

# Adaptation strategies to pasture degradation: Gap between government and local nomads in the eastern Tibetan Plateau

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**Abstract:** In the last decade, there has been increasing interest in climate change, pasture degradation and its driving forces, and innovations in nomadic pastoralism on the Tibetan Plateau. However, little is known of indigenous strategies of adaptation to pasture degradation, which limits the effectiveness of adaptation strategies planned by local government. This paper analyzes nomads' strategies of adaptation to pasture degradation on the basis of a field survey of three townships of Dalag County in the source regions of the Yangtze and Yellow rivers. Pastures there have evidently degraded, with pastures in Wasai mainly in a state of slight or medium degradation and those in Manzhang and Jianshe in a state of medium or severe degradation. With the degradation of pasture, the grazing time is reduced, which affects the livelihoods of nomads. Although the Four-Package Project has commenced in this region, there is still severe fodder shortage in winter and spring. The traditional hay storage strategy does not work because of pasture degradation, and few nomads establish fenced and artificial pastures. Therefore, nomads have employed other strategies, such as renting pasture, providing supplementary feed, and diversifying their livelihoods. Local strategies taken by nomads can provide valuable insights into ecological restoration and livelihood improvement in the region and suggest changes to means promoted by local government. It is necessary to seek new means that combine the best aspects of nomadic pastoralism with modern stockbreeding technologies to help nomads adapt to pasture degeneration and improve their livelihoods.

**Keywords:** pasture degradation; adaptation strategy; nomadic pastoralism; Tibetan Plateau

## 1 Introduction

Much of the pastoral system of the Tibetan Plateau in western China, which is characterized by its high elevation and harsh climate, is probably in non-equilibrium (Miller, 1999). As such, nomadic pastoralism, distinct from pastoralism in most other regions of the world

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where the key factor is usually a lack of water, is the best system for maintaining the long-term balance between environmental needs and human production needs. Depending on their native knowledge, local nomads have developed a set of complicated means to manage pasture and livestock in a harsh natural environment (Goldstein, 1990; Miller, 1999; 2000). Tibetan nomads have mitigated environmental risks through strategies that have enhanced diversity, flexibility, linkages to support networks, and self-sufficiency. Flexible use of rangelands, livestock mobility, and diverse herds are key elements of traditional pastoral production systems and contribute to the ecological stability of the pastoral systems (Miller, 1999 & 2000). Tibetan nomads usually raise a mix of livestock species, each of which has its own specific characteristics and adaptations to the environment. Rangelands are parceled into seasonal pastures and used according to diverse managerial and production objectives. Nomads and their livestock rotate among different pastures throughout the year to take advantage of the most favorable conditions at all times and simultaneously allow pastures to have the opportunity to regenerate. The movements of livestock are often well prescribed by complex social organizations and are highly regulated.

Such pastoral systems are vulnerable to global climate change. During 1971–2000, the main trends of climate change for the Tibetan Plateau were a temperature rise, precipitation increase, potential evaporation rate decrease, and in most areas, an increase in humidity (Wu *et al.*, 2005). The degradation of alpine ecosystems on the Tibetan Plateau over the past 40 years has mainly resulted in a decrease in vegetative cover and shrinkage of alpine meadows (Wang *et al.*, 2001a, b; Dong *et al.*, 2002; Wang *et al.*, 2007). The area of degradation accounts for 33% of the whole Tibetan Plateau (Ma, 1999). Therefore, there has been increasing discussion on rangeland degradation, its driving forces, and the innovation of nomadic pastoralism (Goldstein *et al.*, 1989; Miller, 2001; 2002; Wu *et al.*, 2002, Zhang *et al.*, 2004; 2006; Wang, 2004). The integrated functions of climate change, overgrazing, devastation due to rodents, and human activity are commonly considered the main factors driving grassland degeneration (Chen, 1998; Ma *et al.*, 1999; Zhang *et al.*, 2006; Liu *et al.*, 2008). Against this background, many measures have been taken to recover grassland and improve the livelihoods of nomads (Zhou *et al.*, 2003; Chen, 2007). Nowadays, the main grassland rehabilitation and anti-poverty measure is the Four-Package Project, which comprises the privatization of pasture, building of houses for nomads, construction of barns and fenced grassland for livestock, and growing of fodder for winter.

