GRASSLAND ANIMAL SYSTEM DEVELOPMENT IN CHINA: AN INTERREGIONAL APPROACH

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Abstract

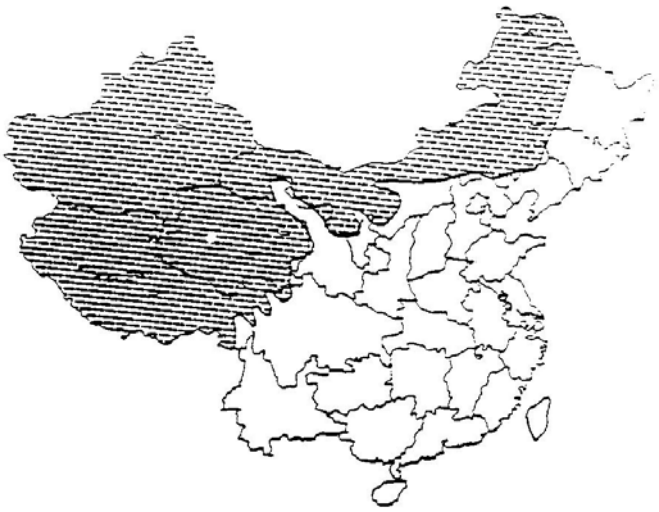
The grassland animal system in Inner Mongolia and other pastoral areas of China, which was transformed over the 4 decades following liberation in 1949 from a nomadic system to a semi-nomadic one, is currently partially sedentary and partially semi-nomadic. An explanation of the transformation process and impact on the ecosystem is provided along with the historical cultural setting. Participatory Rural Appraisal (PRA), the methodology used in an earlier paper by the authors to determine the historical transformation and study the impacts, is explained. This same methodology was used in an evaluation of the transformation during the 1990s in a northeastern area of Inner Mongolia presented in this paper. An economic analysis and a technical analysis are also given about options for structural change in the grasslands over the next quarter century. The analysis involves a shift from an integrated cow/calf and growing-fattening system on the grasslands, to shipping calves from the grasslands to the cropping areas of north central China for growing and fattening. It is concluded that grazing land producers would obtain more net income from selling weaned calves rather than fattened animals. Furthermore, nationally, the country would benefit considerably through reduced use of feedstuffs as well as the rehabilitation of deteriorated and/or desertified grassland accounting to about 30% of the nation's total area. Results presented show that although 14,230 Mcal of metabolizable energy and 738 kg of crude protein are required per 4-year old male sold at slaughter weight by grazing land fattening, a feedlot fattened male would require only 5,670 Mcal of energy and 371 kg of protein.

Introduction

China's economy has traditionally been divided into three zones or geo-geographic regions; East, Central and West. There are considerable differences between them in terms of labor productivity, income and other social and economic indicators. The west is the poorest region and has become the focus of most current regional development policy (Yao, 2000). Much of this region, and also the northern part of the Central region—including Inner Mongolia which has recently been designated part of the Western Region by the central government due to its socio-economic features—is grassland. The low agricultural productivity of grasslands and general lack of water and other natural resources is one of the reasons for economic disparity between the three regions. One problem facing planners and development strategists is what to do about the grasslands, and that problem is the focus of this paper.

China has one of the largest grassland and pasture areas in the world, covering nearly 2.9 million km^2. A wide variety of grazing land environments are included, from tiny pastures in the agricultural areas comprising less than one hectare on which a farmer might keep a few sheep or goats, to the roadside communal areas where a producer grazes a half dozen dairy cows or milk goats, up to the vast windswept areas across north China. Equally important are the deserts and rangeland of Western China and the mountainous regions, home to minority ethnic groups and yaks. Roughly half of China is designated as pastoral and grassland, as opposed to agricultural area (Simpson et al. 1994) (Map 1). The grasslands *per se* are immense, accounting for about 30 percent of the nation's total area. About 2.4 million km^2, or 85 percent of China's grassland and pastures, are in the temperate zone (Zhu et al. 1985).

Map 1. *Pastoral and agricultural areas of China, 1990*



Historically, the major production system in the grasslands has been nomadic animal management, with a small proportion of the population being semi-nomadic. Over time, and especially since China was opened to the outside world in 1978, there has been a major emphasis on settlement of herders into villages or into houses, i.e. an ever increasing semi-nomadic lifestyle in which livestock owners live in houses part of the year.

Curiously, while the sedentarization that planners had envisioned of herders living in houses during winter and spring months, and then following their animals the rest of the year, has changed in a substantial number of pastoral areas. What actually has happened is that herders realized the negative impact of the sedentarization on their grassland resources, and thus developed a pattern in which they live in yurts during the winter months and return to the houses in March, i.e. the beginning of spring. This is the calving and lambing season, and thus the critical time for good nutrition, shelter and care of young stock. Additionally, this system meets their water problems. Furthermore, they return to their yurts in the middle of June, which by then is on summer pasture, or remain at their sedentary location if they don't have special summer pasture. After going *Aoter* (meaning in Mongolian the short time and fast fattening by frequent moving on pastures with better range conditions), the herders then begin to graze their livestock on autumn pasture. Statistics are not available, but it appears that the majority of livestock in the rangeland areas now fall in this semi-nomadic system.

A critical factor for analysis of grassland production, and pastoral systems in particular, is that they are diverse—and for very good reasons (Simpson, Xu and Miyazaki 1994). There is no one solution to the so-called "pastoral problem" of overgrazing and relatively low offtake rates per ha, but there are a number of viable, logical interventions that could result in considerable improvement in productivity. These are discussed later in this paper.

