

Rural Reforms and Changes in Land Management and Attitudes: A Case Study from Inner Mongolia, China

The international science community stresses the importance of the local perspective in the context of dryland degradation. This paper explores changes in management and attitudes in a mixed farming system in northern China, since the introduction of the economic reforms in the early 1980s, and the following changes in land-use rights. The area encompasses a dune landscape scattered with crop-land, as well as the Daqinggou Nature Reserve, an area of natural vegetation. According to farmers new varieties of maize in combination with increased use of fertilizers have improved yields, though high yield variability persists due to erratic rainfall. Farmers acknowledge the importance of the 30-year contract on cultivated land in 1997 for their investment in long-term management, but emphasize the importance of chemical fertilizers for short-term economic survival. The farmers stressed the negative impact of grazing and cultivation on soil erosion and stated that differences in vegetation composition and cover in the nature reserve are due to anthropogenic factors.

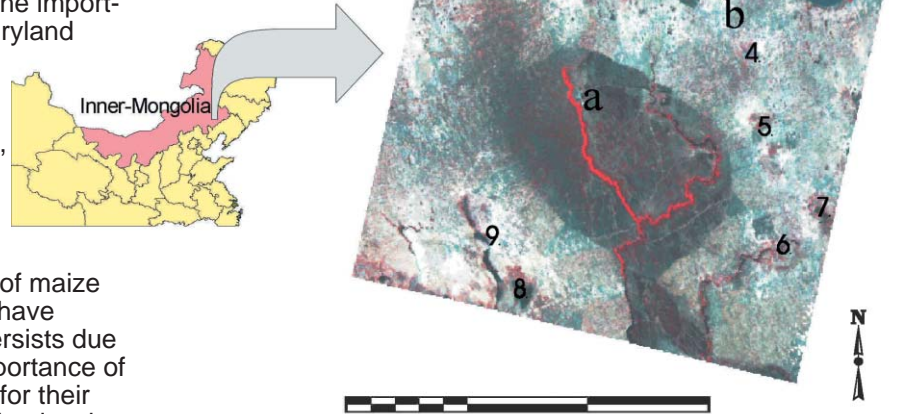


Figure 1. A section of a Landsat TM image for July 1997 of the study area. The darker areas in the image is the Daqinggou Nature Reserve which consists of denser vegetation cover mainly composed of elm and apricot, while the red strip represents the actually valley floor vegetation. The surrounding area consists of shifting to fixed dunes covered by bush vegetation and annual grasses. Figures in the image represent the different villages in the study area: 1. Qianzhanggutala, Figure 2. Dongmandouyingzi, 3. Ximandouyingzi, 4. Guojiaowupu, 5. Shajiaowupu, 6. Laoyemiao, 7. Chaohai, 8. Houxieliuhua and 9. Wuhegao. a and b indicate where photos in Figure 3 are taken.

INTRODUCTION

In 1978, the Central Committee of the Chinese Communist Party initiated economic reforms that have had a profound impact on many aspects of Chinese society. Changes within the rural sector included expansion of free markets, a rise in government procurement prices, a diversification of the rural economy, and product specialization and crop selection in accordance with rural comparative advantages (1). The implementation of the Household Production Responsibility System (HPRS), which in short meant contracting land to each family according to household size or labor force in return for tax payment, contribution to welfare funds and the households share of state procurement requirements, has impacted agricultural production and contributed 30–60% in the growth of agricultural output during the early reform years. The annual gross value output growth was 4.2% between 1985–1997 (2). But development has not been uniform over time and space (3, 4), and China's rural sector still faces considerable challenges for further development. By introducing household contracts on land the Chinese government intended to diverge from a "tragedy of the commons" situation, to individual responsibility for output and management. The reform has been supported by the majority of farmers (5), but negative impacts of the rapid agrarian change since 1978 are also obvious. These include a general shift towards the maximization of short-term output at the expense of long-term agricultural production, social polarization, increased vulnerability and risk for individual households, land fragmentation, changes in cropping patterns to more intense practices, overuse of chemical fertilizers, increased use of steep slopes for cropping, and overgrazing of grasslands (6–8). The impact on the arid areas of China has been discussed by Longworth and Williamson (9) who concluded that the pas-

toral areas of China have been affected by 3 sets of policy-related issues: population pressure; market distortions; and institutional uncertainties. Such factors have interacted with the adoption of new technologies, including the opening of additional water wells; supplementary winter feedstuff from agricultural by-products; and cultivated meadows, which may increase stocking numbers, thus, producing rangeland degradation.