However, little is known of the indigenous adaptive strategies of nomads to combat pasture degradation, which should be considered in the rehabilitation and anti-poverty measures taken by local government. In this study, Dalag County in the source region of the Yangtze and Yellow rivers having a large area of black beach is chosen as the study area to investigate how local nomads cope with pasture degradation and show the differences between adaptation strategies of local government and local nomads, which is the basis for establishing new means of adapting to pasture degradation.

## 2 Study area and method

### 2.1 Study area

Dalag County is located on the southeast Tibetan Plateau and covers an area of 14,600 km<sup>2</sup>.

The county lies between 32°36'42"–34°15'20"N and 98°15'29"–100°32'41"E. Mountains in the northwest are large and relatively low-angled and have wide bottomlands, while there is a wide expanse of steep mountains in the southeast. The elevation of the county averages 4426 m and ranges from 3820 to 5260 m.

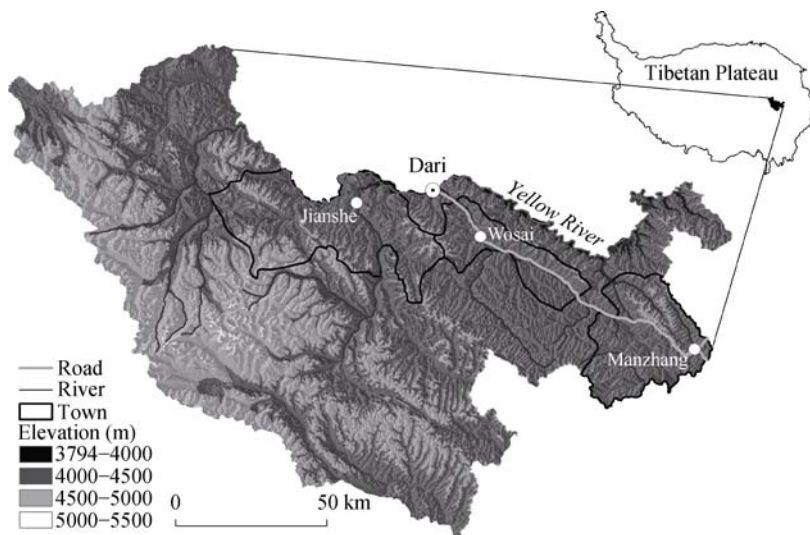
The county has a frigid semi-humid climate typical of the plateau. In the long cold season of about 7–8 months, there is frequent heavy snow and many wind- and snow-related disasters. The climate is wet in the warm season, which only lasts 4–5 months. The annual mean temperature is about  $-0.1^{\circ}\text{C}$  to  $-3.5^{\circ}\text{C}$ , decreasing from southeast to northeast. The annual precipitation amount is about 560 mm, and precipitation mainly falls from June to September. From 1956 to 2002, the annual average temperature of Dalag County increased at a rate of  $0.002^{\circ}\text{C}$  per year. The rate and extent of the temperature change have been greater in winter than in summer (Zhang *et al.*, 2006).

The soils comprise alpine meadow soil, paludification soil, alpine periglacial soil and flowstone soil, montane meadow soil, chestnut soil, and swamp soil. The vegetation has a distinct vertical distribution, comprising alpine flowstone vegetation above 4800 m, sparse alpine vegetation at 4700–4800 m, and alpine meadow at 3900–4700 m. Alpine shrub and grassland are distributed on shaded slopes, half-shaded slopes and river bottomland at 3900–4250 m. Swamp meadow is distributed on river bottomland, at outfalls, and on shaded and half-shaded slopes at 4100–4500 m. Black beach is widely spread, and degenerated grassland accounts for 67.61% of all grassland in Dalag County (Zhang *et al.*, 2006). Studies of pasture degeneration in the “Three-River Headwaters (the source regions of the Yangtze River, Yellow River and Lancang River)” obtained from remote-sensing imagery found severe meadow degradation (Liu *et al.*, 2008).

There are 10 townships in Dalag County. The population of the county is about 24,000, 95.4% of whom are Tibetans. Animal husbandry is the most important industry. The number of animals continually increased from 123,000 in 1960 to 794,000 in 1975 and quickly decreased after 1975. Since 1990, the number has stabilized at almost 450,000. The net annual income of nomads per capita is no more than 2000 yuan RMB.