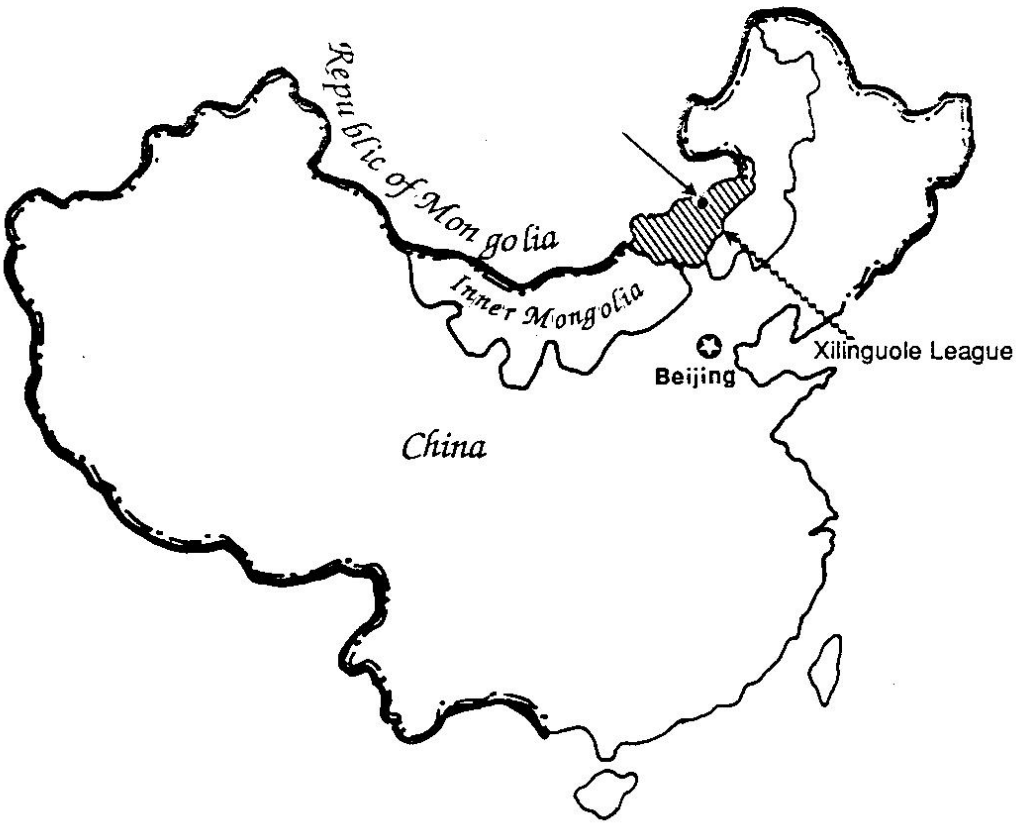
In an earlier article we provided a case study of one village in Inner Mongolia which was transformed over the four decades following liberation in 1949, from a nomadic system to a semi-nomadic one (Li, Ma and Simpson, 1993). A summary of that transformation process constitutes the beginning of this paper with the purpose of explaining how much of the semi-nomadic system in China operates. A second purpose is to provide information on changes that have taken place in the past decade to highlight the transformation process, the impact on the ecosystem, and alternatives for some next steps in economic development of these low-income areas. Additionally, an objective is that to have this paper serve as a basis to promote greater regional productivity of the grasslands, long-term sustainability of the ecosystem, increased incomes to producers and national development. This paper's regional focus is North-eastern

Inner Mongolia. However, the findings have direct implications and relevance for much of China's Western region, an area now targeted for economic stimulation.

The Case Site

The case study site for the 1993 article, and the current study carried out in July 2000 is Hurqige *Gacha* (Village), a former production brigade during the commune time between 1958 and 1982. It is one of four *Gacha* of Shamai *Sumu* (township), also a former commune located in Dong Ujimqin *Banner* (county), Xilinguole League (prefecture), Inner Mongolia Autonomous Region (Map 2). This Gacha of 869 km^2 is on the border between China and the Republic of Mongolia. The average annual rainfall is about 250 mm, and the vegetation is typical Steppe Grassland

Map 2. *Location of the research site*



In 1992 there were 91 households and 516 people, including Han immigrants who had moved to the *Gacha* in the early 1960s. Actually, they have lived at the banner town since the middle 1980s, but still keep their official registration in this *Gacha*. In As of July 2000, there were 103 herder households in the *Gacha*. All were native Mongolian herdsmen except for 2 Mongolian immigrants. Besides those households, more than 80 short-time immigrant herders or herder households from a neighboring banner were employed as herdsmen to look after the flocks of sheep and goats year-round 2000. Most herder households in this *Gacha* hire such herdsmen.

Case Site Research Methods

The methodologies used in the study reported on in this article are the participatory approach to development study, integrated with sociology and economics. Selected methods of Participatory Rural Appraisal (PRA), such as group and key informant's interviews, mapping of the seasonal nomadic movement, wealth ranking, seasonal calendar, historical profiles on changes in land use patterns, trend analysis for grassland condition, daily routines and activity profiles (especially for women) were used. In addition, Farming Systems Research (FSR), causal diagramming, etc. were also main tools used in the survey. 42 households were interviewed in the first survey (1992-93, including 39 herdsmen living in the *Gacha*. The remainder were Han immigrants). The results from those detailed surveys were updated in July 2000 using similar techniques although only 25 informants, 10 households and detailed interviews with village leaders and office officials were conducted.

The rationale for the research methods is that the growing awareness of the failures of conventional development approaches to meeting the needs of resource-poor people has led to the exploration of alternative methodologies for investigating resource management issues; and for planning, implementing and evaluating development activities. Participatory approaches, such as Participatory Rural Appraisal (PRA), offer a creative approach to information sharing, and a challenge to prevailing biases and preconceptions about rural people's knowledge. Advocates of participation argue that the production of knowledge and the generation of potential solutions should be developed with those whose livelihood

strategies form the subject for research.

The methods used in PRA range from field-based visualization, to interviewing and group work. The common theme is the promotion of interactive learning, shared knowledge, and flexible, yet structured analysis. These methods have proven valuable for understanding local perceptions of the functional value of resources, processes of agricultural intervention, and social and institutional relations. Furthermore, participatory approaches can bring together different disciplines, such as agriculture, health, and community development to enable an integrated vision of livelihoods and well-being. Participatory approaches also offer opportunities to mobilize local people for joint action. By participation, a side benefit is that the local rural population can raise their sense of ownership and commitment to the process of development planning, and implementation. In this way programs can produce much more sustainable impacts. This is particularly important to the development of western China during this fast transition period to a market economy in which there is still a strong tradition of the planned economy approach, especially at the local government level.