Desertification, in China's arid northern environments, principally through wind and water erosion, but also salinization, is considered to be one of the country's most serious environmental problems, and is mainly due mismanagement of fragile environments (10–12). The international research community involved in the studies of the complex issue of dryland environmental change has recently emphasized the importance of local knowledge and perceptions as perceptions and attitudes form the basis for human land-related activities (13–15). Different groups make specific demands on the same land area. When the opinions of the state or other institutions contradict those of local farmers, conflicts may arise, and these can make the implementation of conservation strategies or land-use policies difficult or even impossible (16).

The aim of this article is to summarize farmers' views on land management and attitudes toward land use over the last 20-yr period, i.e. since the introduction of the HPRS which involved major changes in land tenure. By combining basic statistics with semistructured interviews, this study presents hypotheses for an ongoing study with the overall aim to investigate land-use and land-cover change of the Keerqin area in the post reform period. The findings are mainly based on 2 field investigations in 1998 and 1999. The paper is structured according to the following: i)

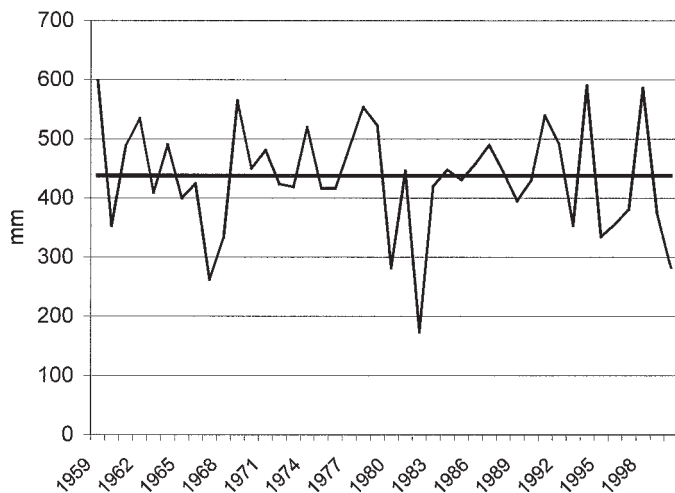


Figure 2. Annual precipitation 1959 to 1996 with a mean value. From Ganjig.



Figure 3. a) The contrast between the woody vegetation of the reserve and the surrounding eroded landscape is striking. View over the major river gully of the Daqinggou Reserve with both the tree crowns of the valley floor as well as the vegetation of the upper part of the valley and the surroundings. b) Parts of the semishifting and shifting dunes that are typical of the landscape outside the reserve. Photo: S. Brogaard.

changes in land-use rights; ii) trends in management practices related to cultivated land and grassland; iii) changes in attitudes towards soil conservation and long-term management; and iv) landscape changes in the area including the role of the nature reserve.

SITE DESCRIPTION

The center of the study area is located at 42°45' N and 122°12' E, and belongs, administratively to the southern part of Zhelimu League (17), Keerqinzuoyihou Banner (18), within Chaohai and Mando Township. The area is about 600 km² in size and consists of a partly vegetation covered dune landscape with scattered cropland. The Daqinggou Nature Reserve encompasses part of the area. The reserve is believed to represent the natural vegetation state of this part of the Keerqin Steppe (Fig. 1), while the surrounding Keerqin Steppe is considered to be one of the worst examples of desertification in China (19). The area has been mapped by Wang (20) for the years 1958, 1975, and 1981 from aerial photography. Wang showed a major increase in shifting and semishifting dunes and a corresponding decrease in fixed and semifixed dunes.

The climate of the steppe region of China is cold and dry in winter and relatively warm and wet in the summer. The Keerqin Steppe belongs to the semiarid to subhumid zone with mean annual precipitation of 430 mm with considerable interannual variability (Fig. 2). The rainfall is monsoon driven with 70% of the annual precipitation falling during the 3 summer months. Mean temperature in January is -12°C and in July 23°C.

The steep rainfall gradient from the wetter east to the drier west gives rise to considerable variation in species composition and biproductivity of the Inner Mongolian grasslands. The temperate steppe region is divided into a forest meadow zone and the typical steppe zone. The former dominates the study area and is characterized by soils with higher organic matter content, higher production of forage and cultivated crops and higher population density (21).

The reserve encompasses a branched river gully (Daqinggou and Xiaoqinggou) and is protected from intense grazing and cultivation by various population groups since the late 1800s. In 1988, the areas became a national nature reserve which today receives about 30 000 visitors a year. The vegetation of the upper part of the valley, stretching outwards to the surrounding dune area is mainly composed of elm (*Ulmus macrocarpa*) and apricot (*Prunus armeniaca*), and other tree species. The trees attain heights of 3 to 6 m (Fig. 3a). The surrounding undulating dune area is mainly covered with scattered shrubs such as *Artemisia halodendron*, and *Caragana microphylla* (22) (Fig. 3b).