## 2.2 Semi-structured interview

The results presented in this paper are based on semi-structured, open-ended interviews held with nomads in August 2006, August 2007, and August 2009. Three townships were selected as sample townships having areas of black beach: Jianshe, Manzhang, and Wasai (Figure 1). Six researchers, including three interpreters, carried out the fieldwork. Samples are selected mainly by probability of access, as many tents being distributed in remote area. Sample tents were first selected from a relief map on which the locations of tents and grazing periods are labeled. As tents are located in the valley floors, we typically drove to the entrance of a valley and continued to the tents on foot. In some cases, male adults were not at home for the planned sample tents, and we interviewed nomads of neighboring tents instead. Each interview lasted 2–3 hours. Because of religious issues, only male adults of each household were primarily interviewed, with other members participating in the interview to a lesser extent and supplementing essential information. In total, 199 herders representing 199 families were interviewed. Afterward, we went to townships and interviewed authorities to obtain background information. Five key questions were asked in each interview. (1) What is the



**Figure 1** Location of the study area

degree of degradation of summer pasture, autumn pasture, and winter pasture? (2) How long is the grazing time for summer pasture, autumn pasture, and winter pasture presently? (3) How has pasture degradation affected livelihoods? (4) What means are used to cope with a fodder shortage? (5) What strategies have the government taken to cope with a fodder shortage?

### 3 Results

#### 3.1 Pasture degradation and fodder shortage

Black beach is widely distributed in the study area. Wang’s study (2005) shows that degraded pastures in the source region of the Yangtze and Yellow rivers account for  $51.0 \times 10^4$  ha, about 45.69% of pastures that can be utilized. Table 1 presents the nomads’ evaluation of the pasture in the three townships. The pasture grade is evaluated by the nomads themselves, with the value 1 indicating no sign of degradation, 2 slight degradation, 3 medium degradation, and 4 severe degradation. When nomads are asked pasture grade, they also point out many specific characteristics, such as lots of rodent burrows, increase of bare areas, short grass layer, more weeds and poisonous weed, desertification of meadows. As these characteristics are hard to quantify, pasture grade is used to indicate pasture degradation status. The

**Table 1** Nomads’ evaluation of pasture grade

Township	Number of samples	Grade of pasture/unit*	
		Summer pasture	Winter and autumn pastures
Wasai	84	2.75	2.50
Manzhang	62	3.73	3.44
Jianshe	53	3.23	3.59

\* The ‘Grade of pasture’ is an average evaluation value of sample households to grassland grade, for example, some herders’ summer pasture is 3, some herders’ is 4, some herders’ is 2, the average is 2.75 and the like.

pasture grade for a township is the average of evaluations by sample nomads. Pastures in Wasai are mainly in a state of slight degradation and medium degradation, whereas pastures in Manzhong and Jianshe are in a state of medium degradation and severe degradation. Summer pastures in Manzhong suffer more severe degradation than those in the other two townships. Winter and autumn pastures in Jianshe suffer severe degradation. Nomads' evaluations of pasture grade are consistent with Zhang's study (2011) in the same region.

Pasture degradation reduces the grazing time of pastures and results in severe fodder shortage. In the study area, pastures are parceled into summer pasture, autumn pasture, and winter pasture. Through migration among different pastures, nomads can successfully solve the problem of forage shortage and prevent disasters. Before the 1980s, according to the nomads, pastures never degenerated and the grazing time of summer pastures was about 5 months and that of autumn and winter pastures was about 7 months. Nowadays, the grazing time has reduced dramatically, which result in overgrazing. In 2008, theoretical stocking number of pastures of Dalag County is 0.65 million sheep units, while the real stocking number is 0.91 million units, with 38.57% of over stocking rate (Zhang *et al.*, 2011). Table 2 gives the average grazing time of summer pastures, autumn pastures, and winter pastures for the three townships. In Wasai, the grazing time of winter pastures, which are at lower elevation, has only reduced to 5 months, whereas in severely degenerated regions such as Manzhong, the grazing time of summer pastures and winter pastures has been reduced to 3 months or so. Nowadays, nomads stay on summer pastures from May to July and autumn and winter pastures from August to November. They then have to migrate to other counties to rent pasture before snow arrives, and they remain there for the rest of the year.