Evolution from the Nomadic Pattern

The native Mongolian herdsmen in Hurqige *Gacha* had traditionally followed a long-distance nomadic movement pattern as late as 1956 when the *Bage* (a synonym of *Gacha* in Mongolian) was formed and its boundaries fixed. In 1952, a work team was sent by the banner government to the Hurqige area to teach herdsmen to read and write. Herdsmen continued a short-distance seasonal movement within its boundary until 1985, at which time they changed into a semi-nomadic pattern. Accompanying the evolution of the movement pattern were changes in institutions of administration and production.

In 1957, the "collective movement" was introduced into this area. By 1958, all animals had become the property of collectives, which paid the owners for the animals during the following 25 years. During the commune period, the brigade was responsible for production and financial management as well as development planning. The brigade leaders made arrangements for seasonal use of grazing land, allocation of labor and money for production, selling products and distribution of income among the Accumulation Fund (for investment), Public Welfare Fund and the households. The households got their income based on their Labor Points (Work Score) gained mainly from looking after the animals.

The nomadic movements were frequent in 1960s. The moves were also shorter (about 2-4 km) within each seasonal pasture, usually a total of 6-8 times (or more) each year. Herders stayed in one camp (i.e. physically took down their yurts and moved them) no longer than two months. But, due to the equalitarianism in income distribution and loose management during the Cultural Revolution, they moved less and less, down to 4-5 times every year during the 1970s.

Since 1985 the seasonal movement in Hurqige *Gacha* has changed into a completely semi-nomadic pattern. Several factors have contributed to it. Intervention from the regional and local governments can be traced back to the 1970s. The government considered nomadism as backward and something to be gotten rid of. Originally, they encouraged the herdsmen to build permanent houses and shelters in winter pastures and follow a nomadic mode during the warm grass-growing season. However, due to water resource shortages or limited grazing land, and the critical time for calving and lambing being in the spring, houses and shelters were actually built in the spring pastures in most of the pastoral areas in Inner Mongolia. The case of Hurqige *Gacha* provides a typical representation not only of Inner Mongolia, but also of a substantial portion of the northern grasslands across China. Apart from the general reasons mentioned above, one in particular is that former summer pasture with water resources (about 200 km^2) was returned to Sunite Pastoral Farm (a commune) in 1986. That farm was forced to move from the national border area in the early 1960s and only returned in the early 1980s to become a new *Gacha* (Bayinaobao *Gacha*) of Shamai *Sumu* in middle of 1980s. What this means is that the herdsmen of Hurqige *Gacha* had to remain all spring, summer and early autumn in their former spring pastures.

In 1985, the herdsmen obtained utilization rights for the grassland after getting back ownership of the animals in 1983. The certificates of use right clarified the area size as well as the boundaries. Beginning in 1987 the households started to build houses, shelters, pens and above ground bunkers for hay storage. By the end of 1992 all the herdsmen had built facilities and also had 35-200 ha of fenced pasture in their spring camps. More than 90 percent of them built houses, mainly of brick with tile roofs. There is now 0.5 - 1.5 km between the permanent homes.

The herdsmen remain sedentary from the middle of March to the end of August to carry out the spring and summer activities. Then, the men or young couples of the families drive the flocks of sheep and goats to the winter pastures for 10 - 20 days for fattening (going *Aoter* in Mongolian means the short time and fast fattening by frequent moving and less watering in the pasture with better range condition). The cattle remain at the permanent residences. After returning back to their permanent homes they herd their animals 2-4 km from their houses, but not more, otherwise it will be too far from water resources. In late October, when snow is available for water, they move to the autumn pasture and stay there until the end of December when the snow cover becomes too thick for animals to graze. Then, they move to the winter pastures.

The new arrangement for animal ownership and grassland utilization is the result of the reform policy. The commune system was dissolved in 1983 and replaced by *Sumu* (for commune), and *Gacha* (for brigade). Village committees took the place of the former brigade committees, and play a greater role in service than in administration. For example, the leaders look for marketing channels for the herdsmen's animal products now that marketing has become decentralized and prices freed. They negotiate the price of hay for herdsmen with some Han immigrants who come back to the Gacha during the mowing season. The *Duoguailun* (group in Mongolian, an organization existing also during the commune period under the brigade) has been reorganized based on the distribution of herdsmen's homes. Within the group, clipping, washing, AI, etc. are organized. *Gaote* (which in Mongolian a pair of herder households staying and moving together to share the task of looking after a flock of sheep and goats) plays a more important role than before. The two households are usually brothers, or father and son. They put their own animals together to form one flock of sheep and goats, one herd of cattle and another of horses. In this way they can save labor and better utilize infrastructure.

Impacts of the Change from a Nomadic to Semi-nomadic pattern

All herdsmen interviewed in 1992-93 were positive about changes from the shift to a semi-nomadic system. For example, that the sedentary lifestyle had improved living and working conditions, strengthened production stability and provided greater resistance to natural

disasters. But, on the other hand, the herdsmen were also aware of some negative impacts. Most herders interviewed in 1992 and 1993 considered that the grassland in Hurqige had deteriorated compared to the 1940s, and it was already worse in the 1970s—the Cultural Revolution period—than in the 1950s. Virtually all the interviewees attributed the reasons for deterioration to the high animal population and over-grazing. Change toward a dryer climate than 1950s and 1960s ranked second. A problem is that animals graze the pasture in sedentary areas during the entire spring and summer (which totally covers the grass growing season) rather than being moved periodically. Herdsmen said that the grasslands were almost bare in May and June (before the rainy season) in most years.

Most people believed that animal performance, especially resistance to bad natural conditions, had decreased due to the reduced exposure to natural hardship and worsened grassland nutrition. They mentioned that the sheep in Mandalatu *Gacha*, where snowfall and cover are always heavier and thicker than in Hurqige, are more tolerate to severe winters. Nevertheless, in general, sedentary life has noticeably reduced animal mortality and increased the stability of animal production. The other important factor has been increased incentive through privatization. The animals belonged to the commune in 1970s while by 1985 they were privately owned.

The living and working conditions of herdsmen are considered to have greatly improved due to their semi-sedentary life and other infrastructure improvement, especially for women. Most households have tractors which the men drive to fetch water and animal droppings (used for cooking fires) rather than this just being women‘s work. Wives do not milk cows as much as before because the cows are on their own and the crossbred calves need more milk. In the evening, sheep are enclosed in pens, which prevents access by wolves so that wives can now sleep peacefully with their families rather than getting up during the night to check on their livestock.