The agricultural system of the area can be classified into semi-farming and semipastoral. Maize, wheat, beans, and rice are the main crops. Livestock consist mainly of sheep, goats, and cattle, while horses are kept mainly for riding and as draught animals. Land degradation manifests itself in the form of partly vegetated dunes, classified as mobile and semimobile. The main causes of wind erosion are related to cultivation of grasslands, intensive grazing, and cutting of trees for fuel, resulting in loss of top soil and sand-blasting of young crops. The situation is particularly severe during the dry spring months when vegetation cover is still low and the frequency of strong winds is high (23).

The population of eastern Inner Mongolia grasslands increased significantly in the 19th century and the first half of the 20th century when Han agriculturalists moved into the more humid parts of the area and converted fertile chernozem soils to agriculture (24). Over the past 50 years the population has continued to increase. In Keerqinzuoyihou Banner the total population is presently just above 380 000 (average population density 33 persons km⁻²), up from 110 000 in 1947, or an average annual increase rate of 2.5%, but this rate decreased after 1985. Of the total popu-

lation, 85% depends on agriculture or animal husbandry, which is a slight decrease from the 89% of 1979. The villages investigated are entirely dominated by agriculture where crop cultivation is the main source of income complemented by livestock, and the only nonagricultural sideline income was teaching at the local school. The dominating ethnic group is Mongolian, with just over 75% of the population (25). This was also the proportion of Mongolians among the interviewed households (26).

METHODS

An exploratory visit was made to the Keerqin Steppe area in 1996, and some secondary data were collected, e.g. maps, climatic data, etc. Interviews with farmers in villages in the Daqingou area were carried out in August to September 1998 and 1999. Altogether, 37 households in 9 villages were interviewed along with village leaders if they were present. Additionally, one of the older villagers considered to have particularly good knowledge of land-use change in the area was interviewed. The households were stratified into income levels to ensure that the sample included households of different economic standards. Stratification was based on advice from the village leader and the use of a prosperity indicator, i.e. the building material of houses such as brick or mud, which is an indicator of household standard in the study area. Although the latter method of selecting informants may not be strictly representative in a statistical sense, due to the nature of the questions including farmers' perceptions and attitudes, informal interviews without the presence of township or village cadres was preferred. To broaden the perspective, 10 interviews were also carried out in other counties of the Zhelimu league.

Village-leader questions were designed for open answers, while some of the questions to farm households were multiple choice or ranking questions. Due to the relatively open structure of the interviews new issues of particular interest to the respondents could arise during interviews according to a semi-structured methodology (27). Interviews usually lasted around 45 minutes and translation was done interactively in between questions. The respondent of the family was usually the senior man, as women are mainly responsible for household work and horticulture, particularly if there are young children in the family. In 1999, the interviews were continued by revisiting some of the villages following up households from the previous year, as well as doing new visits to households in other villages that were inaccessible in 1998 due to flooding.

FINDINGS

Land-use Rights

Keerqinzuoyihou Banner has a long history of livestock breeding, and in 1802, the central government issued an order to encourage cropland reclamation. At that time the land was publicly owned by the minority nationalities living on the rangeland while in practice most of the rangelands were controlled by so-called animal landlords, various officers or monasteries. These groups tried to limit the number of livestock owned by landless herders while increasing their own herds. In Inner Mongolia, the communist land reform began in 1947 and during October 1947 to May 1948 land was confiscated and distributed to farmers and herders. In some areas, livestock was handed over to poorer families or wages were raised considerably for herders and later passed on to the collectives. At the same time, ownership rights to a large part of the rangelands were passed on to the villages for common use, through confiscation of land in favor of village or state ownership (9). Cooperatives were established in 1953, and in 1958 all the cooperatives became communes. Land previously distributed among farmers and herders was now returned to the communes (24). With the HPRS, the cropland was

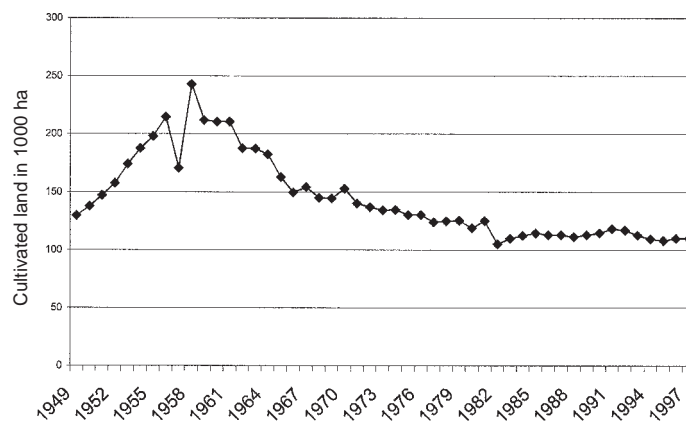


Figure 4. The development of cultivated land area in the Keerqinzuoyihou Banner 1949–1997.

