was widely imitated. These strategies were the 'internal rules' which was spontaneously developed out of constant social interaction. When the internal rules could not completely eliminate the uncertainty of the environment and individual behavior, government should play a compensate role. Government achieved a specific goal from the top down management, which were the 'external rules'. As a formal system, external rules represented the goal of state organizations or rulers to compensate for the possible failures in the internal rules of communities (Hayek, 1988). Sometimes internal rules and external rules integrated and promoted each other, and sometimes they conflicted and restricted each other. Under the joint action of internal and external rules, social relations constantly change, and this change process was called social evolution (North, 1990).

Some research used social evolution theory to analyze the relationship between rural Land Private Use and farmer community governance in China. Small-scale economy with family-based production and privatized ownership of the means of production had a long history in China, and became the internal rules of agro-communities to adapt to the heterogeneity of land and water resources (Mu X, 2019). After the founding of The People's Republic of China, the collective external rules did not match the farmers' desire to operate independently and obtain profits. In 1984, the farmers' community spontaneously formed the way of 'production belonged to household' to meet farmers' needs, and then the government established the external rules of the Land Private Use to confirm the internal rules of the community (Li S, 2010). Zhou (1994) analyzed the changing process of Chinese rural economy system, pointed out that when the low efficiency of the rural collective economy greatly restricted the farmer's production enthusiasm, as well as the government's enormous financial pressure, the government was forced to make a partial retreat to farmers' internal rules. At last, Land Private Use policy implemented in rural areas across the country. Therefore, the reform of rural land system was essentially a long-term game between the internal rules of farmers and the external rules of the country. Collective external rules gradually withdraw, government further confirmed the internal rules of communities of privatized production (Yang X, 1998). However, different from the agricultural area, the Grassland Private Use policy was external rules transplanted from the agricultural area to the pastoral area, during which the herdsmen were in a passive state (Liu X, 2011). Some scholars believed that the Grassland private use policy ignored

local knowledge and the wisdom of herdsmen, and the original community adaptive management methods such as nomadism and mutual cooperation in pastoral areas gradually disappeared under the external rules (Han N, 2018).

In our case, although the summer pasture in Xinjiang agro-pastoral area was distributed to households, part of the pasture still remained common use, and the community management mode under the Land Private Use policy had undergone great changes. In order to explain the interaction between Land private use and community governance, this study uses social evolution theory to explain the interaction between the internal rules of pastoralists community and the external rules of Grassland Private use policy from government on the basis of analyzing the livelihood and ecological results of community EbA management.

To sum up, this study took N County, Xinjiang as a case study to answer the following two questions: 1) Under the Land Private Use policy, livelihood and ecology were taken as the outcome variables to evaluate the adaptability of farmers and pastoralists; 2) From the perspective of Hayek's Social Evolution Theory, explained the reasons for the failure of EbA management of the community in the case through the interaction between the internal rules of pastoral community and the external rules of Grassland Private Use System. The results provided policy suggestions for improving the effectiveness of EbA management in pastoral communities and reforming the Grassland private use mode.

2. Data and Methods

2.1 Case study

N county was located in Yili River Valley of Xinjiang. The annual average precipitation was 516.4mm and evaporation was 1410mm. The annual average temperature was 7.5°C, ranging from -50°C in winter to 42°C in summer. The climate was from the semi-arid agriculture below 1000m above sea level to the wet meadow grassland animal husbandry above 1000m. Village T and Village W in N County were selected as case studies. Both of these villages had implemented grassland private use. However, Village T still maintained the mode of sharing grassland among groups (6-8 households as a group), while Village W completely divided the grassland to households, demonstrating different ways of grassland use mode. The basic information of Village T and Village W was shown in Table 1.

Table 1. Basic Information of T Village and W Village (2018)

	Total area of grassland (1000ha)	Grassland area per household (ha)	Total Agricultural area (ha)	Total Households	Numbers of people	Livelihood	Grassland use	Mode of production
T Village	8.4	19.87	534.73	423	1905	Pure grazing	sharing grassland among groups	Household production
W Village	9.47	46.2	504.4	558	2273	Farming and grazing	Grassland private use	Household production

The privatization of grassland in Xinjiang started in 1984. Each household in Village T allocated pasture and farmland use rights and livestock. Under the traditional co-production mode of pastoralists, each shelter was a group, the shelter leader lead the herdsmen help each other to graze together. Even after the grassland was divided into households, T village still adopted the mode of sharing the grassland use right in groups. The main reasons were that the total area of the grassland was small, and it was not conducive to grazing on the grassland completely dividing in to households. The winter pasture was 200km away from the settlement, and it took two days to transfer from spring-autumn pasture to winter pasture. The shelter leaders took the whole group of livestock to transfer, and other labor forces in the group helped with grazing and maintaining the shelters, etc. However, after the implementation of grassland private use, the herdsmen in the community gradually discarded the mode of grazing together. Instead, a new system of collective action was designed within the group. The shelter leader stook their own livestock and the livestock from other households in group to winter pasture. Only a few wealthy families (usually the shelter leaders) continue to nomadic for three seasons and lead some of the other households' livestock in group to winter and summer pastures.

