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Pathways to Sustainable Grassland Development in China

Findings of Three Case Studies

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Abstract: Grassland development serves as an important part of the national sustainable development strategy in China. This paper defines the strategic objectives of grassland development in China based on the national strategy, the current status of grassland development in China and the status of grassland development internationally. As China is at a transformational stage of implementing an ecological economic system in grassland development, top priorities should be given to enhance the values of grassland ecosystem services, reduce the pressures on the grasslands, and restructure the grassland industry. Case studies on three pasture areas in Sichuan and Inner Mongolia, which have distinct ecological and climatic features and are at different development stages, revealed that the core issue for sustainable development of grassland in China is in addressing the conflict between the people and grasslands. Improving the social security system and enhancing the capacity of the herders in implementing sustainable development are the recommended pathways for sustainable grassland development in China.

Zusammenfassung: Die Entwicklung von Steppengebieten ist ein wichtiges Element der Nachhaltigkeitsstrategie in der VR China. Dieses Papier erläutert die strategischen Ziele der Steppengebietenentwicklung im Rahmen der Strategie zur nachhaltigen Entwicklung in China und bündelt diese in die internationalen Entwicklungen der Steppengebietenpolitik ein. Zur Lösung der Armutsfalle der Herdenbesitzer in Steppengebieten wird eine Transformationsstrategie der integrierten ökologischen, ökonomischen und sozialen Nachhaltigkeit vorgeschlagen und programmatisch ausformuliert. Die Bewertung und Honorierung von Ökosystemdienstleistungen spielt darin eine zentrale Rolle wie auch die Verbesserung der Sozialversicherungssysteme für ländliche Räume. Drei Fallbeispiele aus Sichuan und der Inneren Mongolei zeigen die Machbarkeit und die verschiedenen Stufen dieser Strategie unter sehr unterschiedlichen klimatischen und sozioökonomischen Entwicklungsbedingungen.

Keywords: grassland development, sustainable development, national development planning, grasslands, ecological-economic systems, ecosystem services, case studies, China environment transition management, governance,

Introduction

Grasslands provide not only an ecological sub-system for biodiversity, but also an integrated economic area for the livelihood and development of herders. Thus far, China has made huge investments in terms of grassland infrastructural development, ecological restoration and herders' social security (IPMCAS, 2009). On June 1, 2011, the State Council issued the Opinions on Promoting the Sound and Fast Development in the Pasture Areas (GUOFA [2011] No.17) with the central government making a total investment exceeding 30 billion yuan. Overall, projects on grassland protection focusing on ecological development have progressed well and generated some ecological, economic and social benefits. Nonetheless, the grassland ecosystem in China has become increasingly vulnerable due to factors such as climate change and the effects of socio-economic developments on a long-term basis.

In general, the target and focus of grassland authorities is to maintain the sustainable development of grasslands, and the administrative system in place has changed from a single agricultural sector to the cooperation between/among multiple sectors. At this transitional period, one of the top priorities on grassland sustainable development is to coordinate the different needs of the relevant stakeholders in grassland use. From a national development perspective, grassland sustainable development has now evolved to include ecological, economic and social dimensions. Policies such as the grassland contract responsibility system, returning grazing land to grassland and eco-compensation systems will be implemented, improved and optimized according to the new objective in the national strategy. Livestock over-loading and the inappropriate structure of livestock pose a major challenge to sustainable grassland development in China. The effective methods for grassland sustainable development is to optimize institutional, economic and marketing conditions systematically (Reynolds, 2001). Within this context, studying the characteristics and the relationships among the different contributing factors and assessing the pathways and priorities on grassland sustainable development have become increasingly important in the regional sustainable development strategy in the country.

Researchers have already conducted in-depth studies on specific topics regarding the internal mechanism and growth process of grassland ecosystems (McGilloway, 2005). In China, the two theories, i.e. the balance theory based on the study of pasture control in western United States (Coughenour, 2004) and the non-balance theory based on the study of steppe in Africa (Ellis and Swift, 1988) were employed to address the internal pattern and development model of grassland systems in China. Many case studies were carried out based on the investigation of two competing models. Positive changes in social structures and economic development were in both model frameworks accompanied by increasing the ecological pressure. So careful monitoring to determine long-term change in rangeland conditions is required (Reynolds 2006). At the same time, researchers (Li & Li, 2012; Yang, 2012; Ouyang et al., 2013) have been exploring a more scientific method to calculate grassland capacity according to the patterns of grassland ecosystems

To overcome the limits of ecological models within a single discipline, researchers have begun to focus on the development of a model coupling economic pressures and ecological processes (Li, et al, 2012; Liu et al. 2007, Reynolds 2006). In terms of socio-economic factors, researchers have also conducted interdisciplinary studies on the operation model, the property right system and eco-compensation, among others, of the grassland development process. As for pastoral agriculture system, Nan (2005) set up a well-organized modern farming system, which integrate main factors (soil, crop, forage and grassland). Four production levels, preplant, plant,

animal and postbiotic levels were included in system. They were linked by three interfaces, which are vegetation-site, grassland-animal and production management. In fact, economy development and ecology protection can have a win-win relationship. This was confirmed by the study of livestock farming systems in north-western China (Kemp and Michalk, 2011). In some case, net income of stock raising can be gained with halved livestock numbers. This de-coupling provides the opportunity to reduce grazing pressure and rehabilitate the grasslands. Based on case studies in three typical pasture areas in China, we propose measures and pathways for an economically and socially sustainable development of grassland management.

1. The characteristics of grassland development in China

1.1 Models of grassland use in China

Grassland takes up 63% of the green vegetation system in China, and is known to be the largest green ecological shelter and a key carbon sink in the country. Unlike milk, wool, cashmere and other competitive sectors, the grassland livestock industry does not make up a high proportion of the whole livestock industry in China. Table 1 shows that in 2009, the output values of the grassland livestock sector in six provinces and autonomous regions rich in grassland resources (i.e. Inner Mongolia, Gansu, Sichuan, Tibet, Qinghai and Xinjiang) accounted for 6.3% of the overall livestock industry across China, while other livestock sectors accounted for 8.8% in these areas. In contrast, the agricultural areas recorded outputs of 15.9% and 69% respectively.