Table 1. Summarized findings of land-holdings per household (hh) and person in the surveyed villages. The number of interviews includes older farmers as well as village leaders.

	Number of interviews	Average persons hh ⁻¹	Average land-holding ha hh ⁻¹	Average land-holding ha person ⁻¹
Qianzhanggutula	6	3	1.8	0.58
Dongmandouyingzi	9	5	2.6	0.53
Ximandouyingzi	6	5	3.4	0.72
Guojiaiwopu	6	5	3.4	0.69
Shajiwopu	7	6	4.2	0.76
Laoyemiao	2	4	3.2	0.90
Chaohai	1	3	1.1	0.37
Houxuelihua	4	5	1.5	0.31
Wuhegao	2	5	5.0	0.74
Total/average	43.0	5	2.9	0.63

first contracted to families in 1979 or in the early 1980s. During the interviews, it became evident that the contract period, as well as the number of redistributions of cropland, has varied even within the same township. Some of the villages had only distributed land once, while others redistributed land several times to adjust for inequalities or changing village population. The initial contract periods varied from 1 yr, up to 10 yrs in some cases. From 1997, a 30-yr contract on cropland was introduced in the whole area and families now have land inheritance rights. Livestock was distributed to households in 1981 or 1982 but unlike other parts of Inner Mongolia the process of contracting grasslands to households did not begin until 1999.

Land-holdings and Crop Yields

The cultivated land area in the Keerqinzuoyihou Banner has not increased since the early 1980s, rather it has levelled out at a slightly lower level than in the pre-reform period (Fig. 4). The same general picture is found in township-level data on total grain cultivated area except that Mando Township data shows a small increase after 1985 (25). The amount of land distributed to each household in a village depends on the total amount available in the village, on the quality of the land, and the size of the household. In most villages, the land is divided into a minimum of 2 quality categories; black and white land (heishadi and baishadi). The former refers to the land of the depressions between dunes, or in flat areas where the organic matter content is high and which has often been allocated for cropping since settlement of the area. The latter is nearly pure sand, poor in organic matter, and often cropped at a later stage in the village development when land became scarce. In the villages, the size of the average land-holding per person varied from 0.3 ha to 0.9 ha with an average of 0.63 ha person⁻¹ (Table 1). All villages

had restrictions on further expansion of cultivated land, and among the interviewed households 80% would cultivate more land if allowed to. The few families who did not desire more land were either among the wealthiest households or had a lack of labor. As the cultivated land per household is usually fixed by the village, additional land above the quota can be rented, for example for a 30-yr period, if a special contract is set up between the village and the farmer. This land is usually unfertile soil, e.g. a dune outside the village, which is then fenced and protected by a shelterbelt of poplars, etc. According to the agriculture bureau in Keerqinzuoyihou, farmers are encouraged to cultivate 3 land-cover types that are not taxed for a 30-yr period; dunes, alkaline land, and water-logged land, but few have taken advantage of this offer even though most farmers wanted to increase their cultivated land. Migration to larger towns for off-farm employment rarely occurred and was not major issue when allocating land in the villages.

All farmers experienced a significant increase in the yields of the main crops since the reform, and farmers also noted improvements over the last 5-yr period, which is also consistent with county-level statistics. However, yield variability is still high in the area. Farmers report a 150–200 kg mu⁻¹ (mu is equal to 1/15 ha) i.e. 2400 kg ha⁻¹ harvest of maize in a bad year and 300–400 kg mu⁻¹ (3800 kg⁻¹ to 6400 kg ha⁻¹) in a good year. Both in low and high rainfall years, yields are low. Fields located in depressions are flooded in high rainfall years while the dunes experience drought during low or normal rainfall years.

Farmers Views on Improvements and Constraints in Crop Production

The respondents were asked to identify the most important changes that had affected crop production during the last 20 years. As can be seen in Figure 5, by far the most important factors are the use of chemical fertilizer and the introduction of new crop varieties. New knowledge of agricultural practices and the use of herbicides and/or pesticides were considered to be of about equal importance, followed by increased mechanization, the introduction of other crop types, and irrigation. Other techniques such as plastic film to increase temperature and decrease evapotranspiration were not used.

The main constraints to further increases in crop production today were considered to be low soil fertility, lack of money (mainly to improve soil fertility or for digging a well), as well as irregular rainfall that has only partly been compensated for through increased irrigation (Fig. 6). Lack of land for expansion of cultivation and soil erosion were ranked equal. Other factors mentioned were poor knowledge of modern agricultural practices, low seed quality, and lack of farm machinery. Labor, weeds, and pests were less important, while soil degradation in terms of salinization, or land fragmentation, were alternatives that the farmers did not believe to be constraints.