W village continued the labor division of farmers and herdsmen in Collective era. Farmers got farmland and engage in agriculture work, while herdsmen got pasture and livestock and engaged in livestock grazing. Under the development of market economy, farmers raise more and more livestock. They kept their livestock in shelter and fed

forage in winter, and let herdsman grazing their livestock on summer pasture from May to October every year. The behavior of grazing livestock from agricultural areas and charge fees belongs to market transaction, while the behavior of leading other herdsman's livestock to winter pasture (free or lower than the price of grazing farmers' livestock) belongs to collective action.

2.2 Evaluation Indicators and Methods of Community Adaption Management

Firstly, the adaptive management of the herdsman community in the case study was evaluated. When evaluating the effectiveness of adaptive management, it should include both adaptive capacity and ecological vulnerability of the community in response to changes (Kelly, 2000; Downing, 2001). Livelihood indicators such as income level, livelihood mode and social relationship of community members determined adaptive capacity, while the sensitivity and resource carrying capacity of ecosystem itself determined ecological vulnerability (Smit, 2006). Based on the summary of existing adaptive evaluation research, this study selected key factors reflecting the results of community adaptive management from both livelihood and ecology as criteria to evaluate whether the management is effective.

In terms of the adaptive capacity of communities to deal with changes, this study selected three indicators: Cash income and livestock number of herders, Diversity of livelihoods, Collective action and mutual assistance of community.

Indicator 1: Whether cash income and livestock number of herders had increased

The greater the household cash income and livestock of herders were, the more conducive it was to maintain the stability of livestock livelihood when herders were under external changes. According to the county statistical data, the changes of per capita net income and livestock number of herders family in N County from 1984 to 2015 were analyzed to judge whether the adaptation strategy under Land private use could help improve the cash income and livestock wealth of herdsman. Specifically, it includes the following 3 indicators:

A. Constant price per capita net income = real per capita net income * (100 - inflation rate) / 100

On the premise of eliminating the impact of inflation on income changes, the net income per capita of N County from 1984 to 2015 was calculated. The net income per capita at constant prices described the trend of net income per capita. The difference between the per capita net income of N County and the national average was judged by comparing it with the national per capita net income of farmers at constant prices.

B. Average annual growth rate of per capita net income = (current period/previous year) × 100%

Calculate the average annual growth rate of per capita net income and describe the trend of the average annual growth rate. Compared with the average annual growth rate of farmers' per capita net income in China, the difference between the growth rate of per capita net income in N County and the national average growth rate was judged.

C. Total livestock stock (sheep unit) = number of sheep + number of large livestock (cattle, horses, etc.) * 5

The total livestock stock (sheep unit) in N County from 1984 to 2015 was calculated to describe the change trend of livestock stock.

Indicator 2: Whether pastoralists achieve diversified livelihoods

In addition to animal husbandry, the development of diversified livelihoods for herdsman was an effective adaptive measure to cope with the impact of external changes. Based on the interview data from 2016 to 2018, the proportion of herdsman's income from agriculture and animal husbandry and the proportion of the labor force engaged in alternative livelihoods other than agriculture and animal husbandry were used to judge whether the herdsman's strategy of adapting to external changes through diversified livelihoods was effective.

A. Proportion of agricultural and animal husbandry income = (animal husbandry income + agricultural income) / total income * 100%

By observing the income structure of herdsman in T village and W village, the income from animal husbandry included all the income related to animal husbandry, such as selling livestock, helping farmers to graze their livestock, selling livestock products, leasing pastures, and grassland subsidies. According to the classification standard of the National Agricultural Census (2016), those with more than 90% of their income from animal husbandry and agriculture were pure herders, those with more than 50% of their income from agriculture and animal husbandry were called mostly engaged herders, those with 10-50% of their income from agriculture and animal husbandry were called herders with other work, and those with less than 10% of their income from animal husbandry and agriculture were non-farmers. Therefore, the classification standard of this study was that the proportion of agriculture and animal husbandry was more than 90%, which was regarded as no diversified livelihood, 50-90% was regarded as partially diversified livelihood, and less than 50% was regarded as diversified livelihood. At the same time, the types of

work that herdsmen engaged in other than agriculture and animal husbandry were described (Table 2).

B. The proportion of non-agricultural and animal husbandry labor = the number of labor engaged in other jobs other than agriculture and animal husbandry/the total number of labor *100%

The labor distribution of herdsmen in case area, the total number of family labor and the number of migrant workers were calculated to judge the degree of livelihood transition of farmers and herdsmen. The classification criteria were that the proportion of non-agricultural and pastoral labor exceeding 50% was regarded as diversified livelihoods, 10-50% was regarded as partially diversified livelihoods, and less than 10% was regarded as herders no diversified livelihoods (Table 2).