Another important impact on attitudes and behavior of herdsmen was not been directly caused by the nomadic pattern change, but rather by changes in the land tenure system. As a result, herdsmen had developed a confidence in their utilization rights for grassland, and no longer worried about new families getting land from the *Gacha.* Ironically, and in contrast to

views about degradation of pasture quality, they said they wanted to maintain their assigned pasture in good condition for the upcoming generations. In the previous five years they had spent 15-25 percent of their total expenditures on fencing, building shelters and houses, and developing wells. Rapid increases in animal product price and income in recent years also helped. The result was that total *Gacha* expenditures increased four fold from 1985 through 1992. Nevertheless, all agreed during the 1992-93 interviews that there was still an urgent need to introduce and adopt appropriate technologies in the new semi-nomadic pattern to stop grassland deterioration, and to keep the ecosystem and pastoralism oriented to a sustainable development manner.

Case Study Site Interviews in 2000

The PRA survey carried out in July 2000 not only served as an update on understanding the changes in the institutional setting and nomadic movements in the Mongolian pastoralism areas, and the impacts on the grassland ecosystem and Mongolian herder households' culture and life, but also traced the new changes and challenges the herder households are facing. From the following table, it can be determined that income disparities between households widened from these in 1992/93. Informants used the number of livestock as the indicator of wealth status. Thirty-six households (about 1/3 of them) had less than 500 livestock. Fifteen of them have even less than 300, a number so low that it results in a difficult life considering the increased annual expenditures in living and production. The informants attributed the growing differences mainly to the capacity of individual herder's planning and management in production, income and expenditure. The stage in a family's life cycle also contributed to the disparity. Because the grassland is limited, new and young families have less grassland and livestock per capita than other households.

Table 1. Results of wealth ranking of herder households in Hurqige *Gacha* (by Mr. Danbi, Da Alaha and Batemengke)

Category	HH No.	Livestock	Features and reasons
1	31	800 – 2,000	With the same environment and conditions, they are good at management, arranging/planning the inputs and income. Therefore, they could expand production scale.
2	36	500 – 800	Similar with category one, however, the population increased, new families were split, pasture reduced, which limited the production expansion.
3	21	300 – 500	No good at management, planning & arrangement of inputs and income. Some of them engaged in the activities other than pastoralism in part time.
4	15	150 - 300	Poor at management and arrangement of income and expenditure. No plan for production and living. Some of them are lazy.

The following table shows the investment, income and expenditures of two households representing the 1st and 2nd categories of households respectively.

Table 2. Expenditures by interviewees, July 2000

HH head	No. ca	Proper stocking rate	Current stocking rate	Infrastructure investment since 1991	Machinery investment	Average of 10 years	Income 1999	Production expenditure	Present gifts	Seeing doctor
Enkebayar	6	953	1,717	132,600	53,000	18,560	80,650	27,000	5,000	n.a.
Suhe	4	n.a.	n.a.	40,000	60,750	10,075	32,740	15,327.76	n.a.	5,000

From this it can be concluded that:

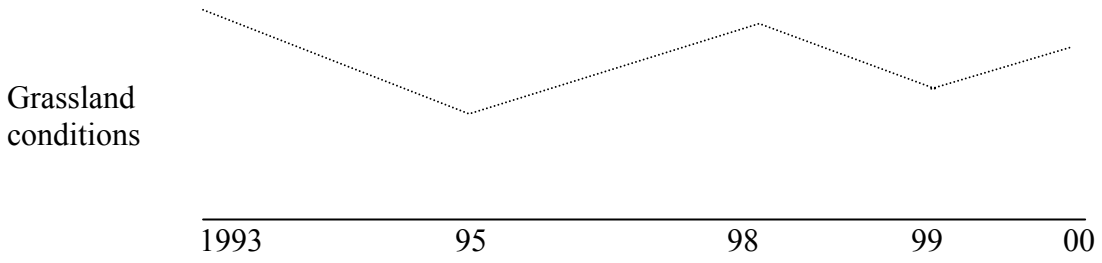
- The better-off and upper middle income households have considerable capacity for investment in housing, animals shelters, and pens, fencing of pastures, machinery, etc. accounting about 20 – 30 percent of their annual income (1999). The two households had about 3,000 and 1,000 mu (15 mu equal 1 hectare) or 18.9 percent and 13.1 percent respectively of their grassland fenced.
- Some of the young families, such as Mr. Suhe, have unnecessarily high investment in machinery, showing poorer planning ability as mentioned by the informants.

- Production expenditures were quite high, especially for young families with fewer livestock.
- Presenting gifts among relatives was a quite high proportion of living expenditures for herder households. Some households had high medical expenses, which often contributed to the lower wealth status of those households.

Overall, it can be concluded that about 50 percent of herder households in the *Gacha* have the means to significantly improve their grassland and animal system. But, information on the appropriate technological methods and management knowledge/skills are still missing, as they were 7 – 8 years ago. Besides these, it was also found that current grazing pressure was much more than the proper stocking rate identified in 1985 when grassland use rights were allocated. Considering the proposed fall sales of animals, the grazing pressure will be reduced. However it would still be much more than the proper stocking rate, the current one of which should be lower than the one identified in 1985, considering the grassland deterioration since then.

The trend in range conditions since 1993 was evaluated using time line analysis, and causes analyzed by key informants. It was found that although general conditions had fluctuated, it had mostly decreased. The conditions of livestock production and herder households' life were evaluated at the same time.

Situation analysis (by Mr. Da Alaha and Enkebayar on July 16, 2000)



Reasons for fluctuations and decreasing range conditions:

- Changes were mainly due to drought. The stocking rate would be not a problem if it rained during May to Aug, otherwise it would.
- Grasses in dry years cannot conserve rainwater. There is no longer pasture for hay. It was allocated to individuals (in the east part). Hay making is now done individually.

Livestock condition:

- Production performance has decreased somewhat (in fattening).

- Animal survival rate has increased due to the improvement of infrastructure and epidemic prevention (a kind of responsibility system is applied for the latter one).
- Livestock numbers have increased.