**Table 2** Grazing time of pastures

Township	Number of samples	Average grazing time of pastures of sample households/month		
		Summer pasture	Autumn pasture	Winter pasture
Wasai	84	3	–	5
Manzhong	62	2.5	–	3
Jianshe	53	3.5	2.5	4

Pasture degradation severely affects nomads' livelihoods. The main effect is livestock loss. Livestock loss for the three townships was 1551 in 2007, or almost eight livestock per household. As the average number of livestock per household is only 47, successive livestock loss would reduce the number of livestock held by nomads. From 1976–2006, there are 60.90%, 57.78% and 25.96% of decrease of sheep, horse, yak herds, respectively (Zhang *et al.*, 2011). In Wasai, 64 households provided us with information on livestock numbers at the time of their largest drive. The data show that nomads in Wasai have lost nearly 50% of their livestock in the last 10 years and other townships has similar trend. There are many causes for livestock loss, including frost, starvation, disease, beast attack, hailstones, and poisonous weeds. Frost and starvation are key factors of livestock loss and livestock died owing to frost and starvation in 2007, accounting for 43.65% of the total livestock loss in the three townships. As yaks provide milk, butter, and dregs for nomads, livestock loss affects the nomads' nutritional intake and income from butter and dregs.

### 3.2 Government means to cope with fodder shortage

Nowadays, a series of means have been taken by local government to cope with fodder shortage. The main means are referred to as the Four-Package Project, which comprises the fencing-in of about 20 to 30 ha of the most productive winter rangeland, which is reserved from grazing in the summer and fall, to provide grazing during the late winter and/or spring; the construction of barns or sheds for livestock; the construction of homes for nomads at their winter pasture site; and the establishing of small (0.5 to 2 ha) plots in corrals around the nomad winter settlements for the provision of hay. In the study area, the Four-Package Project commenced in 2007, especially in terms of building houses for nomads. In Wasai, 50 of the 84 households have fenced pasture. The policy of privatizing pasture cannot meet the balance of environmental needs and human production needs; therefore, nomads form small groups on the basis of consanguinity and the neighborhood for which grassland can be justly used. Local government often distributes one bag of barley or flour, with a mass of about 50 kg, to each family in the event of a snow-related disaster. In 2003–2008, ecological immigration was also implemented, but only 429 immigrants were involved in the scheme and these immigrants still graze yaks as they used to (Du, 2009). Although the Four-Package Project has had some benefits for nomads, there is still severe fodder shortage in the three townships, especially in winter and spring. Therefore, nomads there have to rent pastures in other counties.

### 3.3 Nomads' adaptation strategies

Among traditional strategies employed by nomads, the cultivation of fodder, setting aside of pastures for use when grazing becomes scarce in late winter and spring, and gathering of grass from the wild were the three measures having the greatest effect on yak mortality. In Dalag County, although winter pastures are still set aside to cope with fodder shortage, nomads there cannot harvest enough fodder because of pasture degradation. Thus, nomads are seeking new strategies, mainly renting pasture, providing supplementary feed, and diversifying their livelihoods (Table 3).

**Table 3** Nomads' means to adapt to a fodder shortage

Township	Number of sample households	Percent of sample households (%)				
		Rent pasture	Supplementary feed	Artificial pasture	Hay storage	Fenced pastures
Wasai	84	46.43	57.14	4.76	29.76	3.5
Manzhang	62	87.10	62.52	8.06	0	1.6
Jianshe	53	58.49	56.60	0	26.41	1.9

#### 3.3.1 Hay storage

Hay storage is a traditional means for nomads to cope with a harsh winter. Sufficient stocks of hay reduce livestock loss. According to Levine (1995), one yak needed 30 kg of surplus fodder to ensure survival through the cold season in the township of Tawu in Sichuan. Although hay storage is still popular in agro-pastoral regions, nomads in the three townships find it difficult to harvest wild grass because of pasture degradation. Nowadays, 29.76% of nomads in Wasai and

26.41% nomads in Jianshe generally harvest 250–1000 kg of hay. In Wasai, nomads who store hay prepare about 34.42 kg of hay for one yak for the whole winter and spring, and the amount is only 8.72 kg in Jianshe. Thus, hay storage is insufficient. Nomads in Manzhong can no longer harvest hay. The limited availability of hay decreases the ability of nomads to cope with a harsh winter.