Table 2. Diversified Livelihood Standards of Herders

Type	Proportion of income from agriculture and animal husbandry	Proportion of livelihood transition	Livelihood strategies
Diversified livelihood	Less than 50%	More than 50%	Mainly go out to work
Partially diversified livelihood	50-90%	10-50%	Mainly animal husbandry and agriculture, part of the labor working outside
No diversified livelihood	More than 90%	Less than 10%	Pure animal husbandry and agriculture

Indicator 3: Collective action of community

The collective action of community members to help each other in production was an effective mean for herdsmen to deal with uncertainty, which was an important content of community adaptation strategy. Pastoral communities cooperation was mainly manifested in livestock transitions, community members shared the camel and other means of transition. However, after the private use of grassland, livestock transitions had largely disappeared. Collective action was defined as one herder household took other households' livestock in community transit between summer, spring and autumn, and winter pasture. Although the grassland in Yili was divided to households, it was still partly in the form of sharing use, and the herdsmen in community all had the right to use the grassland. If herdsmen bring livestock outside the community to pasture for grazing, it meant that herdsmen and outsiders (such as farmers) share pasture resources. When the community grassland resources were open to users outside the community, the collective action would inevitably disappear and the tragedy of the Commons occurred (Ostrom, 1990). Therefore, behavior of sharing pasture resources with herdsmen in community belonged to collective action, while the behavior of sharing pasture resources with people outside the community did not belong to collective action.

A. The behavior of grazing other herdsmen's livestock in the community: discuss the pasture use way of communities in T and W village. If very few or no herder grazed others livestock in the community, the collective action had weakened or disappeared.

In terms of ecological vulnerability, an indicator was selected:

Indicator 4: Whether the grassland ecology is effectively protected

This paper summarized the description and evaluation of the grassland ecological situation from the herdsmen in case area, and judged whether the grassland ecology had been effectively protected. The main reasons for grassland degradation was put forward by asking herdsmen about their perception of grassland ecological change in the past 30 years (since 1984).

A. Whether grassland ecology was degraded: the change of grassland ecology in the past 30 years could be divided into three degree-degradation, no obvious change and improvement. If the pasture was considered degraded, further questions were asked about the cause and time of the degradation.

B. Effectiveness of pasture supervision: whether the herder community's supervision and punishment of illegal grazing behaviors were effective, whether overgrazing were effectively limited under community management.

The above criteria could reflect the effectiveness of community adaptive management from different aspects. If the judgment result was negative, the community adaptive management would be considered as partially or completely ineffective (Figure 1).

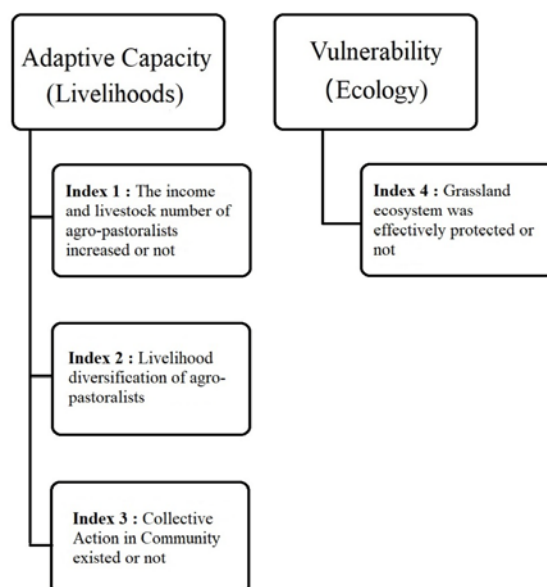


Figure 1. Evaluation Criteria for the Effectiveness of Community Adaption Management.

2.3 An Analytical Framework for the Interaction between Internal and External Rules of the Community

Based on the theory of social evolution, this paper constructed an analytical framework to explain the interaction between the external rules of land private use and the adaptive strategies of the community. The traditional culture of herders’ society formed the internal rules of the community to guide grazing production activities. Under the influence of external rules from the government, the internal rules of the herdsman community and the external rules of the government experienced the interaction process of conflict or integration, and three different types of interaction relations could be formed between the internal rules and the external rules: complementary interaction, accommodating interaction and substitutive interaction. Finally, the social order results in the internal and external rules unified, co-adapted, or failed (Figure 2).

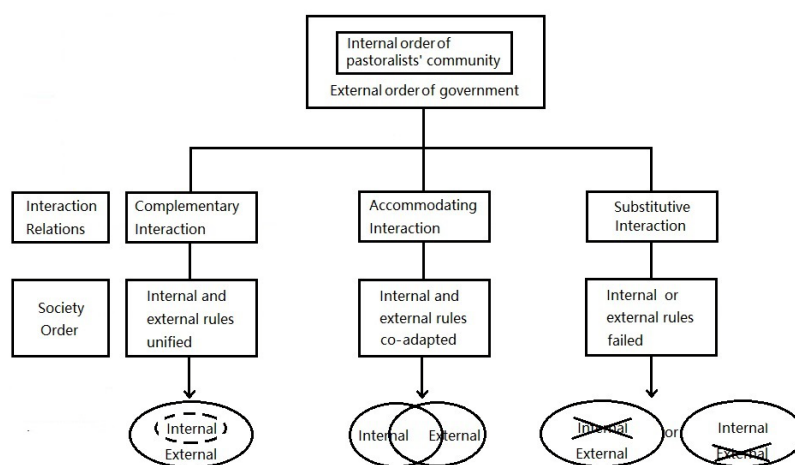


Figure 2. Analysis Framework for the Interaction between Community Internal Rules and External Rules.