Living conditions of herder households was summarized as:

- Income and expenditures have increased (infrastructure construction and machinery in production, presenting gifts, etc.)
- Taxes and levies have increased.
- Workload basically remains the same as in 1993.

In terms of dealing with grassland deterioration, the herder households have taken measures to change the movement pattern. Compared with the seasonal movement pattern shown in the table with the seasonal calendar, it can be found that herders remain less time at their sedentary locations. Instead of staying at it until October with only 10 – 20 days of break during going *Aoter* from late of August to early September, those households with summer pasture return to their yurts at the middle of June on summer pasture. After going *Aoter*, the herder households move on to autumn pasture to graze their livestock until the middle of November when they move to winter pasture. It means the grazing pressure on the spring pasture where the sedentary house is located has been reduced.

It was also be found that although most of the herder households hire labor to look after the flocks of sheep and goats all year round, they are still busy at other activities that are the most important to their income generation. They themselves look after the flocks of ewes/female goats with lambs and kids in lambing season. They take care of cattle and horses all year round, including calving. They do all of the veterinary prevention for livestock and harvest of products such as cashmere and wool.

Following is a problem analysis made by group interviews, moderated by Li Ou on July 17, 2000. The main points are instructive to really understand more about the herder's daily life. It was found there was:

- A shortage of water
- Overgrazing
- Degraded grassland
- Lack of funds

- Lack of technology
- Lack of marketing channels
- Heavy burden of taxes and levies, exceeding the national regulation (5% of net annual income per capita).
- A few herder households hire people to look after their livestock rather than doing it by themselves although they have relatively few livestock.
- Herder's costs of boarding their school children in town (renting a house and school fees) are very high because they do not have a registered permanent residence in town. They like children to study in town to build a better academic foundation, especially in Han Chinese, mathematics, foreign language, etc.
- The quality of the school at *Sumu* is low, although the education law stipulates that elementary schooling should be carried out locally.
- The young (< 30 years old) have no skills for non-pastoralism work and they are low in education.

From the analysis made by the group of the informants, it was concluded that:

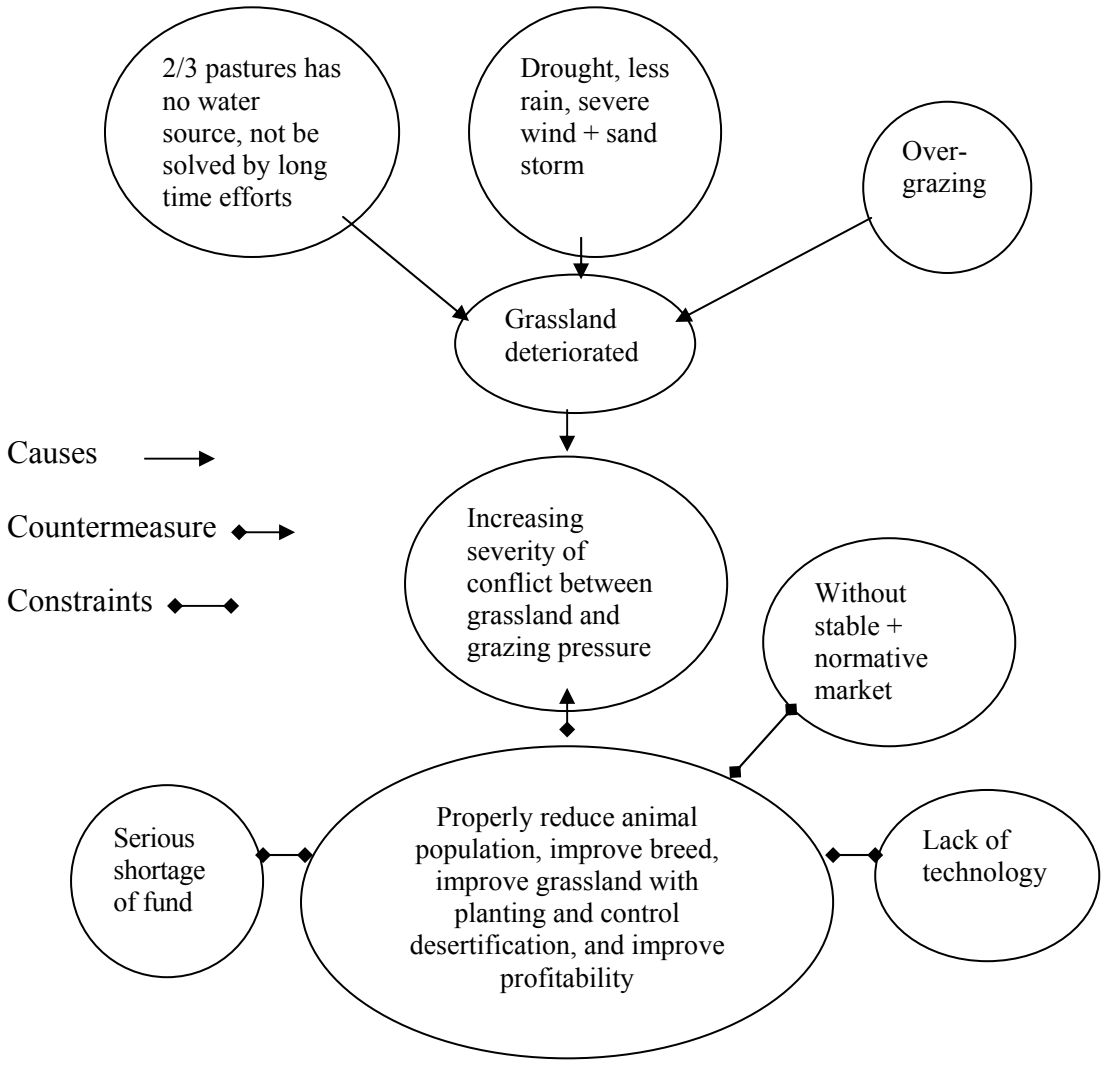
- The senior herders and former *Gacha* leaders were worried about the attitude and behavior changes of the young herders towards labor work, which might result in loss of Mongolian herders' culture.
- The Mongolian herders want their children get more education, and some of them find jobs outside the grassland area and pastoralism, an attitude that is in contradiction the attitude about culture loss. This is quite interesting considering that such cultural transition situations are happening all over the world in development situations are expected to increase as the west of China receives increased development priority.