Farmers used amounts of chemical fertilizers of between 10 and 45 kg mu⁻¹ (150 to 675 kg ha⁻¹); averaged over the total cultivated area. The mean value being 21 kg mu⁻¹ (315 kg ha⁻¹). The fertilizer used was either a phosphoric-nitrogen compound fertilizer or nitrogen in the form of urea. In some villages, nitrogen was applied in 2 applications 40% close to sowing, and 60% in early June. Farmers emphasized that even in a year with good rain, yields are low if inorganic fertilizers are not applied and lack of money to buy fertilizer is a major problem for poor households. The results of the fertilizer used were generally good, but concerns were expressed by wealthier farmers that more fertilizer had to be applied every year to uphold the same yields. Those households that could afford to apply large amounts of nitrogen meant that further application would only increase yields marginally. Only around 10% of the farmers had land in fallow and about 10% practiced rotation cropping. Crop rotation was mainly practiced between maize and soybean to im-

Figure 5. Most important changes in management of cropland according to farmers (n = 35).

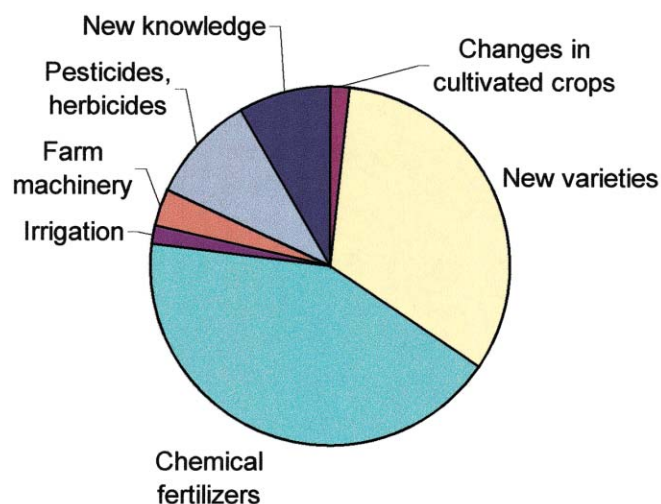
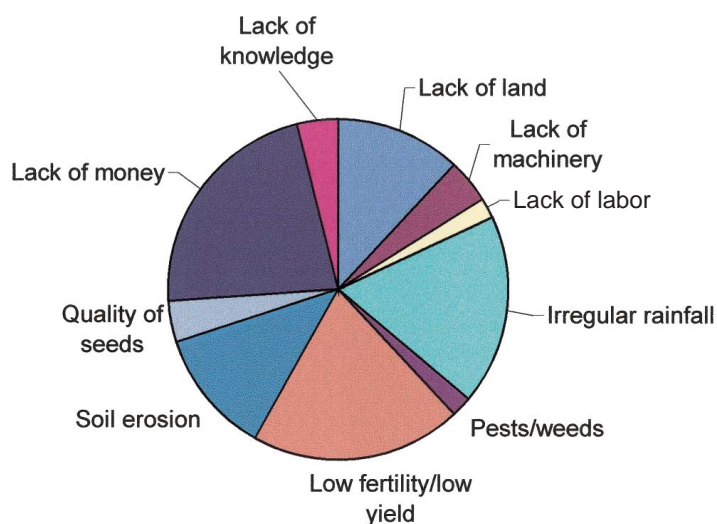


Figure 6. The most important factors pointed out by farmers preventing further increase of crop yields in the study area (n = 35).



prove the nitrogen status of the soil. Manure is occasionally used by most farmers, but amounts vary greatly; between 7500 and 30 000 kg ha⁻¹ (500–2000 kg mu⁻¹) depending on the number of livestock and land. Manure is mainly applied on the fields closest to the farmhouse, as transportation to further distances is difficult.

New seed varieties have replaced the some traditional varieties of crops, of which the most important is the substitution of white maize or sweet maize for hybrids of yellow maize *Zea mays subs. Saccharata*. The quality of some of the seeds sold by the township or county is sometimes low, giving meagre or no yields, and farmers who can afford to travel may do so to buy good quality seed of a special variety.

Knowledge about new agricultural practices is acquired through training through educational television programs and books. In some villages an annual course is organized by the township where new agriculture practices are presented. Most families have a television set even though other capital goods in the household generally are few.

Groundwater pumped from wells 30–40 m deep is used for irrigation. Irrigated land is mainly used for small patches of rice

for household consumption, and the initial investment for drilling and purchasing a pump is expensive. The degree of mechanization is still very low. The only machinery owned by the interviewed households was a water pump and a motor tricycle. Renting of machinery was unknown.