In the period of Land private use, a certain interactive relationship was formed between the external rules of the government and the internal rules of the herders community, which triggered the change of the community internal rules and the production strategy of herdsman, and finally determined whether the adaptive management of the

community in the case site was effective. This paper constructed an analysis framework of the interactive relationship between community internal rules and government external rules, analyzed the conflict and coordination process between community internal rules and government external rules during the Land private use period, and how the social order formed, so as to explain why the community adaptive management in the case area was ineffective.

2.4 Data Collection

The per capita net income of farmers and herdmen in N County, the number of livestock and the per capita net income of farmers nationwide were selected from the statistical data from 1958 to 2015. The fieldwork was completed from 2016 to 2018, and semi-structured interviews were mainly used to conduct household surveys among pastoral households in T and W villages. According to the definition of the villagers, households with more than 100 livestock belonged to the rich household, 50-100 livestock belonged to the medium household, less than 50 livestock belonged to the small livestock household and no livestock household. They had more difficulties in livelihood. The interviewees were selected from the three groups. A total of 60 households in T village and 83 households in W village were interviewed, both of which accounted for 15% of the total number of households in the village. The interviews mainly focused on the income structure, labor force, social situation and pasture use. At the same time, through the interviews with the managers of N County government, the livelihoods and pasture resources of farmers and herders in the county were understood.

3. Results

3.1 The Adaptive Capacity of Communities to Deal with Changes

3.1.1 The income level of herders has increased, but the gap between rich and the poor become wider

During the Land private use period, the average income of household in the case area had increased significantly. From 1984 to 2015, the per capita net income of farmers and herdsmen in N County increased from 35 dollar to 1,222 dollar, with an average growth rate of 10.6%. The per capita net income of farmers nationwide reached 1,512dollar in 2015, with an average growth rate of 14.7% over the past 30 years. From 2005, the gap between the net income of agro-pastoralists in N County and the net income of farmers nationwide had widened. In 2015, the net income in case study was about 80% of the net income of farmers nationwide (Table 3, Figure 3). It shows that with the development of economy, although the income level of agro-pastoralists in N County increased year by year, there was still a gap compared with the average level of farmers in China.

On the other hand, the total number of livestock was constantly increasing. At the same time, the number of few and no livestock households was also increasing. From 1984 to 2015, the livestock of herders in the county increased from 450,000 sheep units to 2 million sheep units, and the number of livestock continued to increase until 2011, when it began to turn to a downward trend. However, the field survey showed that in recent years, more and more households had less than 50 sheep units, the gap between the rich and poor households was wider.

Table 3. Indexes of Income and Livestock Wealth of Farmers and Herdsmen

Index	Variable	Mean value	Maximum value	Minimum value	Standard deviation
Cash income and livestock of agro-pastoralists	1. Per capita net income of agro-pastoralists in N County(dollar) ^a	193.31	1,204.96	8.68	297.55
	2. Growth rate of per capita net income of agro-pastoralists in N County (%) ^a	9.04	41.71	-18.6	12.24
	3. Per capita net income of farmers nationwide(dollar) ^b	231.66	1,512.46	2.42	373.58
	4. Growth rate of per capita net income of farmers nationwide(%) ^b	13.2	122.38	-8.57	19.24
Diversify of herders livelihoods	5. Livestock number in N County(sheep units) ^a	108.62	203.93	35	45.69
	6. Proportion of agro-pastoral income in total income(%) ^c	90.5	93	88	3.64
	7. Proportion of non-agro-pastoral labor force(%) ^c	17.25	18	16.5	1.06

The data sources and description in the table were as follow: A. ‘N County Statistical Yearbook 1984-2015’; B. ‘China Rural Statistical Yearbook 1984-2015’; C. Field interview data from 2016 to 2018.

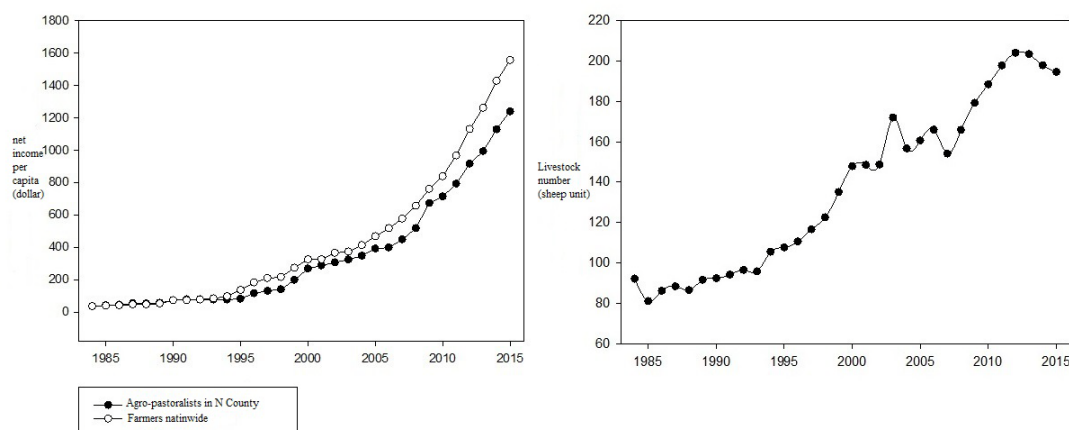


Figure 3. Changes of Agro-pastoralists Net Income per capita and Livestock Number in N County.