From the above PRA results made in 2000, it can be concluded that:

- When the methods and tools of PRA are thoughtfully selected and systematically used, the current situation, problems, needs and countermeasures can be well defined and analyzed within a short time. The changes and differences in space and time, and among herder households could be easily and clearly found and from them better research and development planning can be organized.
- Mongolian herders are aware of the negative impacts of livestock over-populations on their grassland resources. But, livestock are their only source of income. Considering ever- increasing production and living expenditures, it will be difficult to reduce the number of livestock to the proper stocking rates too sharply and fast. Rather, alternatives should be found to meet additional income generation.

From the following causal diagramming, more awareness of the herders on the grassland deterioration and causes, and solutions can be found.

Problem analysis (by Mr. Danbi, Da Alaha and Batemengke, moderated by Li Ou)



- Mongolian herders have the ability and potential to analyze their problems and find solutions. Outsiders should facilitate the process, but not instruct them to do this and not to do that. PRA provides the approach and methodologies to the process. In this way, herders will hold a sense of ownership and commitment over the planning results and actions of the process.
- Considering all the relevant factors, some off-pastoralism activities might be alternatives to sustainable development of the grassland area and animal systems in the western area (including Inner Mongolia) of China. One of these is now evaluated.

Economics of Structural Changes in Development of Northern China's Beef Industry and Grazing LandS

A major concern of the Chinese government is how meat and other livestock products can be produced more efficiently. This translates to optimizing the amount of feedstuffs required to produce a given product. Alternatively, it means determining how more product can be produced with a given amount of input. Feedstuffs are the focus of this as they are the major limiting factor preventing transition from subsistence grazing to an integrated livestock production system on China's grasslands. The problem dealt with is evaluation of cattle feedlots as a substitution for grass fattening to slaughter weights.

Livestock production and pastoral systems in China are as varied and complex as the grazing areas are ecologically diverse. For example, a substantial portion of cows in all grassland areas are milked, used for draft and consumed for meat. In the pastoral grazing areas, herdsmen generally own both cattle and sheep. Furthermore, beef in China has traditionally been a by-product of draft animals rather than being a principal output of cattle. In 1996-98 there were 100 million head of cattle in China (called "yellow oxen" in China to differentiate them from buffalo, but including single purpose and dual purpose dairy cattle). About a quarter of China's beef and 40 percent of the lamb and mutton come from the grassland area. However, due to mechanization, greater reliance will be placed on rangelands as a source of beef cattle.

A critical factor for analysis of livestock, and grassland area production systems in China in particular, is that they are diverse -- and for very good reasons. There is no one solution to the so-called "pastoral problem" of relatively low offtake rates per hectare as well as overgrazing, but there are a number of viable, logical interventions that could result in considerable improvement in productivity. An unfortunate longer-term impact of overgrazing and the cropping of inappropriate areas is that despite commendable efforts, little scope exists for significant widespread rejuvenation of degraded grasslands due to relatively high cost, although much can be done to *prevent* further problems. In effect, the problem is of such massive proportions and rangeland productivity so low compared with agricultural areas, that massive investment alone is not the answer to greatly expanded red meat production from China's grasslands. These factors and details of the feasibility study reported on in this paper are found in Simpson and Ou's paper (1996).

There are a number of reasons for the low productivity of cattle in China, some of which can be overcome, while there is little possibility for changing others. Climate and land are factors over which humankind has little control and thus must adapt systems and management to

expand output. One way is to shift from a system in which cattle are raised to slaughter weight on grass (sometimes being sold at four to six years of age) to a cow/calf system in which calves are shipped to agricultural areas for fattening at weaning time. In this way the vagaries of climate, which lead to weight loss in the winter or during periods of drought, can at least be partially overcome. Stocking rates can only be reduced if some management mechanism is developed that allows offtake to remain the same or perhaps even expand when animal numbers are reduced. Therefore, there is need to design and implement systems that can accomplish that goal.

Most range grasses cure well and do not suffer great drops in protein content as happens in tropical and semi-tropical areas. Nevertheless, protein is short for much of the year whether livestock graze, are fed hay, or are provided crop residues. In other words, from the technical side, nutrition coupled with limited production, and most important winter feed, is the most serious constraint to expanded production. But, for a nutrition improvement program to be successful, there must be changes in production systems and in management as a whole.

Methods

A computer spreadsheet program based on standard economic enterprise budgeting procedures (Simpson 1988) was developed for this study. There are about 45 variables in the model, as shown in Table 4. These include economic units such as cost of minerals and price per kg for each class of cattle. Multiplication of these economic units times physical units provides totals for cost and income. These data reflect economic conditions in 1992. A second part of the model for a feedlot located near Beijing is based on data developed by researchers at Beijing Agricultural University as shown in Simpson et al. (1994).

Four analyses of the model grassland cattle operation are developed. There are two systems, each with a current typical operation quantitatively evaluated and an improved operation. One of the systems is based on the current practice of fattening cattle to slaughter weight on grass while the other one is a simulation in which weaned calves are shipped to feedlots. The objective is to determine if the improved system is economically viable and if it would be superior to the traditional system in terms of feedstuffs utilized.

Results, Cow/Calf Operation

The model breeding cow enterprise is based on 2,000 hectares (Table 4). The scale may seem rather large, but does reflect a situation of a larger producer or, as in the case study, a village in which smaller producers operate together. It is recognized that most producers in Inner Mongolia raise sheep as well as cattle. However, even though the two species are often grazed together, conceptually the cattle can be considered a separate

enterprise and the costs that pertain to them partitioned out and allocated to the cattle enterprise. In any event, there are relatively small economies of scale in cattle grazing so that the unit costs would not vary significantly regardless of the size. The parameters for the improved operations were determined by discussion with animal husbandry and range management specialists at Beijing Agricultural University and local specialists in Inner Mongolia as well as evaluation of existing operations by the authors. For example, in the current operation (based on the early 1990s) there was a 45 percent weaned calf crop and a 10 percent death loss of calves while the improved system embodies a 65 percent calf crop and a 5 percent progeny death loss. In the current operation fattened progeny are sold as 4-year olds while in the improved system they reach market as 3-year olds.