Over the last decade, many models on grassland use, such as the settlement of nomadic herdsmen, stable grazing, grazing prohibition, seasonal grazing bans, and rotational grazing, have been developed in China, each focusing on the effective protection of the ecological values of grassland use. The innovation and promotion of the grassland use models are led by the government and supported by other relevant stakeholders. As grassland is a complex ecological, economic and social system which involves human beings, livestock and grass, great efforts should be made to explore and to innovate the grassland use models in order to promote the balance and stability of different sub-systems.

Table 1 Livestock production and proportion of outputs in China in 2005 and 2009

Area	Outputs of grassland livestock sector(in 100 million RMB)		Proportion in the total outputs of the livestock industry in the whole country (%)		Outputs of other livestock sectors (in 100 million RMB)		Proportion in the total outputs of the livestock industry in the whole country (%)	
	2005	2009	2005	2009	2005	2009	2005	2009
	The whole country	2636.8	4323.9	19.8	22.2	10674	15144.5	80.2
Six major pasture areas	676.0	1228.8	5.1	6.3	1393.1	1714	10.5	8.8
Agricultural areas	1960.8	3095.1	14.7	15.9	9280.9	13430.5	69.7	69.0

Source: China Rural Areas Statistical Yearbook

1.2 The grassland management institutional system in China

The Ministry of Agriculture (MOA) takes charge of integrated grassland management in China. In 2002, the State Council officially launched the ‘returning grazing land to grassland’ program. In 2005, the first national grassland monitoring data was published by the MOA. In 2010, grassland protection and development was listed by the MOA as one of the top eight priorities for that year.

Great changes have also taken place in the grassland institutional system of the MOA(2010). In July 2001, MOA established the Grassland Supervision and Monitoring Center, which began to exercise its administrative power in April 2003. Compared with the production-oriented grassland stations under the livestock bureaus, which are important MOA branches on regional level, the center is more independently operated and can make greater contributions to grassland protection. MOA, as a specific industrial management agency, has transformed its grassland management approach from an economy-oriented focus of improving livestock production to the ecology-oriented focus of protecting grassland vegetation and productivity. Management targets have also been shifted from simple livestock production to balancing the development of grass and livestock, and the management objective has been changed from maximizing the economic benefits of grasslands to sustainable grassland development.

Other governmental agencies such as the State Forestry Administration (SFA), the Ministry of Environmental Protection (MEP) and the Ministry of Water Resources (MOWR) have also made great efforts in terms of grassland ecological control. As of 2010, a total investment of 17.6 billion yuan have been made by the central government, in which SFA, MOA and MOWR have contributed 40%, 30% and 30% respectively. In addition, the Ministry of Human Resources and Social Security (MOHRSS) and the Ministry of Civil Affairs (MCA) are also involved in the management of herders’ development.

In summary, a complex integrated grassland management system has been put in place in China. To restore the degraded grasslands, the SFA launched the programs of ‘Grain for Green’, and ‘control of wind and sand sources’, while the MOA and MOWR have been implementing the programs of ‘returning grazing land to grassland’ and water conservancy projects respectively. However, overlaps exist between the MOA and the SFA on the uncultivated land management of ‘grassland forest’ and ‘forest steppe’. Overlaps also exist between the MEP and the MOA on industrial development projects in grasslands and the issuing of herbal medicine collecting licenses.

The various common areas administered by various government agencies indicate that the ambiguous definition of rights and responsibilities and conflicts between/among different sectors related to grassland management need to be addressed. In addition, as MOHRSS focuses on the employment of the herders and the development of a social insurance system for the herders, a better policy synergy can be achieved if the efforts of MOHRSS to help herders can be effectively integrated with the poverty alleviation efforts of MCA for the herders.

1.3 Grassland management-related stakeholders

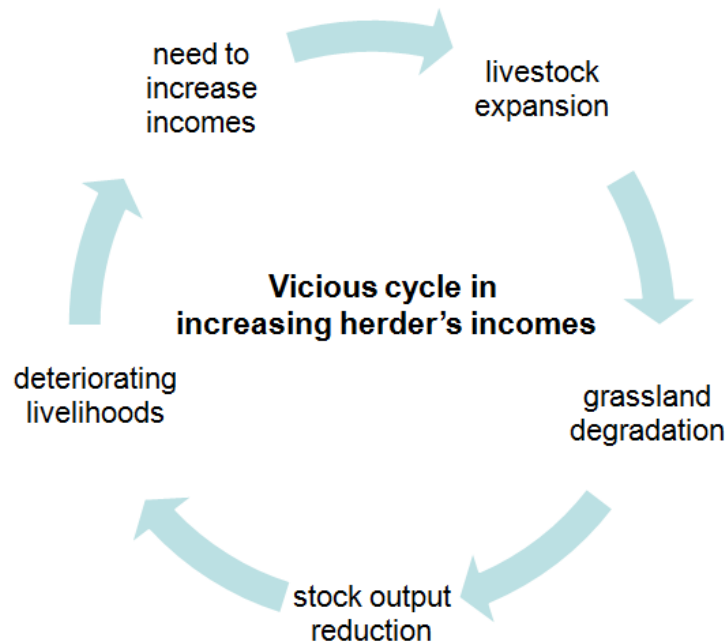
Grassland-management related stakeholders mainly include: policy makers (the central government), policy implementation agencies (local governments), and the target group of policy implementation (farmers and herders). These different stakeholders have both common and conflicting interests in the process of grassland development.