3.1.2 Herders mainly relied on animal husbandry for their livelihood, it was difficult to achieve diversified livelihoods

From the perspective of income structure, the proportion of agriculture and animal husbandry related income of farmers and herders in T village and W village was 88% and 93% respectively (Table 3, Figure 4), which showed that the residents of the two villages still relied on animal husbandry and agriculture as the main source of income. The most important source of income for both pastoralist and farmers families was the sale of livestock. The income from selling livestock in T village and W village accounted for 66% and 72% of the total income respectively. Other sources of income related to animal husbandry included renting pastures, grazing for others, selling livestock products such as dairy products and wool, and government subsidies, while income from wage work only accounts for 12% and 7% (Figure 4). For farmers, the area of farmland was too small and the price of crops was too low to make a living from agriculture alone. So farmers generally relied on livestock husbandry and the main source of income was selling livestock. The income related to agriculture and animal husbandry accounts for about 90% of the total income, which showed that farmers and herdsman still maintain pure animal husbandry and agricultural production, and did not achieve diversified livelihoods.

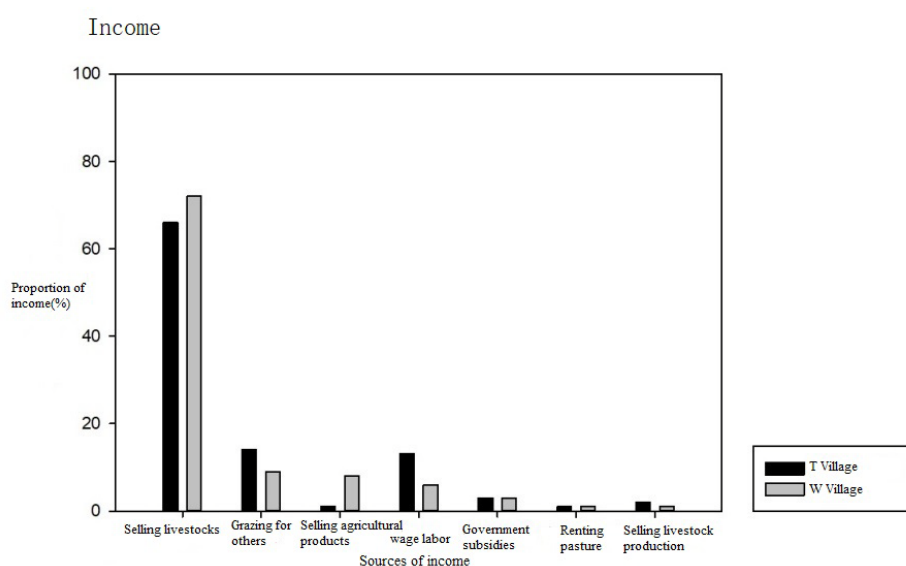


Figure 4. Income Structure of Farmers and Pastoralists in T village and W village.

Among the interview, there were 136 labor forces in T Village, 26 were wage workers, and the proportion of non-agricultural and animal husbandry labor was 19%. There were 125 labor forces in W Village, 21 were wage workers, and the non-agricultural and animal husbandry laborers account for 17%. In the field interview, it was found that the mainly livelihood of the family was still animal husbandry, and the labor force engaged in non-agricultural and animal husbandry activities was small. More than 80% of those who chose to go out for work were young herdsmen separated from large families. They had no pasture and were difficult to engage in animal husbandry, so they need to find other ways to make a living. In the interview, some farmers rented farmland to grow cash crops, leased agricultural machinery and sold forage, but most herdsmen still relied on animal husbandry for their livelihood.

Low level of economic development in western China hindered the farmers and herdsmen increasing income and livelihood diversification. Because of the culture and languages of ethnic minority, education level, limit employment ability, local farmers and herdsmen were lack of ability to find alternative livelihoods. The livelihood transition had not been successful.

3.1.3 The collective action disappeared, and grazing for farmers became a common phenomenon

In T village, 15% of the herder households asked rich herder to take their livestock to winter pasture, and 21% of the herding households asked rich herder to take their livestock to both winter and summer pasture. Therefore, the proportion of pastoral households in the village involved in collective action was 36%, while 43% of households with few livestock could not pay the high cost of livestock transition. They grazed animals in spring and autumn pasture and summer pasture all year round (Table 4). Herder households who took others' livestock in group to winter and summer pasture would also be paid, but it was generally lower than the price of taking livestock outside the community to graze on group pasture. In W Village, the pasture in winter and summer was close to the settlement, and the pasture was distributed to household, and the collective action in community was already disappeared.