The current system assumes overstocking, with 220 animal units (AU) compared to an "ideal" or recommended carrying capacity of 200 AU. The improved system has 20 ha of improved land used to provide winter feed. The actual carrying capacity of 208 AU in the improved model is nearly equal to the optimal carrying capacity of 207 AU. The current alternative has 120 cows while the improved one only has 105 breeding cows. The difference in breeding cow numbers in the grass-fattening alternative is due to a greater number of progeny carried to slaughter weight in the improved operation.

Basic production costs (i.e., mainly cash costs) are greater in the improved system ($7,014 versus $4,076) due to added supplementation, labor cost, improved pasture, fuel, etc. But, much greater income leads to nearly double net income, $3,923 in the improved system compared with $2,068 in the current system when only basic production costs are considered. If all costs are taken into account including opportunity cost on capital invested, but with no charge to labor, there is negative net income of $846 in the improved operation which, while still a loss, is less than in the current operation ($1,404). Evaluation of worldwide beef operations indicates that very seldom are all costs covered (Simpson and Farris 1982).

The cost per kg produced is $0.30 for the current operation when only basic production costs are considered and $0.32 in the current system. These costs are not much higher than in similar areas of Canada and the United States; however, the cost in the drier cow/calf areas of Australia would be lower.

The second grassland system, results of which are provided in the 3rd and 4th columns of Table 3, represents a situation in which calves are shipped after weaning to a feedlot in the agriculture area. Two alternatives, also called current and improved, are analyzed. The current system rests on the basic production parameters in the grass fattening systems except that progeny are sold as weaned calves rather than fattened animals. There are 168 total breeding

cows in each alternative, substantially more than in the grass fattening alternative, because the only progeny held to the second year are replacement heifers. There are 88 calves sold in the improved alternative compared with 52 if the current production methods were continued. Net income to producers above basic production costs is $3,430 in the improved alternative compared to $2,123 in the low efficiency or current one. Production costs per kg produced are less than in the grass fattening system.

The net income of the improved operation in which calves are sold at weaning is 13% less than the improved grass-fattening alternative. The reason is that China does not have a beef grading system, feedlot fattening is still in its nascent stages and transportation costs of calves are high. Consequently, as in all countries where cattle are grass fattened, heavier animals sell for a higher price per kg than calves. Although the grass fattening is the higher income alternative in the improved model, the feedlot alternative produces more net income if current production methods were to be continued ($2,123 versus $2,068).

Results, Feedlot

The feedlot operation is modeled as a continuation of the weaned calf sales from the cow/calf operation. It is possible, for example, for herdsmen to own the feedlot in the crop area, or at least to retain ownership in the cattle while being fattened. Thus, the numbers purchased by the feedlot enterprise are based on 35 head from the cow/calf, current level of management and 52 head from the improved one (Table 4). There are two alternatives in the feedlot, calves from current and improved alternatives. Management, type feedstuffs, etc. is the same in both of them. However, because the calves from the current cow/calf operation are of a lower quality than in the improved cow/calf alternative, the average daily gain is lower (1.09 kg versus 1.15 kg). The weight into the lot (shrunk weight) is also less (134 kg versus 156 kg) although the weight at sale of 450 kg is the same. The result is that 290 days are required for cattle from the current management cow/calf operation compared with 255 days with the higher-grade cattle. Transportation cost is reflected in the difference between selling price of calves and purchase price. For example, in the improved system, transportation costs would be $0.13, the difference between $0.46/kg calf sale price in Inner Mongolia and $0.59/kg purchase price at the feedlot in the Beijing area.

The cost per kg sold is $0.61 for the higher-grade cattle versus $0.65 for the calves from the current cow calf operation. There is $16 net income from each head of the higher-grade cattle sold compared with $1 from the lower grade cattle.

Feedstuffs Utilization

One of the most dramatic parts of the analysis, and of particular interest for macro level planning, relates to a comparison of feedstuffs use as measured on an energy and protein basis. Results in Table 5 show that while 14,230 Mcal of metabolizable energy (ME) and 738 kg of crude protein are required per 4-year old male sold at slaughter weight in the current alternative, a feedlot fattened animal from the current alternative cow calf operation needs only 5,670 Mcal of ME and 371 kg of crude protein (CP). In the improved operation, only 5,410 Mcal of ME and 351 kg of CP are required. In effect, less than half as much ME and CP are required when the feedlot system is introduced. The ME and CP in the grass fattened operation are an accumulation of utilization by the calf as well as the amount attributable to each year of life. Grass fattened cattle in China gain during the summer months but then lose during the winter. The ME and CP are calculated dry matter based requirements for minimal growth. The feedlot ME and CP are based on dry matter based equivalents of feedstuffs consumed (Simpson et al. 1994).

Discussion and Conclusions

The economic and feedstuffs use models presented clearly indicate that considerable advances can be made in improving the efficiency of China's cattle industry. A shift to a cow/calf orientation would also free up some rangeland for renovation. Furthermore, although the analysis was done for cattle, the principles hold for sheep production as well. One conclusion is that feedlots are a viable alternative. However, use of them will take time to develop due to the need for improved transportation and communication systems and knowledge about management. Fed cattle prices are not particularly favorable for feedlot finishing but, as the economy develops and demand grows, prices will improve. Meantime, for wide adoption of feedlots, a number of market and institutional changes will be necessary. For example, sale price of slaughter cattle may be bid up to reflect higher quality, or cow/calf operators and feedlot operators might form joint ventures. In this type of business venture cow/calf operators would gain by selling calves rather than grass fattened animals. Another possibility is that advances might be made in feeding efficiency or in reducing feedstuffs cost in the feedlot.

Development of China's beef industry has to be evaluated from a micro as well as macro viewpoint. The micro, or producer-oriented analysis, indicates that a substantial increase in profitability could be obtained from an improved system, even when fattening on grass. Additionally, shipment of calves to feedlots is more profitable than the present grass fattening oriented system. Naturally, there are considerable differences among producers, part of which is

based on management and part on location. Some producers are so isolated that calf production will not be a viable alternative for many years. In other cases, where producers are located near rail lines or major roads, many of them could shift over to a cow/calf system if a viable marketing system were developed. To date, the rail, road and communication infrastructure has been inadequate to support the proposed feedlot system. But, rapid development of infrastructure is taking place and, by the end of the 1990s, is expected to be sufficiently adequate that some grassland producers could participate.