The Chinese central government has been focusing on grassland development from a national strategic perspective. Before the late 1990s, priority was given to the production and living functions of grasslands, and grasslands were regarded as a key resource basis for the livestock development and a fundamental factor of production for the livelihood of farmers and herders. Since the early 21st century, the central government has been switching top priority to the grassland ecological protection and development, and has implemented a number of key ecological development initiatives, such as the sandstorm sources control, fence construction, and returning grazing land to grassland programs. In 2011, a total of 13.6 billion yuan was earmarked by the central government to optimize the concept of grassland development and to promote the sustainable development of pasture areas. In the same year, the Opinions on Promoting the Sound and Fast Development of the Pasture Areas was issued by the State Council (GUOFA[2001]No.17).

In contrast, local agencies generally have two roles: 1) to maximize the regional benefits to achieve fast growth of the regional economy and 2) to implement the long-term national development strategy. Due to the dual roles, local governments have both common and different objectives with that of the central government. In China's western grassland areas, the ecologically fragile counties often overlap with the poverty-stricken counties, resulting in the challenging combination of environmental fragility and economic poverty. In the case where short-term economic benefits contradict with the long-term ecological benefits, the local government will often choose the former ones. Among the six provinces and autonomous regions in west China, which are rich in grassland resources, only the Sichuan provincial government has proposed the objective on grassland protection in its 11th Five-Year Plan. With the optimization of regional allocation mechanisms and the improvement of administrative performance assessment system, the local government will play an increasingly important role in grassland ecological management.

As one of the major groups in protecting the grasslands, the herders are sometimes involved in damaging the grasslands. Since 2000, the gap between the herders' income and the national average income level has been widening. For instance, the production and living costs for the herders, which include utility bills, children's education, medical care, transportation and operating costs such as fodder, covered pens and fences have been rising year on year. Grassland protection efforts cannot get rid of the vicious cycle of "difficulty in increasing the incomes → livestock expansion → grassland degradation → stock output reduction → difficulty in increasing income without first improving the livelihood of the herders"(fig 1). One of the underlying causes for grassland ecological deterioration is the conflict between human basic needs and grasslands rather than the conflict between livestock and grasslands. For the successful implementation of grassland ecological protection policies and ecological development programs, it is necessary to ensure the livelihood and protection of the basic needs of the herders. Without the full participation of this key group of stakeholders in grassland use, it may be difficult to execute the planned measures on grassland protection and maintain the desired results.

Figure 1 Vicious cycle in increasing herder's incomes



2. Background of grassland development: China's national strategy and global grassland development context

2.1 China's national strategy on grassland development

Grassland development is defined as a key component of the national sustainable development strategy in China. Therefore, the perspective of national development is crucial to understand the policy evolution of grassland and analyze the characteristics, the process and the stages of grassland ecological construction. To date, the grassland development strategy in China has undergone three stages. Before 2000, grassland development efforts were focused on developing the livestock industry, leveraging grassland as a key material basis for the livestock industry and the fundamental production material for farmers and herders. Between 2000 and 2010, the grassland development efforts in China entered the stage of implementing ecological development projects to promote grassland protection. After 2010, the focus has shifted from ecological construction to the integration of ecological, economic and social dimensions. In the process of grassland control, the central government has enacted and promulgated a series of policies and measures, such as the grassland contract responsibility system, the reinstatement of grazing land to grassland and the eco-compensation system, which have contributed a lot to the grassland control efforts in the country.

(1) Grassland contract responsibility system. Currently, the household contract responsibility system, which achieved wide acceptance in agricultural areas, leads to severe grassland degradation even though it also stimulated herders' initiative of producing. Another disadvantage of the household contract responsibility system in grassland areas is the high cost involved in maintaining exclusive property rights. Furthermore, the operating income rights of pasture areas without fences cannot be ensured and these areas often become a shared resource with no clear boundaries and subsequently, the rise of strong competition among user groups (Ostrom, 2000). At present, the household contract system of the pasture user's right is just

a basic form to define the legal entity for the pasture user's right, which still has a big gap towards a long-term, stable and cost-effective pasture property right system. To ensure exclusive property rights, measures to improve the grassland contract responsibility system in China should include:

i) an improvement of the supporting laws, rules and regulations related to grassland contract responsibility system. For instance, efforts should be made to enhance supervision and develop regulations that impose severe penalties on the offenders, impose severe penalties on the offenders, and reduce the occurrence of infringement upon the rights of pastures contracted to other herders.

ii) the adoption of a more flexible institutional arrangement in order to reduce the costs of exclusive property rights. The major objective of the grassland contract responsibility system is to resolve the issue of property rights, which may not be necessarily implemented on the basis of households. Instead, a mechanism for collective grazing among various households can be adopted based on the clear definition of the rights, responsibilities and interests among the herders.

(2) The program of restoring grazing land to grassland, and policies related to grazing prohibition, seasonal grazing bans and rotational grazing. The program of reinstating grazing land to grassland is mainly funded by the central government, while the local government provides some co-funding. The implementation of this program recorded a positive restoration of grassland vegetation in some areas, particularly the project areas, which has been effective in reversing grassland degradation. However, 70% of the grasslands in China are still moderately or heavily degraded and it will be extremely difficult for these isolated local and short-term ecological projects to fundamentally ensure the sustainable development of grasslands. As the effort of reinstating grazing land to grassland is defined as a long-term strategic task in China, it is necessary to thoroughly plan, develop and promote development schemes and practical procedures that meet the natural and economic conditions of each locality. Meanwhile, it is important to integrate the program of reinstating grazing land to grassland with the objectives of addressing the issues faced by the livestock industry, pasture areas and herders with a focus on improving the livelihoods of the herders.