Table 4. Different Pasture Use Types of Herders

Pasture use types	Households	Proportion	Sheep unit(per household)	Pastoral labor force(per household)
Two - or three-season transition	31	21%	124	1.73
Transition in winter and summer	53	36%	77	1.21
No transition	67	43%	31	0.29

On the other hand, it is common for herders grazing the livestock of farmers outside their communities on pasture in both T and W villages. 18 families grazed farmers' livestock on pasture among the 33 families interviewed, accounting for 55%. The leader of W village also pointed out that 25% of the pastoral households in W village grazing livestock from surrounding agricultural areas, and 20% of the pastoral households grazing livestock from farmers in the village, with a total grazing rate of 45%. It mainly occurred in summer pasture. The average number of farmers' livestock grazed by one herder household was 220, and the number of the herder's own livestock was 102. It could be seen that the average number of farmers' livestock was more than double of their own livestock. Villagers approved that herders should graze more than 200 sheep of farmers to make a profit. In 2018, the price of grazing farmers' livestock was 2dollar/month for sheep and 14dollar/month for large animals such as cattle and horses. The herders' average income of grazing farmers' livestock was 1,878.5dollar, accounting for 24% of their total income.

From the perspective of farmers, because the income of animal husbandry was much higher than farming, it was very common for farmers to raise livestock. Farmers had no pasture under the land private use policy, so there was a demand for farmer to ask herders to grazing livestock on pasture. The initial accumulation of livestock by farmers was in the late 1980s, when herders usually gave farmers 1-2 livestock in return for obtaining wheat straw from farming areas as winter forage. After 2000, with the increase of sheep price, the number of livestock of farmers began to increase significantly. Due to the increased demand for forage, some farmers stopped growing crops. They planted forage grass in 2010 to meet the demand of their own livestock. Among the 23 farmers interviewed in W village, 9 of them still grew crop, and the remaining 14 all grew forage grass. As a result, farmers had more and more livestock, and they need to find herders to graze their livestock on pastures in summer.

From the perspective of the herdsmen, after livestock were divided to household, the grazing experience of herders was different. Some of the herders family had sell their livestock for hospital or marriage, and families with few or no livestock gradually appeared in pastoral areas. These households lost the ability to use the grassland by livestock

grazing. So they need to find a way to benefit from the sharing use pasture. For households with few or no livestock, it had become a more economical way to take farmers livestock on pasture in summer, because if they raise their own livestock, they also need to buy forage in winter. Under the grazing mode of group sharing of pasture in T village, households with more livestock occupied the whole pasture, but did not provide compensation to households with few or no livestock. Therefore, households with few livestock and no livestock chose to get the opportunity to use collective pasture by means of grazing farmers' livestock.

3.2 Ecological vulnerability: grassland degradation

During the interview, all herders believed that the pasture was degraded year by year. 60% of herdsman believed that the grassland began to deteriorate from 2000 to 2010, which was consistent with the period when the number of livestock in agricultural areas increased and the development of herder grazing farmers' livestock. Herdsman confirmed that the top three reasons for grassland degradation were overgrazing, drought, and herders' large number of livestock, accounting for 42%, 30% and 28% respectively. They believed that too many livestock on pasture exceeded the approved carrying capacity, which was the main reason for grassland degradation. 50% of the herders believed that the degradation in summer pasture was the most serious, followed by spring and autumn pasture and winter pasture.

For the violation action of overgrazing by herders, there was no supervision and sanction mechanism for the violators in the herder's community. Taking T Village as an example, the collective action designed by T village (the shelter leader took livestock of group members to winter and summer pasture) was very weak, because it lacked institutional guarantee. If collective action broken, it would face the problem of compensation. Since there was no higher-level management unit to organize effective negotiations, the two sides could not reach a timely consensus on the amount of compensation, who was eligible for compensation, and who should be compensated. Therefore, once the compensate could not be achieved, the strategy of herders with few or no livestock was to obtain the benefits of pasture using through grazing farmers' livestock outside the community, and it was inevitable of disputes in this process.

At the village level, there was no grassland management department to supervise villagers' daily grassland use behavior and deal with disputes among villagers. When herders needed to deal with disputes, they often went to the grassland department of the county and invited grassland management officers to the village. The cost was very high, and the grassland management department had limited supervision capacity to deal with villagers' conflicts.

According to the interview with the grassland management department, we learned that the rights of the grassland department was limited to pastoral areas, and there was no enforcement rights for agricultural areas, so it could not stop farmers ask herders to grazing their livestock. The measures taken by grassland departments to deal with overgrazing of herdsman include: 1) it was forbidden to rent pasture to people from other counties; 2) Overgrazing herder households could not achieve grassland ecological awards and subsidies. However, the grassland management department did not prohibit grazing for farmers within the county, as long as it did not exceed the carrying capacity. If overgrazing were found during inspection, the herders would be fined, and if more than 100 animals, the livestock would be confiscated. In April and June, the grassland station set up inspection station on the way to the spring and autumn pastures and summer pastures to check overgrazing and livestock epidemic prevention certificates. However, the number of herders was too large, the funds and manpower of grassland management department were limited, and led to the problem of insufficient supervision capacity.

It can be seen from the above results that although the farmers and herders in the case area had increased their cash income, they still relied on animal husbandry for a living, and it was difficult for herdsman to achieve livelihood transition. Therefore, community adaptation strategies in the case study were inefficient in improving the adaptive capacity of farmers and herders to reduce ecosystem vulnerability.