### 3.3.2 Fencing-off pastures

Fencing-off pasture is helpful in restoring degraded pasture and can provide fodder for a harsh winter. Nowadays, some nomads realize the advantages of fenced pasture and buy fencing materials. Apart from fenced pastures established by local government, only five fences were built by nomads themselves in the three townships—three in Wasai, one in Manzhong, and one in Jianshe. Fencing a pasture of about 20 ha costs 6000 yuan. Many nomads said that they have little cash income and could not afford to buy wire netting, angle iron, and other fencing materials. Therefore, this new strategy is hard to popularize by nomads themselves.

### 3.3.3 Artificial pastures

Although establishing artificial pastures is a good means to address fodder shortages, it is difficult to popularize the concept in the study area. In Dalag County, corrals are used for artificial pasture. When nomads migrate to summer pastures, they plant seed in corrals and harvest when they return in winter. Apart from corrals, few nomads have plots of artificial pasture nearby. In Manzhong did we find five households that had artificial pastures and the number is 4 in Wasai. The main reasons for the approach not being widely adopted are that there is insufficient land for the cultivation of artificial pastures and a lack of available labor and technologies to take care of the artificial pastures. Zhang's study (2011) show that only 12.95% of nomads have artificial pastures, and an important reason is low stability of artificial pasture.

### 3.3.4 Renting pastures

Renting pasture has been popular with nomads since 1992. Among the sample nomads in Manzhong, 87.10% rented pastures, compared with 46.43% of those in Wasai and 58.49% of those in Jianshe. Nomads rented summer pastures in near townships for grazing in winter. For example, nomads in Jianshe rented pastures in Madoe County at a cost of 3 000 to 5 000 yuan for nearly 6 months, mainly from November to May, which shows the average price of renting pastures. Nomads in Manzhong rented pastures in Jiuzhi, Banma, and Aba Counties. It takes 7 to 9 days for nomads to travel from their own pastures to rented pastures. As pastures in Wasai are only slightly degenerated, nomads there rented pastures from neighbors having less livestock. Nowadays, as pastures of other counties have also degenerated, and it is more difficult for nomads to rent pastures than previously. Therefore, renting pastures is unsustainable in the future.

### 3.3.5 Supplementary feed

Providing supplementary feed has become an increasingly important means to cope with fodder shortage. More than half of nomads buy flour and rapeseed oil to feed animals in a harsh winter. In Manzhong, 40 of 62 households buy flour and rapeseed oil, the proportion of supplementary feed being 62.52%. The percentage is 57.14% in Wasai and 56.60% in Jianshe. Nomads in Manzhong on average buy 165.5 kg of flour and 21.60 kg of rapeseed oil, costing 550 yuan. In Jianshe, nomads spend 500 yuan to buy flour and rapeseed oil. However, nomads in Wasai on average buy 233 kg of flour and 39.6 kg of rapeseed oil, costing 1100 Yuan. The expense of sup-

plementary feed is determined by how many yaks a nomad owns, what he can afford, and where he rents pasture. Nowadays, supplementary feed has become a large financial burden for nomads. Many poor nomads complain that as they have no money to buy flour and rapeseed oil, and thus do not buy supplementary feed, which increases livestock mortality.

### 3.3.6 Livelihood diversification

Livestock husbandry and herb collection are the backbone of nomads' livelihoods. Pasture degradation increases nomads' dependence on herb collection and secondary and tertiary industries, such as running a shop, driving taxis, and petty trade. *Cordyceps sinensis* has been the main herb sourced by nomads and its price has increased rapidly since 2007. However, nomads have been earning more money from *Cordyceps sinensis* even if the quantity of *Cordyceps sinensis* has decreased year by year. Through the sales of *Cordyceps sinensis*, nomads in Man Zhang, Jianshe and Wasai earned on average 2300, 14,000 and 6856 yuan, respectively, in 2007. Apart from livestock husbandry and herb collection, more and more young nomads are seeking off-farm employment (Yan *et al.*, 2010). Among sample households, 3% were involved in wage laboring, 11% had a business (mainly petty trade or running a shop near a township), and 9% had salary incomes (usually from work as cadres in rural villages or townships). Incomes from herb collection and secondary and tertiary industries help nomads rent pasture and buy flour and rapeseed oil for themselves and livestock, coats for themselves, veterinary medicine, wire netting, and angle iron.