(3) The grassland eco-compensation mechanism. The legal system for the development of the grassland eco-compensation mechanism has been made available in China. This mechanism has been clearly defined in some laws and regulations, such as in revised Constitution in 2004 and revised Grassland Law in 2003. Many fields have started to explore approaches for eco-compensation, such as eco-compensation mechanism of forest, grassland, wetland, mineral resources and watershed eco-compensation between upstream and downstream river. This far, the mechanism faces the following challenges:

First, conflicts between the short-term eco-compensation policy and the long-term ecological protection. Most of eco-compensation policies applied to special period and refers to some key ecology fragile district. It is vital to establish long-term ecological protection mechanism and set up a coordination and interaction mechanism between the key protection areas and beneficial areas, and guide the beneficial areas to provide socio-economic support to protection areas. Meanwhile, compensation should be encouraged through initiating of eco-conservation and capacity rising programs, instead of only applied for the ordinary people.

Second, conflicts between the low standard of eco-compensation and the high opportunity costs of the herders. In most cases, compensation standards include human resource, materials and capita resources. Besides that, opportunity cost of the herders should also be considered.

Compensation standards could be determined four values: herdsmen's direct cost and opportunity cost, gains of the beneficiaries, cost of ecological restoration, and ecosystem services. The fundamental components of compensation include direct and opportunity cost, while the value of ecosystem services should be considered as theoretical ceiling values for compensation (CCICED, 2006). Practical standard could be determined through Game-negotiation and In keeping with local conditions, such as economic development stage, extent of ecological destroyed.

Third, conflicts between the small areas of grassland eco-compensation and the large areas of grassland degradation. Eco-compensation system should include central government level and local levels. Meanwhile, various sources should be encouraged to contribute eco-compensation financial system instead of only government dominant. Under the integrated eco-compensation system, more grassland region can get eco-compensation, not only for important ecological areas and key ecological elements. On the whole, although significant progress has been made on the ecological protection of grasslands in China, many challenges are still present in this area of development. Successful ecological protection and development efforts in China may be achieved if measures are taken to define an optimal model and an effective pathway that could i) balance economic growth with environmental protection, ii) promote the integration of the eco-compensation system and the ecological development projects, and iii) maintain the social sustainability (Mutlak and Schwarze, 2013) and cost-effectiveness of eco-environmental development.

2.2 Context of global grassland development

Grasslands are the most important type of terrestrial ecosystems globally. Different countries share common objectives and are confronted with common challenges in developing the grassland development models that adapt to climate change, that achieve a balance between grassland ecological values and their economic values, and to alleviating poverty in grassland areas. Many useful experiences have been learned during this process of development.

Many measures in pasture use were practiced. Such as specialization of pasture, enclosed grazing, cross-regional rotational grazing, grassland improvement, construction of man-made grasslands, and the improvement of livestock all around the world have provided best practices to promote sustainable grassland development. Some advanced countries including Australia, Canada and the US have already established grassland management systems based on ecological protection and economic growth. Integrated ecosystem management approaches have been applied to manage and coordinate various resources, and sound legal and policy systems have been employed to undertake science-based protection and the use of grassland resources. In addition, monitoring and evaluation systems, such as the Australian Collaborative Rangelands Information System (ACRIS, 2013) and the US Grassland Health Evaluation System, are used to deploy information on agricultural and livestock production, and to maintain the ecological services of grasslands.

The livestock industry development in China is in a transitional period from traditional to modern development models. As shown in Table 2, China's livestock industry productivity is still low, while the grassland stock capacity is high and livestock structure needs to be improved. In 2009, the ratio between adult and young livestock in the six major pasture areas in China was recorded as 0.2:1 while grassland stock capacity was 2.2 heads/hectare. Large groups of livestock put heavy pressure on the grassland ecosystem and the conflict between grassland and livestock has been compounded due to the imbalance of livestock structure.

Table 2 Livestock industry development of major countries rich in grassland resources in 2009

Country	Per-unit yield (kg/head)				Livestock population (sheep unit ¹)	Ratio between adult and young livestock	Grassland stock capacity ² (head/hectare)
	beef	mutton	milk	wool			
Australia	77	8.9	336.4	4.9	21656	0.4:1	0.6
US	125.8	11.7	908.4	1.6	52892.1	12:1	2.2
New Zealand	63.9	14.8	1527.5	6.7	8260.7	0.3:1	7.5
the Netherlands	100.6	9.9	2870.1	2.6	2216.5	2.7:1	26.7
Mongolia	22.7	4.3	125.4	0.5	6303.7	0.1:1	0.55
Kazakhstan	66.1	8	879	2.1	5358.7	0.4:1	0.29
Argentina	55.8	3.7	206.9	3.6	28892	3.2:1	3.1
China (six major pasture areas)	27.3	7.1	225.7	0.9	57552.6	0.2:1	2.2

A sustainably-developed grassland provides an integrated system for the different variables (i.e., human beings, livestock and grass) to co-evolve on a long-term basis. The integration of different sub-systems, such as climatic conditions, economic development, operational model and management measures, allow for a sustainable grassland development. In Australia, fodder production bases are mainly developed in the warm and humid areas, while native vegetation in the arid inland areas are undeveloped. In US, man-made grasslands mainly occur in the eastern areas, which record an annual rainfall of between 750-1000 mm, while most of the grasslands in the arid western areas are developed as holidays resort areas.

The grassland areas in China have a complex climate. Different regions vary greatly in terms of climatic types, resources endowment, economic growth and social system, and are threatened by diverse issues. In consideration of such a context, studies on grassland development models should be based on the key influencing factors on grassland resources, such as the geographic and climatic features, the economic development stage and grassland ecosystem characteristics, in order to provide an accurate evaluation of grassland development in China through comparative analysis, to fully understand the integration and systematization of grassland development, and explore the best pathway for sustainable grassland development that meets the actual conditions in China.