4. Discussion: Why adaptive management failed in pastoral communities

4.1 The internal rules of herders community were replaced by the external rules of land private use

Land private use was transplanted to pastoral areas after confirming the internal rules of farmers' household production mode in agricultural areas. The government had implemented the external rules of grassland private use and household production, which totally changed the herders' production mode of grassland sharing use, grazing livestock together and mutual assistance and cooperation since tribal era. The grassland management departments at the county and township levels were in charge of grassland resource use and protection, and communities no longer had

the right of grassland management and supervision.

Under the external rules of land private use, herders in both T and W villages switched to household livestock production. Farmers and herders independently made a living and traded resources and products through free market mechanism. The household production mode had improved the enthusiasm of individual production, and the income level of farmers and herdsmen had increased significantly. However, from the perspective of herders, the livestock production system at the household scale was very fragile. When family lose their basic livestock due to natural disasters or family changes, it was difficult for the family to recover the livestock scale without the mutual assistance from the herder community, and it could only rely on renting out the pasture use right to maintain the livelihood. From the perspective of farmers, the income of growing crops was low, and raising livestock had become an optimized livelihood strategy for farmers in the agro-pastoral area to obtain higher income. Under the market mechanism, farmers' livestock could also use herders' pasture resources by finding herders take their livestock to pasture or renting pasture.

The implementation of government external rules had replaced the internal rules of cooperate production and mutual supervision in herders community. Farmers and herders formed household independent production mode, the internal rules of livestock grazing cooperation between herders disappear, it is very common that herders took farmers' livestock to graze on pasture, and the supervision within the community under household production and transaction mode failed. It could not effectively supervise the grassland use behavior of villagers and mediate conflicts among villagers.

4.2 The social order of household independent production

According to the analytical framework in Figure 2, the interaction between internal rules and external rules of the herders' community belonged to the substitutive interaction, traditional internal rules were replaced by the external rules of the government, and finally the social order of herders household independent production was formed (Figure 5). Under the household production mode, the gap of the livestock number per household was gradually widening, and the collective action within the herders' community lacked an effective supervision and compensation mechanism. Once the collective action failed, there was no compensation measure for the herders who suffered a loss on pasture use right. Therefore, in order to maintain their livelihood, the households with few livestock or no livestock generally chose to engage in grazing livestock for farmers, which brought livestock outside the community into the pasture, and the pasture carried an excessive number of livestock, resulting in pasture degradation. The management mechanism within the community had lost its power, and the village level also lacked the ability to supervise the grassland use behavior of the villagers, punish the illegal behavior of overgrazing and solve the disputes among the villagers. Although the central and local governments carried out a series of grassland ecological compensation policies to decelerate grassland degradation, they could not solve the problem because the social order of household independent production of pastoralists had not changed.

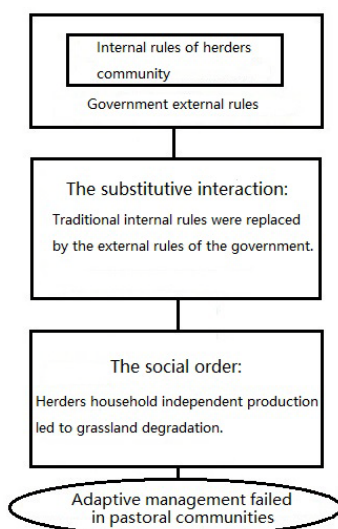


Figure 5. Analysis of the Interaction between Internal and External Rules in Case Study.

5. Conclusion and policy suggestions

Under land private use policy, farmers and herders income had increased, but they still relied on animal husbandry for a living. It was difficult to achieve livelihood transition in agro-pastoral area. Community collective action gradually disappeared, and the action of grazing farmers livestock on pasture led to grassland degradation. Therefore, community adaptation strategies in the case study were ineffective in improving the adaptive capacity of farmers and herders and reducing ecosystem vulnerability. The external rules of household production in agricultural area were extended to pastoral area. The original internal rules of collective grazing had been replaced by external rules of land private use, forming a social order of household independent production. The mutual assistance and cooperation relationship of herders in community had been destroyed. The transaction between herders and farmers of grazing farmers' livestock on pasture was widespread. There was no effective supervision and punishment mechanism in the community, and overgrazing led to grassland degradation.

In order to protect grassland ecology, the internal rules of herders' collective action needed to be re-established. It was difficult to achieve the goal of grassland protection only by strengthening the government's administrative management on grassland. The grassland rights and responsibilities could be divided in household unit, but it should not be used in household level. The way of grassland sharing use was in accordance with the characteristics of grassland resources. Grassland was a typical common pool resource. It was urgently to re-establish effective collective action and social norms to manage the livestock grazing behavior of herders. It can be divided into the following two aspects:

Firstly, rebuild the internal production rules of herder's sharing use of pasture, group grazing and mutual cooperation. After the internal rules of herders were replaced by the external rules of land private use, herdsmen carried out animal husbandry production in household level, resulting in the problem of pasture degradation. Thus, collective-scale livestock production should be reconstructed. Under the land private use policy, the establishment of animal husbandry production cooperative is a feasible way. The herders in the village unite on the basis of voluntary mutual benefit, risk sharing and benefit sharing, so as to meet the needs of production and protect their own rights and interests through joint action. The cooperatives should have the following characteristics: First, voluntary mutual benefit, herders have the freedom to join and withdraw from the cooperative. Second, collective self-management, each member has the right to participate in and make decisions. Third, the establishment of public funds, accumulated public funds for resource protection and risk response. Through the form of cooperatives, the scattered pasture resources can be integrated to solve the problem of the relative shortage of pastoral labor, and the mutually beneficial community cooperative relationship can be restored. The adaptive strategy of pasture sharing, group grazing, mutual assistance and cooperation would be rebuilt through the herders cooperative.