Soil Conservation

All respondents stated that an increasing number of villagers recognize the importance of soil conservation with the introduction of the HPRS, and that people spend more time on soil conservation today. One farmer pointed out that “land forms the basis for our living and soil conservation work is for our survival”. Farmers indicated that it is now worth paying more attention to how the land is distributed, especially after the introduction of the 30-yr contract, but that common grassland is still not properly managed. As one farmer said “we have to take more care of the land as there is less available per person”. Four farmers indicated that they wanted to plant more trees, fence their land, or improve their rotation practices in the coming year. According to the township cadres, there are regulations that state that the cultivated land should be fenced and surrounded by shelterbelts of poplar. However, this rule did not seem to be generally known in the villages, and those who recently had fenced their land and planted shelterbelts had done so on their own initiative. The fact that certain land-management regulations and land-use policies from high administrations, e.g. the Prefecture Agricultural Bureau, were not followed, or even known, at the village level, is not a new phenomena (28) and constitutes a major problem for the central government when enforcing policy decisions.

Management and Attitude Changes towards Grasslands

The villages have areas of natural pasture at some distance from the village to which sheep and cattle can be taken each day. Sheep, goats and horses are often grazed around rainfed or irrigated fields in the dunes or depressions. Livestock is kept near the houses at night, and in sheds during cold periods in the winter. The number of livestock (Fig. 7) in the county has generally increased since the late 1940s, but decreased again in the late 1970s. Big livestock have lately shown a moderate increase, while the sheep and goat population have increased rapidly since the mid-1990s. The picture for the Chaohai Township is slightly different with small livestock numbers decreasing as breeding of goats is now totally banned; goats are seen as the biggest threat to the grassland. The grassland area in the county has not changed appreciable with the reforms. Locally, zones along roadsides or in the villages have been fenced and planted and have decreased available grazing areas somewhat.

The most important changes affecting the livestock sector since the reforms, according to interviews, were changes in livestock management followed by improved farm economy. Management changes included improved animal health care and additional fodder. Economic changes were related to management changes. The development of market economy now makes it possible to sell pork, the profit usually being invested in improving the quality of the remaining livestock. Before the mid-1980s, most of the cattle in the area were of local species. Recently, stock has been improved by the introduction of Dutch species. According to one farmer, improved varieties at the expense of fewer numbers of individuals is the

solution to better herd and grassland quality. Often the farmers commented that the actual reform and the development of the HPRS is the most important factor contributing to the growth of the livestock sector.

The main constraints to raising more livestock were found to be lack of money, and the availability of grazing land (Fig. 8). Apart from capital for fodder and medicine, taxes are high; goats are taxed at 20 RMB (around 2.3 USD) per year, cattle at 15 RMB (1.8 USD) or lower. Money is also needed for building shelters. Alternatives not chosen by farmers were rainfall variability, land degradation, grazing regulations, and low meat prices.

It was unanimously agreed that increasing numbers of livestock degrade the grassland. One farmer from Shajiaowopu explained “first palatable species disappear, thereafter the non-palatable species followed by the formation of desert”, while a man from Houxielihua stated “first trees are cut, then the grasses are degraded and the sand spreads”. Another respondent from Houxielihua stated, “together with unreliable rainfall, the increasing number of livestock is degrading the grassland day by day”. Another farmer was more precise; “when land is used for common grazing, 30–40% will be turned into sand within three to four years”. However, some farmers stressed that the livestock is not the triggering factor of grassland deterioration, but rather

Figure 7. The livestock development of the Keerqinzuoyihou Banner 1947–1997. Big livestock include cattle, horse, mule, donkey and camel, and small livestock include goat and sheep.

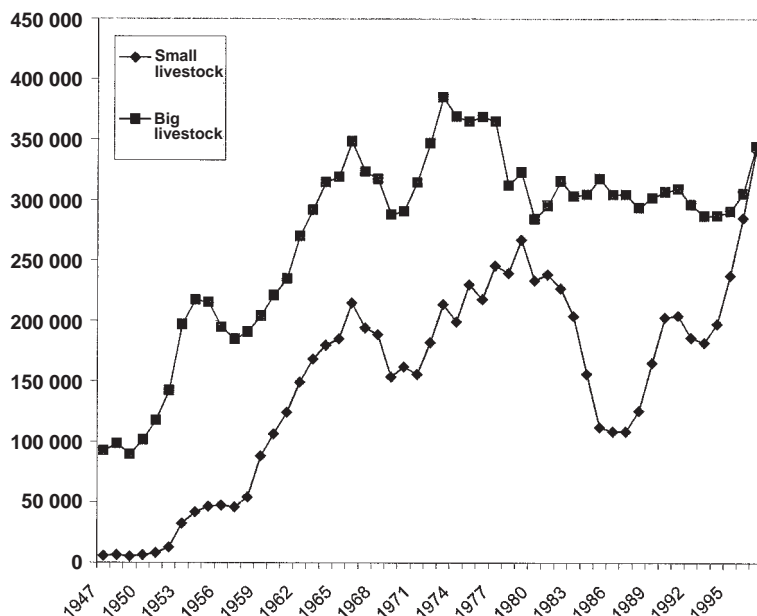
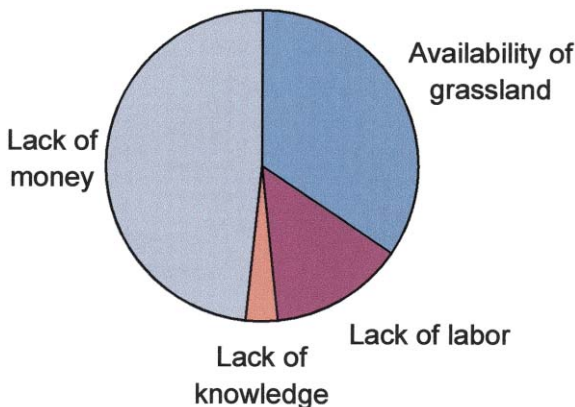