1 Calculated according to the ratio of 1 adult livestock=5 sheep

2 Calculated according to the figure of FAO

3. Promoting grassland protection through development: best practices from the three pasture areas in China¹

The three pasture areas (i.e., Hongyuan County in Sichuan; Abaga County, Xilingol Prefecture, Inner Mongolia; and Wushen County, Ordos Municipality, Inner Mongolia) with different development stages and distinct ecological and climatic features were selected as the sites for the case studies. By integrating the case studies in the typical regions with macro context assessment, the authors attempted to explore the optimal pathway for sustainable grassland development in China.

3.1 Hongyuan County, Sichuan Province

Hongyuan County, Sichuan Province is located in the southeastern margin of the Qinghai-Tibetan Plateau. Home to a typical meadow steppe, the county serves as an important ecological water conservation site. Livestock industry is the pillar industry of the local economy, with nearly 80% of the local population involved in livestock industry. At present, the county is confronted with the dual pressures of economic poverty and ecological degradation.

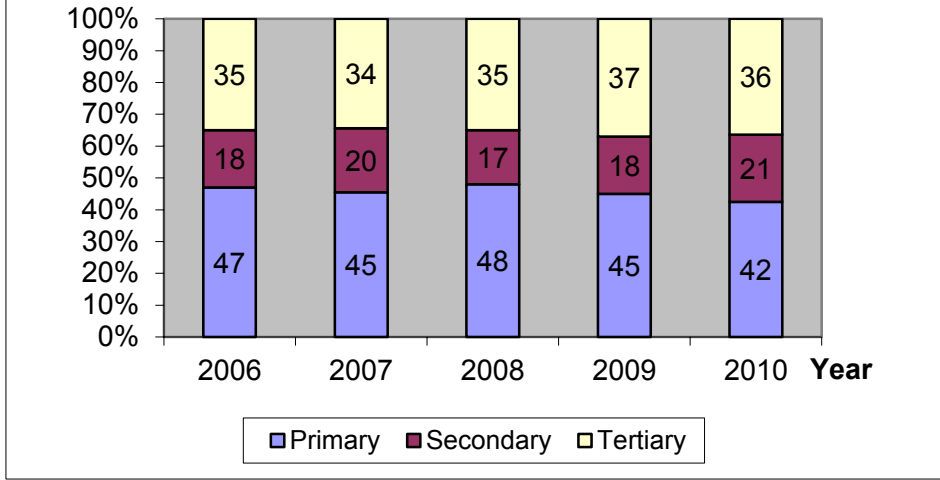
Climate change and economic pressure have accelerated the ecological degradation in Hongyuan County, where desertification is increasing while grassland productivity is declining. The Hongyuan County Grassland Station monitored the basic conditions of plant community and grass yield of the marsh meadow in 2006, 2007 and 2008 respectively. The average grass yield was recorded to be 653.2 kg/mu, 410.3 kg/mu and 323.7 kg/mu, with the average height of 27.7cm, 23.9cm and 18 cm in 2006, 2007 and 2008 respectively.

Within the economic structure of Hongyuan County, the primary industry serves as the pillar industry in the county, led by the livestock industry, whose output value accounted for 85.5% of the total output value of the agricultural and livestock industry of the county in 2010. The secondary industry takes up only a small percentage, with its annual output value representing 20% of the total output value of the county. At present, only four industrial enterprises above the designated size² are involved in dairy product and meat processing. The eco-tourism sector within the tertiary industry, mainly is eco-tourism, has been growing. Its output value in proportion to the total output value in Hongyuan County has increased to 37% in 2010, which is shown in Figure 2. In 2010, the per-capita GDP in Hongyuan County was 60.7% of that in Sichuan Province and only 42.8% of that nationwide. The income structure in the pasture areas depends largely on the economic structure of Hongyuan County. According to the household-based survey data in the rural areas, the operating incomes of the farmers' and herders' households in proportion to the per-capita net incomes of the farmers and herders in Hongyuan County was 82.3%, 81.1% and 74.4% in 2008, 2009 and 2010 respectively. The incomes of wages and salaries take up a small percentage in the net incomes of the farmers and herders in the county. Among the samples in 2011, no household reported incomes of wages and salaries, which indicated the pressures of economic structure and income structure on the livestock industry development and grassland ecological protection in Hongyuan County.

¹ Except otherwise noted, all the data applied in the case studies are from the local statistical yearbook or historical statistical bulletin.

² enterprises with an annual sales over 5 million yuan

Figure 2 The proportion of three types of industries in Honyuan Country between 2006 and 2010



In view of the economic pressure on the livestock industry development and grassland ecological protection in Hongyuan County, development efforts to promote grassland protection are necessary to protect the livelihood of the farmers and herders. The pasture area in Hongyuan County needs to promote the grassland protection through development. The sustainable development strategy for the pasture area in Hongyuan County should focus on the following areas: 1) to improve the eco-compensation system, enhance support for ecological protection and explore the best pathway for ecological protection, which provides a basis for the development of ecological conservation areas; 2) to optimize the industry structure and develop a modern livestock industry while fully utilises and sustainably develops the eco-tourism resources and channels new sources to increase the incomes for the local farmers and herders; and 3) to strengthen the infrastructural development in the pasture area, build capacity on the medical care and education for the herders, gradually transfer the surplus agricultural labor force and mitigate the ecological pressure on the pasture area.