On the macro or national level, the analysis indicates that a substantial savings is possible in feedstuffs per kg of meat produced (on a protein and energy basis). Furthermore, there is an abundance of low quality roughage in farming areas such as rice and other straws as well as stovers such as maize residues, which can, and do, serve as a basis for feeding cattle. China has a very large program in farming areas for treatment of low quality roughages with ammonia and urea. This will expand with demand for higher quality feeds. Research has been carried out on feedlots, especially by Beijing Agricultural University and through the Food and Agriculture Organization of the United Nations (FAO) programs. The government has a self-sufficiency food policy that is oriented to importation of technology rather than feedstuffs or food. This policy, articulated through both tariff and non-tariff means, will stimulate development of the feedlot industry. Beef imports and exports about offset each other.

One impediment to development of a large-scale feedlot industry is knowledge, i.e. a technical problem. In general, capital is not a constraint, especially to villages and cities, which are already major owners of hog and chicken operations. However, lack of grading systems for live cattle and carcasses are major barriers, especially when considering tourist trade outlets. As incomes increase, quality aspects of carcasses via a grading system, especially those related to grain feeding, will have to be instituted for feedlots to really flourish.

Continual land tenure changes will be required which draw people from grassland areas to urban settings. The grasslands are overpopulated in the sense that expansion of holdings--and thus greater incomes--through size, scale economics and more sophisticated management requires human depopulation. An example of measures being taken is experimentation of land use rights sales in Anhui province (in central eastern China). The last impediment is need for a marketing program that will facilitate sales from grassland areas to crop areas. One innovation being experimented with at Beijing Agricultural University is a contract system in which cow/calf producers retain ownership of calves through the fattening process and/or a contract system.

Nationally, massive investments are being made in roads, the rail system and in communication services. It is not unrealistic to expect that within a decade a substantial number of former nomadic pastoralists will have telephones, television sets and indoor plumbing. In addition, rapid development in the economy is bringing about increased demand for meat. As the country mechanizes, the number of draft animals will decrease. Price relationships will develop so that the grasslands will slowly, but surely, be transformed from a production system in which cattle and sheep are raised to slaughter weight on grass, to one primarily oriented to a breeding system in which calves and excess lambs are shipped to farming areas for fattening.

Sustainable production of China's grazing lands -- and continued improvement of them -- means that in addition to programs related to livestock owners, infrastructure development such as roads, marketing channels and transportation mechanisms are critical. Massive programs are being carried out. If China continues the high rates of economic growth recorded over the past decade (8 - 12 percent annually), there will be potential for a profound impact on China's grazing lands.

Rapid and dramatic changes have taken place on China's grasslands in the past several decades as a very isolated, traditional lifestyle has been transformed to one heavily oriented toward a market economy. The case study presented in this article is representative of the changes that have taken place. There are, of course, differences between regions in terms of integration with the market economy and in the degree to which the production system has been transformed from nomadic to semi-nomadic. Nevertheless, the panorama described does accurately portray the sweeping changes that have taken place.

The transformation that has taken place, and will continue to take place, is nothing short of revolutionary. Furthermore, as national infrastructure is developed there will be increased use of the whole plethora of viable production and marketing technologies now available that can easily be adapted to the herdsmen's needs. We do lament the passing of an era, the demise of an entire subculture that spawned the great Genghus Kahn and led to the Yuan Dynasty that ruled China for 97 years, from 1271 to 1368. The trade-off is development of a low cost, efficient supply of beef, lamb, mutton and wool as well as improvement of the ecology at the national level and increased income, leisure time and greater economic security for herdsmen on China's grasslands at the micro level. Not documented in detail here, but particularly striking, were the women's narratives which evolved during the field work, which indicate that few of them would return to those earlier days.

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Table 4. Economic and feedstuffs use analysis for grass fattening versus selling calves to a feedlot, China, 1992.

Parameters and results	Grass fattening		Calves to feedlot	
	Current	Improved	Current	Improved
		Cow calf operation		
Total animal units				
Potential (AU)	200	207	200	207
Actual (AU)	220	208	208	208
Total breeding cows (Hd)	120	105	168	168
Total, basic prod costs ($)	4,076	7,014	3,886	7,002
Total, all costs ($)	7,547	11,782	7,592	11,785
Sale price				
Grass fattened				
3-year old males ($/Kg)	0.55	0.57		
4-year old males ($/Kg)	0.55	0.57		
Calves to feedlot ($/Kg)			0.46	0.49
Total income ($)	6,144	10,937	6,009	10,432
Net income above				
Basic prod cost ($)	2,068	3,923	2,123	3,430
All costs ($)	(1,404)	(846)	(1,583)	(1,352)
Cost per kg produced (a)				
Basic prod cost ($/kg)	0.30	0.32	0.19	0.26
All costs ($/kg	0.72	0.62	0.67	0.58
Kilos of cattle produced/ha				
Non reproductive cattle (Kg)	4.1	8.1	3.9	7.5
All animals marketed (Kg)	6.1	10.2	6.9	11.1
		Feedlot operation		
Net income per head sold ($/kg)			1.41	15.59
Cost per kg sold ($/kg)			0.65	0.61
Cost per kg sold ($/kg)			0.92	0.94
Cost per head sold ($)			292	276
Breakeven price on				
Purchase, feeder cattle ($/kg)			0.47	0.58
Sale of finished cattle ($/kg)			0.62	0.59

Source: Author's fieldwork. Results are summary from computer program.
(a) Heifers and male calves or fattened males only.

Table 5. Metabolizable energy and crude protein per head sold.

Parameters and results	Grass fattening		Calves to feedlot	
	Current	Improved	Current	Improved
	Cow calf operation			
ME/Hd finished to slaughter weight				
Grass finished		13,320		
3-year old males (Mcal)	14,230			
4-year old males (Mcal)			5,670	5,410
Feedlot finished (Mcal)				
CP/Hd finished to slaughter weight				
Grass finished		730		
3-year old males (Kg)	738			
4-year old males (Kg)			371	351
Feedlot finished (Kg)				

Source: Author's fieldwork. Results are summary from computer program.