Figure 8. Farmers' opinion of main constraints for raising more livestock (n = 35).



cultivation. The dominant view was that vegetation cover had decreased and bare sand had accelerated over the last 20 years, but the situation over the last 5 to 10 years had improved somewhat due to afforestation in some enclosed areas and along roads. In the village of Guojaiawopu all respondents agreed that the situation had improved as expressed by one farmer: "The quality of grassland has improved even though we have more cattle. When I was young there was only one cow per family. Even with more livestock the situation has improved. Now we use more input and better management and therefore we have less shifting sand but more grazing land in the village".

Perceived Landscape Changes and Attitudes towards the Daqinggou Nature Reserve

Farmers were asked to comment on the most significant landscape changes around their village and older respondents emphasized the changes in population and livestock numbers as one farmer in Dongmandoyingz said: "In 1947 there were 170 people and 100 animals, mainly donkeys and cattle. Now there are 570 people and 1000 animals including 300 horses. The land around the village is of course affected by this. 50-60 years ago there were trees both inside and outside the reserve and less desert. But since then there has been a large increase of people and livestock and there is a higher demand for firewood."

The farmers in Dongmandouyingzi indicated that the periods of the *Great Leap* and the *Cultural Revolution* had been the most devastating for the natural vegetation cover of the village, but that the situation had improved since the 1990s as more trees had been planted. Again the prevailing view in all villages was that the overall condition of the land had worsened in terms of fewer trees, grassland degradation, and an increase in the amount of shifting sand at the same time as cultivation had increased. A man herding his sheep on a shifting-sand dune 2 km northwest of the Daqinggou reserve describes the transformation:

"The dune was here more than 50 years ago but before the 1960s the landscape then was partly covered by vegetation. We used to cut bushes for firewood here but now the dune is without any vegetation and the area is expanding."

A recurring opinion was that despite overall degradation there has been an improvement along the major roads, which can be explained by more tightly controlled grazing and shelterbelt plantations for protection against sand. The difference in the perceptions of landscape change between different villages was striking. In Houxielihua, located in the southern part of the area close to a large dune complex, all respondents mentioned increased areas of cropland, expanding areas of shifting sand and fewer trees. One farmer complained that he now has to cross the border to Liaoning Province to collect firewood as forested areas of the northern part of the village have decreased.

Conversely, in Guojaiawopu, farmers said that the landscape had improved greatly after the commune period, tree cover has increased considerably through planting, and areas close to the village have been excluded from grazing. The village committee decided that anyone who cuts down a branch from a tree in the village can be fined 50 RMB (6 USD) and a horse grazing in protected areas would be fined 30 RMB (3.5 USD).

The setting of the villages close to the Daqinggou Nature Reserve enabled us to survey local attitudes toward the nature reserve, including the opinion of whether the reserve represents the potential vegetation of the area. Responses as to whether the farmers experience benefits from the conservation area fell into 3 equally large categories: *i*) overall positive effects; *ii*) mainly negative effects; and *iii*) indifference. The positive effects most often mentioned were expressed by the general statement "the nature reserve is beneficial for the environment" or more specifically "the reserve serves as an example to the people [of] how the land could actually look". In addition, possibilities for extra income from selling meat to one of the restaurants serving visi-

tors along the main road in the reserve and renting horses to the tourists were mentioned. Responses from farmers with parts of their village territory overlapping the reserve were often negative, as the reserve prevents the use of land for grazing or cultivation. The group of respondents indicating indifference toward the reserve said they were living too far away to experience any benefits or drawbacks.