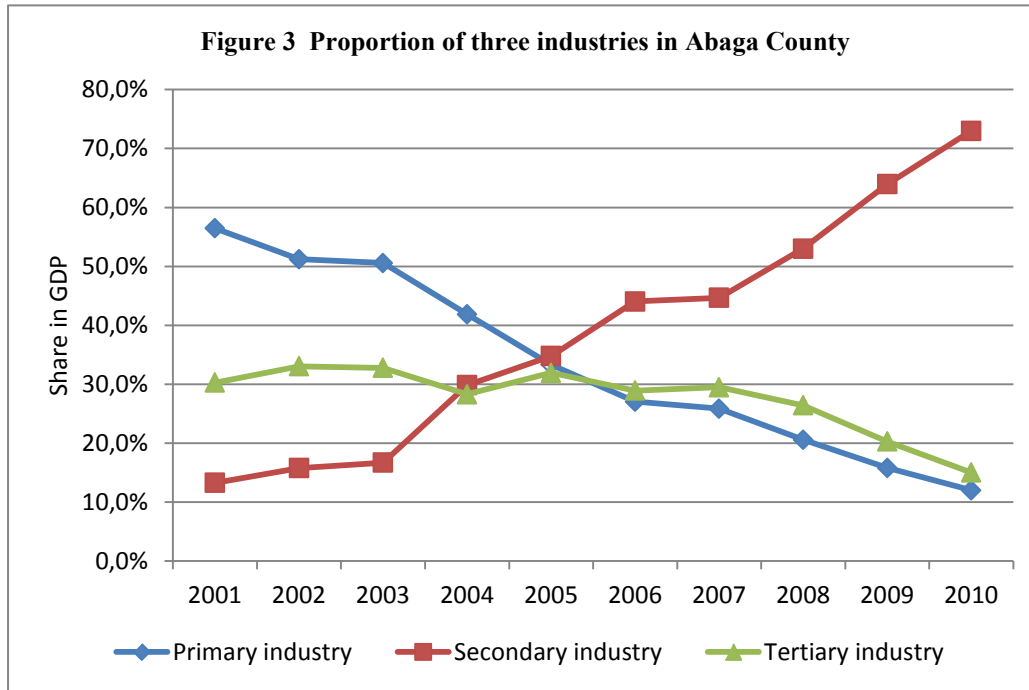
3.2 Abaga County, Xilingol Prefecture, Inner Mongolia

Abaga County, Xilingol Prefecture lies in the northern and central part of the Inner Mongolia Autonomous Region. One of the ten natural pastures in the autonomous region, Abaga's livestock industry used to account for approximately 60% of the local economy. With the fast growth of the local economy, the proportion of secondary and tertiary industries has been rising, and the pasture area is undergoing an early economic transformation. Meanwhile, the pressure on the livestock industry is being gradually reduced, and the overall degradation of grassland ecological conditions have been initially contained. In general, the economic structure and ecological conditions of Abaga grassland have entered a new stage of sound development.

Abaga County has a temperate and semi-arid continental climate and is rich in grassland resources. During the late 1990s, the ecological conditions of Abaga County became very fragile, there was a recorded loss of biodiversity in the plant community, the density of the plant population declined, the forage grass in some areas became short, and there was a significant area

of exposed land surface due to many years of over-grazing and unwise use of grassland. To date, a series of ecological protection projects implemented in the county have shown significant improvement: the sandstorm source control project in Beijing and Tianjin, grazing prohibition and barn feeding, ecological resettlement, agricultural integrated development, and poverty alleviation efforts. In addition, the county government has been adjusting livestock structure, improving livestock species, and undertaking industrialized operation. The monitoring results on the grassland indicated that the average coverage rate of the pastures in Abaga County increased from 35.2% to 45.6% from 2005 to 2010, a growth of 10.4%. The yield of grass per mu grew from 64.4kg in 2005 to 105.6kg in 2010, a growth of 64.2%. Within the same period of time, the grassland stocking capacity rose from 41.6mu/sheep unit in 2005 to 24.3mu/sheep unit in 2010, recording a growth of 71.2%. Even though the grassland stocking capacity increased and the absolute number of livestock decreased, the actual carrying capacity is more than theoretical carrying capacity with an overloading rate of 28.2% in 2010. Furthermore, the actual carrying capacity keeps 2.2 million sheep unit since 2006, which means that the livestock industry benefited more than the herdsmen from these measures. The economy in Abaga County has been growing fast over the recent years. With the help of rich natural resources such as coal, steel and wind energies, the county has grown from an underdeveloped pasture area focused on livestock industry ten years ago to an important heavy and chemical industry base in Xilingol. In 2010, the total output value in Abaga County was nearly ten folds of that in 2001, with an average annual growth rate of 27.0%. During the same period of time, the total fiscal revenue of the county grew from 21.75 million yuan to 260 million yuan. In 2011, the per-capita net income for the farmers and herders in Abaga County reached 11,923 yuan, 1.8 times of the average income level of Inner Mongolia and 1.7 times of that nationwide.

In terms of economic structure, industry began to dominate the economic structure of the county while the proportion of the primary industry in Abaga County contracted significantly, as shown in Figure 3. In 2001, the output value of the primary industry in proportion to the total output value in the county reached 56%, and fell to 12% in 2010. During the period of the 11th Five-Year Plan (2006-2010), a total domestic investment of 14.3 billion yuan was recorded in Abaga County, and 20 projects each with an investment of over 100 million yuan have been implemented. The added values of the industry in the county reached 1.99 billion yuan, accounting for 58.2% of its total output value, 37.9% higher than that at the end of the 10th Five-Year Plan (2001-2005). With the economic growth, great progress has also been made in terms of social security in Abaga County. During the period of the 11th Five-Year Plan, the area per-capita for school buildings grew from 10.2 m² to 16.7 m²; the rate of participation in the new collective medical service program for the pasture areas reached 98%; and the per-capita annual rate of basic living allowance for the people in pasture areas rose from 432 yuan to 1,800 yuan. The capacity of the local area in creating new jobs steadily improved and provided employment to 11,000 people.



The major tasks for sustainable grassland development in Abaga County are defined to be the following areas: 1) The industry structure needs to be optimized and great efforts should be made to develop the industries which can help increase the local farmers' and herders' incomes, strengthen the regional economy, enhance the capacity of the secondary industry in absorbing labor force and grow the tertiary industry. 2) As the conflict between grassland and livestock still poses a major challenge to the ecological protection in Abaga County, it is necessary to control the stocking capacity of the grasslands in the long run. 3) To promote and consolidate long term efforts for grassland protection, it is important to balance the relationship between ecological development and local herders' income generation activities, to conduct training programs on science and technology, employment and practical technologies for the local herders, to promote the transfer of surplus agricultural labor force and subsequently, reduce the population in the pasture areas.