Secondly, establish community participates in farmers and herders grazing transactions. The community organizes herdsmen to conduct resource trading with farmers. When farmers trade pasture resources with herders, the village collective must sign a formal contract on behalf of herders, and the overgrazing behavior must be restrained through the contract. The number of livestock on the pasture should be controlled, and the moderate use of the pasture should be ensured after the grazing transaction between herders and farmers is reached, so as to achieve the social and ecological sustainable development of the agro-pastoral area.

References

- CBD. Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Technical Expert Group on Biodiversity and Climate Change. CBD Technical Series No. 41. Convention on Biological Diversity, 2009, Montreal, Canada.
- Chong J. Ecosystem-based approaches to climate change adaptation: Progress and challenges. *Int Environ Agreements*. 2014, 14(4): 391-405.
- Cui Y. The issue of resocialization of nomadic settlement [J]. *Journal of Xinjiang Normal University*. 2002, 23(4):76-82.
- Ertör-Akyazi P. Formal versus informal institutions: Extraction and earnings in framed field experiments with small-scale fishing communities in Turkey [J]. *Marine Policy*, 2019, 10:1-12.
- Fernández-Giménez, M, E, Batkhishig B, Batbuyan B, et al. Lessons from the Dzud: Community-Based Rangeland Management Increases the Adaptive Capacity of Mongolian Herders to Winter Disasters. *World Development*, 2015, 68:48-65.

- Gongbuzeren, Li, Y.B. and Li, W.J. (2015). China's rangeland management policy debates: what have we learned? *Rangeland Ecology & Management*, 68:305-314.
- Hayak F. *The Fatal Conceit: The Error of socialism*. 1988. Great Britain. T.J. Press. Ltd. Padstow, Cornwall. 1988.
- Holling C. *Adaptive Environmental Assessment and Management* [M]. London: John Wiley, 1978:377.
- Jeans, H. The role of ecosystems in climate change adaptation: Lessons for scaling up. In: Schipper, ELF et al. (eds) *Community Based Adaptation to Climate Change: Scaling it up*. Routledge, 2014, London.
- Johnson F, Williams B, Schmidt P. Adaptive decision-making in waterfowl harvest and habitat management [J]. *Proceedings Internal Waterfowl Symposium*. 1996, 7: 26-33.
- Lee K. *Compass and Gyroscope: Integrating Science and Politics for the Environment* [M]. Washington, DC: Island Press, 1993:243.
- Li D, Tracy H, Shalima T, et al. Changing Agro-Pastoral Livelihoods under Collective and Private Land Use in Xinjiang, China. *Sustainability*. 2019, 11, 166.
- Li Y. *Research on the Improvement of Management mechanism of Grazing Livestock Capacity in Inner Mongolia* [D]. Peking University. 2014.
- Li, W and Huntsinger L. China's Grassland Contract Policy and Its Impacts on Herder Ability to Benefit in Inner Mongolia: Tragic Feedbacks. *Ecology and Society*. 2011, 16(2): 1.
- Meinzen-Dick R, Markelova H, Kelsey M. The Role of Collective Action and Property Rights in Climate Change Strategies. *Policy Brief*. 2010, 2(7):1-4.
- North, D. C. *Institutions, Institutional Change and Economic Performance*, Cambridge University Press, 1990.
- Osei-Tutu P, Pregernig M, Pokorny B. Interactions between formal and informal institutions in community, private and state forest contexts in Ghana [J]. *Forest Policy & Economics*, 2015, 54: 26-35.
- Raymond C M, Robinson G M. Factors affecting rural landholders' adaptation to climate change: Insights from formal institutions and communities of practice [J]. *Global Environmental Change*, 2013, 23(1):103-114.
- Reid, H. *Improving the evidence for ecosystem-based adaptation*. IIED Working Paper. 2011. London.
- Salafsky N, Margoluis R, Redford K. *Adaptive Management: A Tool for Conservation Practitioners* [M]. Washington DC: Biodiversity Support Program, World Wildlife Fund, Inc. 2001:34.
- Shalima Talinbayi. *The Dilemma of Collective Action Based on Kinship: A Case Study of the Kazakh Community in Northern Xinjiang* [D]. Peking University. 2019.
- Sokile C, Mwaruvanda W, and Koppen B. *Integrated Water Resource Management in Tanzania: interface between formal and informal institutions*. International workshop on 'African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa', January 2005, South Africa.
- Wong N, Morgan J. *Review of Grassland Management in South-eastern Australia* [M]. Melbourne: Parks Victoria. 2007: 1-27.