To assess whether the distinctly different species composition and vegetation cover of the Daqinggou reserve was considered to be the natural condition of the area, respondents were asked to comment on the contrast. The uniform answer was that the contrast was due to good management of the reserve. Within the reserve the original vegetation is preserved due to lower pressure from cultivation and grazing. Forest guards protect trees from being cut. One man said "the difference is that we have to live off our land". The status of the land was expressed as; "there is no erosion because of good vegetation cover".

DISCUSSION AND CONCLUSIONS

According to county level statistics for Keerqinzuoyihou Banner, the cultivated land area has been relatively stable since the early 1980s, as has the total population and the agricultural labor force. The fact that farmers generally wanted to increase their cultivated land but were hindered by village regulations on cropland expansion, implies that even in areas where land is abundant, low quality and fear of reclamation failures have restricted cropland expansion. Thus, intensification remains the primary method by which to increase total output. This trend is also in line with a recent Chinese land-use policy, which aims to limit the reserve arable land reclamation in order to reduce negative environmental impact in the erosion prone northern environments (29).

Farmers acknowledge the importance of the 30-yr contract for cultivated land, introduced in all the villages in 1997, as an investment for long-term management. All respondents from the surveyed villages said that they now are more motivated to apply soil conservation methods, such as tree planting around fields, crop rotation and to increase their use of manure. Farmers emphasized improving yields over the period since the start of the 1979 reforms, but were also concerned about variations in output mainly ascribed to unpredictable climate as irregular rainfall. Yield increases were attributed to new crop varieties but also increased use, and dependence on, chemical fertilizers. The application of chemical fertilizers differs considerably between households (150–675 kg ha⁻¹ nitrogen) depending on household economy. According to researchers at the Naiman ecological station, the complaints from farmers in the study area that more fertilizer is needed each year to maintain yields are due to a lack of phosphorous or micronutrients. The amount of chemical fertilizer (e.g. nitrogen), applied in many areas of China is far too high, both from an environmental and economic perspective (7, 30, 31). The study shows the urgent need for information on sustainable fertilization practices also in the marginal grain producing areas of China. The fact that farmers ranked the availability of chemical fertilizers and the economic means to buy them as more critical in crop production than soil erosion indicates that farmers are opting for short-term economic sustainability before long-term environmental sustainability; a short-term survival strategy also found among small-scale farmers in the West African Sahel (32).

According to statistics and interviews there is no general trend toward increasing livestock numbers since the reform, which is the picture normally reported from China's pastoral areas. The costs of keeping further livestock as well as the limited availability of grassland are the main constraints to increasing herd sizes according to farmers. They are also well aware of the problems of overgrazing and emphasized the importance of village

leaders to follow up grazing restrictions. In this area, the process of contracting grassland to individual households did not begin until 1999 and the expectation among farmers regarding the distribution of grassland to each family is high. The process should, however, be carefully monitored and evaluated both from an environmental and socioeconomic standpoint. It has been suggested from other studies that the distribution and fencing of grassland in arid areas of China has not been successful as in practice many areas are still characterized by "open access", or no control at all, often leading to grassland degradation despite fencing (33). Poor farmers cannot afford to enclose their land as wire-fencing is costly, and those who can afford graze their herds on areas still used as public range as long as forage is still available (33, 34). Some rangelands in China are still managed in common despite household contracts as such tenure arrangement can be more cost-effective and also ecologically sustainable for poor regions with marginal and highly variable resources.

The uniform response from the farmers when they were asked to comment on the difference in vegetation cover within the

Daqinggou Reserve was that the area reflects the potential vegetation and is a result of good management. This is in line with findings from studies of pollen analysis and archeological studies (35), indicating that the bush-covered dune landscape of today has been strongly influenced by humans. The human impact on land cover was also stressed when older farmers commented on the major changes in landscape during their lifetimes. The human- and livestock population has multiplied since the 1950s. Distinct differences in opinion between the surveyed villages in terms of post-1978 land development were revealed during the study. A possible explanation for this could be an increasing importance of the village leader in environmental resource management, parallel to increasing economic influence of the village leaders on the economic situation (36). Recent natural catastrophes, e.g. flooding in 1998 and sandstorms over Beijing and other northern Chinese cities in spring 2000 and 2001, have drawn increased attention to the importance of a sound land-use policy (37, 38), but the potential success of recently planned or initiated afforestation programs in China still remains to be studied.

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- One issue that could have effect on the response on attitudes could be the ethnical belonging of the household related to the Mongolians' traditional nomadic grazing background. In order to enable a comparison between the two groups ethnicity of the interviewed households was asked. Based on the themes discussed during interviews no systematic differences could be distinguished between Mongolians and Han Chinese that could be related to that the influx of Han agriculturalists in this region has been a relatively gradual process. Further research would be needed to gain a better understanding of Han and Mongolian differences in the study area.
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