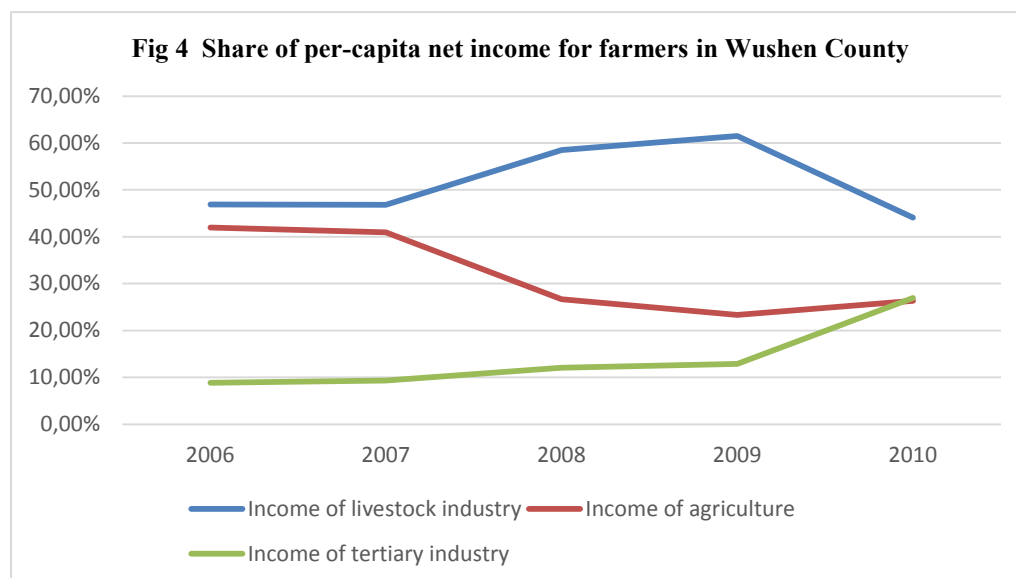
3.3 Wushen County, Ordos Municipality, Inner Mongolia

Situated in the southwest of Ordos Grassland, Wushen County lies in the hinterland of Maowusu Desert, belonging to a transitional zone between the semi-arid and arid areas. Over the recent years, the local economic structure has been improved and its economic output value takes a leading role among the pasture areas. In this respect, Wushen County is known as a good example that balances socio-economic development and ecological protection, and promotes grassland protection through development.

Since the late 1990s, Wushen County has been exploring a pathway to balance ecological protection with economic growth. In the early 1980s, 40% of the total land area in the county suffered from wind erosion and desertification. 80% of the grasslands were affected by desertification and degradation between 1998 and 2000. However, ecological development efforts began in the county through a series of key projects. In 2003, the concept of 'putting people first and developing a green Wushen' was proposed signifying a new stage of ecological protection

efforts in the county. In 2009, the Development Plan of Three Zones in the Agricultural and Pasture Areas in Wushen County was prepared ¹based on the principle of ‘balancing economic development and ecological protection’. As a result, the ecological conditions of the county transformed from severe deterioration to overall containment, regional improvement and local stability. A science-based development model that aims to enhance the ecological conditions, develop the local economy and improve the living standards of the local people was also employed.

In terms of economic development, the per-capita GDP in Wushen County exceeded US\$ 20,000, and the per-capita disposable income of the urban residents reached RMB 21,116 in 2010. The per-capita net income of the farmers and herders amounted to RMB 9,276, which is 1.7 times of that in Inner Mongolia, and 1.6 times of that nationwide. In terms of economic structure, the total output value of the livestock industry in the county was RMB 968 million, representing less than 4% of the total output value in the county in 2010. The proportion of the incomes generated from the tertiary industry also increased significantly. In 2010, the net incomes of the local farmers and herders generated from the tertiary industry in proportion to the total net incomes reached 27.0%, three times that of the value recorded in 2006 (Fig.4). The surplus agricultural labor force had also been gradually transferred from the primary industry to the secondary and tertiary industries. In 2009, a total of 15,920 households were predominantly involved in the grazing industry in the county. In 2010, that figure dropped to 9,400 households, dropped 41% than 2009.



Useful lessons can be derived from the Wushen County sustainable development program in its pasture areas:

1) the concept of ecological control focused on the herders’ interests. The herders’ livelihood support and capacity building were defined as enabling conditions to promote ecological protection;

¹ The pasture areas in the rural areas are generally divided into prioritized, restricted and prohibited development zones.

2) the balance between economic growth and ecological development. ‘Green Wushen’ is the main guideline for sustainable development. Under this guideline, an ecology-based industry system was established, focusing on green industry, ecological agriculture, emerging urban industries and a cultural tourism sector and