There are vulnerabilities underlie nomads' livelihood diversification. Degeneration of *Cordyceps sinensis* resources and price fluctuation will affect income of nomads. To safeguard *Cordyceps sinensis* resources, many townships and villages only permit local nomads to collect *Cordyceps sinensis*, and nomads from other townships are forbidden to collect *Cordyceps sinensis* from April to May. Off-farm employments are not available for all nomads, and only those families have good human assets, social assets and financial assets have opportunities to seek employment opportunities in secondary and tertiary industries.

## 3.4 Gap between nomads and government

The study shows an apparent gap between adaptation strategies of nomads and governments. This gap is also shown in other regions of the Tibetan Plateau (Zhao and Jia, 2009; Zhang *et al.*, 2011). Although the Four-Package Project is taken by the local government, few nomads build fenced pastures and artificial pastures. These gaps imply contradictions of two paths of pastoralism: nomadic pastoralism taken by nomads or sedentary pastoralism popularized by government. Nowadays, sedentary pastoralism is seen by the local government as the only means to resolve pasture degradation and poverty of nomads and the Four-Package Project is popularized in the whole Qinghai Province and major part of Xizang region. However, sedentary pastoralism ignores the basic elements of nomadic pastoralism: vulnerable environment and severe man-land relationship. Vulnerable environment determines herds should migrate in different pastures at different seasons, let pastures regenerate when herds move to other pastures. Severe man-land relationship implies that rotation grazing is not feasible as there is not enough privatization pastures for rotation. By their traditional knowledge, nomads realize deficiencies of sedentary pastoralism and insist on nomadic pastoralism and their adaptation strategies are only complement for nomadic pastoralism. However, renting pasture and supplementary feed becomes burden for



nomads, which also implies challenges to nomadic pastoralism. Therefore, more and more nomads resort to livelihood diversification.

It is necessary to seek new measures that combine the best aspects of nomadic pastoralism with modern stockbreeding technologies to help nomads adapt to pasture degradation and improve their livelihoods. Firstly, some changes need to be made about Four-Package Project. As one fenced pasture about 20–30 ha can not meet fodder need in harsh winter, more pastures should be fenced by government. If government can provide seed and mature technology, artificial pasture should be greatly enlarged to increase hay production. Barley, flour and rapeseed oil should be provided by local government in harsh winter. Hence, nomads would not depend on renting pasture and supplementary feed. However, this will give the government a tremendous financial burden. Privatizing pasture should be realized according to nomads' willingness and group grazing based on consanguinity and the neighborhood should be encouraged. Secondly, nomads in all black beach region should migrate into townships and black beach should be retrieved from grazing, as it is expensive to build fenced pasture and artificial pasture in black beach. Thirdly, livelihood diversification should be encouraged in this region and local government should provide skills training, interest-free loan and employment opportunity to nomads to help livelihood transformation.

#### 4 Conclusions

1) This paper presents a case study of nomads' adaptation strategies and means of government to pasture degradation in the headwater regions of the Yangtze and Yellow rivers on the eastern Tibetan Plateau. Pastures there have evidently degraded, with pastures in Wasai being mainly in a state of slight or medium degradation and pastures in Manzhang and Jian-she being in a state of medium or severe degradation. Therefore, the grazing time of pastures has reduced, affecting the livelihoods of nomads.

2) Although the Four-Package Project has recently commenced in this region, there is still severe fodder shortage in winter and spring. The traditional hay storage strategy does not work owing to pasture degradation, and at the same time, few nomads establish fenced and artificial pastures; therefore, nomads follow other strategies, such as renting pasture, providing supplementary feed, and diversifying the livelihoods. However, these strategies are unsustainable; for example, renting pasture is problematic as pastures in other counties have also degraded. Supplementary feeding is becoming a financial burden for nomads. It is necessary to seek new measures that combine the best aspects of nomadic pastoralism with modern stockbreeding technologies to help nomads adapt to pasture degradation and improve their livelihoods.

3) Pasture degradation of this study is consistent with other studies of this region (Yan *et al.*, 2006; Du *et al.*, 2009; Zhang *et al.*, 2011), and nomad's adaptation strategies, such as renting pastures and hay storage, are not listed in their studies. There are also some uncertainties and more field works are needed. The key reason is that nomads there are unwilling to tell the true number of yaks and income. Although nomads provide the number of hay storage and supplementary feed, it still needs confirmation. In addition, the results of the Four-Package Project need in-depth investigation.

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