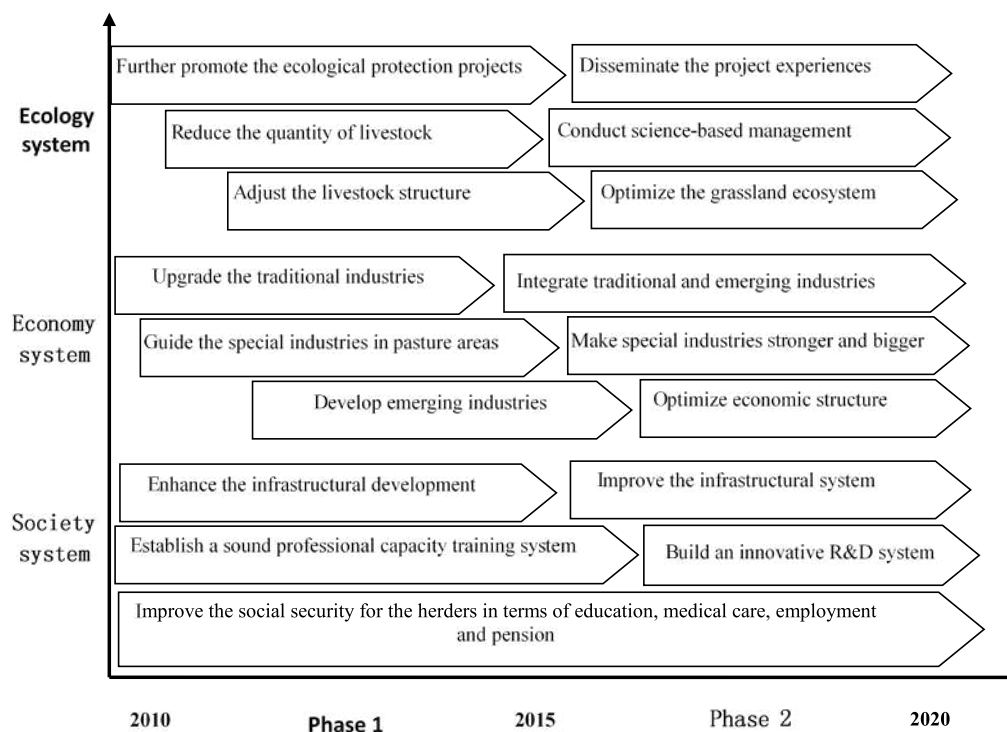
3) the development of a modern livestock industry.

By integrating the existing land and pasture resources, Wushen County has actively developed many production bases for green agricultural and livestock products. Various models on modern livestock industry development were also explored, such as modern agricultural and livestock industry demonstration bases, analysis on the influence of leading enterprises, and the development of entrepreneur associations on the industrialization of agriculture and livestock. Nevertheless, Wushen County is also confronted by many challenges: product quality and brand awareness of the agricultural and livestock companies need to be improved; insufficient funding is a major constraint on the development of agricultural and livestock product processing companies; and a sound mechanism for coordinating various interests along the industry chain has yet to be established.

4. Key tasks and pathway for the sustainable grassland development in China

On the basis of the above-mentioned research findings, we propose the pathway and key tasks for sustainable grassland development in China in two stages with three focus areas (i.e., ecological protection, economic development and herders’ well-being), which is shown in Fig.5.

Figure 5 Pathway and key tasks for sustainable grassland development in China



4.1 To reduce the grassland stocking capacity and optimize the grassland ecosystem

The over-stocking of grassland still poses a major challenge to sustainable grassland development in China in the areas of restoration of overall grassland ecological conditions and grassland protection in the ecologically fragile areas. Therefore, efforts to constantly improve the program of restoring grazing land to grassland, effective implementation of policies on grazing prohibition, rest grazing, and rotational grazing, reduce the quantity of livestock and adjust the livestock structure.

Apart from reducing the stocking capacity of the grassland and developing a reasonable livestock structure, optimizing the grassland ecosystem will become a key task in grassland ecological restoration, such as selecting the right animal species and establishing an appropriate food chain. In addition, it is crucial to disseminate the experiences learned in pilot ecological projects to wider areas, and enhance studies on the basic theories of grassland, including the stocking capacity, the best practices for livestock industry production and science-based management approaches and technologies.

4.2 To upgrade the traditional industries and promote economic restructuring

At present, the herders have not yet developed the skills needed in modern enterprises and new industries production. To promote the economic development in the pasture areas, measures are needed to transform the traditional production practice, upgrade the traditional industries, shift the livestock industry production from the traditional model to the modern development model, and explore the potential of traditional industries. These steps are vital in pasture areas that focus on livestock industry production for the long-term capacity building of the herders.

While transforming the traditional agricultural and livestock industries and the economic growth in the pasture areas of Western China, the challenge of promoting a combination of traditional and emerging industries will also need to be addressed. In terms of grassland development, it is important to integrate the energy, mining industries, emerging industries and local economic development. The integration of these industries in the overall strategy will play a key role to improve the pasture areas' capacity in economic growth, benefit the herders' livelihood and develop the region's economy. The development of local competitive industries is equally important, in particular the establishment of an eco-tourism industry by fully leveraging on the cultural heritage of the pasture areas and continuous improvement of the quality of tourism products.

4.3 To improve the infrastructure and social security system in the pasture areas and enhance the capacity of herders in sustainable development

Efforts should be made to further enhance the development of infrastructure such as energy, transportation, telecommunications and water conservation facilities. In addition, steps should also be taken to improve the social security system and the provision of better educational and medical care services for the herders. When a comprehensive and equitable social security system is accessible to all the herders, the enhanced capacity of the herders in sustainable development will provide the basis and boost the ecological, economic and social development in the pasture areas.

Under the broad context of China's western development program, the emerging competitive industries will be promoted on a large scale. However, the lack of a high-caliber labor force prevents the emerging industries from being integrated with the regional industry development.

Therefore, a sound professional capacity building system, an innovative R&D system, and an employment support system in the pasture areas can help to improve the herders' capacity in engaging in modern industries and to develop a human resource system in the pasture areas that is adaptable to the conditions of contemporary industrial and service sectoral development.

Grassland development in China is at a key stage of transformation, and strong policy support is needed to ensure sustainable grassland development. To make the policies more effective in the highly diverse nature of different grassland areas in China, it is important to define the key influencing factors on grassland use. In terms of policy guidance, it is necessary to focus on the livelihood of the herders, raise the expectation of the herders on grassland-related policies, and discourage the use of unsustainable practices for short-term gains. In implementing the policies, a degree of flexibility will enable relevant stakeholders to explore new models of grassland control. In summary, the transformation of policy environment, policy guidance and policy implementation models will not only become the key components for the transformation of grassland development models, but also provide strong support for sustainable grassland development in China.

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