Management Changes and Strategies to Improve the Environmental Services from Grasslands in Northern China and Mongolia

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Abstract
The grasslands of Mongolia and northern China are part of the vast Eurasian grasslands that extend from east Asia to eastern Europe, with many common problems. Grassland degradation and herder livelihoods in the steppe regions of China and Mongolia are widely acknowledged as major issues that need to be improved. The core problem is too many animals are now grazing grasslands, initially driven by significant policy changes, and decisions that assumed more animals would lift herder incomes. Problems are accentuated by poorly defined property rights over the land. The effectiveness of current Government Programs aimed at reducing grazing pressures has been questioned, especially for their ability to deliver better environmental outcomes without impacting herder livelihoods. This panel session examines ways to understand the opportunities for improvement of grasslands. This first paper outlines some general aspects of the pastoral sectors, and management responses and strategies that can improve the services from grasslands.

Introduction
Since 1950 the average stocking rate in sheep units in China has risen four-fold, while in Mongolia total sheep units have doubled since 1990 (Brown 2020, Chapter 3; Kemp 2020, Chapter 2). The increase in livestock numbers has followed major changes in Government and the belief that increasing animal numbers will increase herder household incomes, but that had major deleterious effects on grasslands increasing the proportion of less-desirable plant species and reducing plant and per head animal productivity (Kemp 2020, papers in this session). In China, 90% of the grasslands have been regarded as degraded (Kemp & Michalk, 2011) while in Mongolia the problem is less, but significant in central regions, especially near towns and the city (Densambuu 2018). Both countries now have policies designed to rehabilitate the grasslands that focus on improving the environmental services from grasslands as well as improving herder household incomes. The aims of this paper are to introduce the issues influencing the condition of grasslands of northern China and Mongolia and the solutions investigated to improve them (Kemp et al. 2013). As discussed here, management changes can help livestock system changes move in desirable directions, but there is the need for Government intervention to augment those changes to achieve grassland environmental goals. Other papers in this panel session will then deal in more detail with policy investigations designed to improve environmental services.

Environment
The main grassland areas of China (~400m ha) and Mongolia (~130m ha) are in cold temperate regions. Around two-thirds of the annual precipitation (50-500mm) occurs over summer when temperatures are above freezing. Temperatures vary from 30-40°C in summer to -40°C or less in winter, and altitudes from 1000-4500m. Snow falls do occur through winter and in some years, these are heavy enough to prevent grazing of the limited, poor quality frosted grass. As animals normally lose 20-30% of their liveweight through the 8-9 months of cold weather, their mortality can be high during snow falls. Heavy snow falls often follow a summer where grass growth was poor. In Mongolia, this is one form of a *dzud,* where in recent times half the animals in the country have died. In China, warm sheds are now widely used to help protect animals in winter and the use of improved fodder supplements is more widespread, along with other management changes that have improved animal productivity (Kemp 2020, Chapter 3). In Mongolia, livestock remain outside through winter, spending the nights in open-air shelters; meagre supplements are only given to animals that are young or obviously sick.

Early responses
In Inner Mongolia, the main grassland province in China, the initial response to grassland degradation was to impose five-year grazing bans in the 2000s; 70m ha were progressively closed to grazing. This followed the allocation of individual household user rights in the 1990s, to specified land areas to replace the traditional

transhumant systems. Livestock numbers rapidly increased after herders were allocated user rights. The grazing bans did not work very well as 'night' grazing then occurred (to avoid detection). There was often no clear evidence that the state of the grassland had improved (less-desirable species still dominated) and after the ban stocking rates resumed at the former high levels. It has been evident that any changes in grassland condition often take much longer than five years (Kemp & Michalk 2011). Herders received a small payment to not graze, but the same rate was paid per hectare irrespective of the type of grassland (desert to meadow or alpine). These policies were revised in 2011 to include reducing stocking rates, imposing a grazing ban in early summer to enable better whole of season growth and variable subsidy rates based on local plans and conditions; though acceptance of these policies among herders is uncertain. In Mongolia, a number of Government and non-Government initiatives have been developed, such as an insurance scheme for *dzuds*, and the formation of *pasture user groups*, where local herders work collectively to decide when and where to allow grazing. However, in both countries there is concern that the goal of improving grassland condition and the environmental services from grasslands is not being achieved at the rate desired (Brown 2020, Chapter 1).

What management changes help?

The improvement of grassland condition in China and Mongolia is seen as requiring various changes in livestock and grassland management, and in Government policy, to ensure that herder households are not disadvantaged. The policy options are dealt with more in other papers in this session, here we deal with some examples of how changing management practices can contribute to better environmental outcomes.

The doubling of animal numbers in China, since the introduction of household user rights in grassland areas, does suggest that the target in livestock reductions needs to be about 50%, as prior to that rapid rise the grasslands were considered to be in reasonable condition (Kemp 2020, Chapter 2). Initial modelling found that a 50% reduction in livestock numbers actually increased net household incomes (Kemp & Michalk 2011). That then reduced grazing pressures and enabled some recovery in grassland condition. Grazing experiments (Kemp 2020, Chapters 8, 9, 10) found that the botanical composition of grasslands and herbage mass were in a more desirable state when stocking rates were reduced by 50% from the district average. This also meant the optimal consumption rate of grassland was only half that promoted by the Animal Husbandry Bureaux in China. For example, the optimal average consumption rate by sheep for the desert steppe grasslands (250mm, 1 t DM/ha, Kemp 2020, Chapter 8) was only 10%, while for the typical steppe (350mm, 3t DM/ha, Zhang *et al.* 2015) the optimal consumption rate was 20%. Consumption rates are the estimated amount eaten by a standard 50kg sheep which is generally about half the estimates of 'utilisation' derived from the herbage mass differences inside and outside a cage. The modelling and experiment evidence was then tested and shown to be viable in farm demonstrations (Figure 1, Kemp & Michalk 2011).

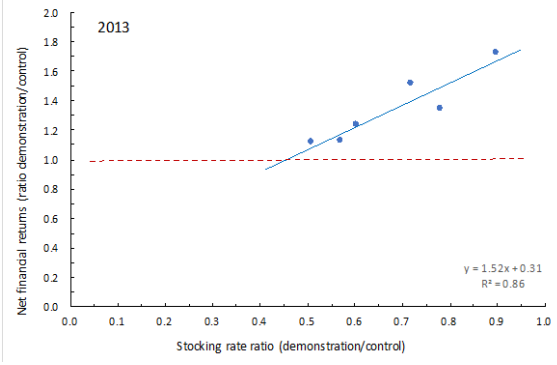

Figure 1. Average ratio of net income for demonstration / control farms (six villages) in relation to the ratio of stocking rates for demonstration/control farms in 2012/13. The horizontal dashed line shows where the net income of demonstration and control farms were equal.

These demonstrations combined improved feeding of supplements through winter (meadow hay, silage, grain; though not to optimal levels) while reducing animal numbers. They showed that net financial returns would be higher than controls at higher stocking rates, but if Government policies are to improve the grasslands, stocking rate reductions down to 50% did not result in any reduction in net household returns. Some incentives are needed so that herders do reduce stocking rates on the grassland. In the demonstration farms, those with apparent higher stocking rates, actually kept their animals more in sheds and did reduce their grazing, hence the reduction in grazing pressure was greater than Figure 1 would imply. Unfortunately, it wasn't possible to accurately estimate that grazing pressure reduction.

Other modelling showed that the better way to reduce animal numbers, was to cull the least productive animals. Herders do not normally do this, they let traders select the animals they wish to buy. Simply culling unproductive animals often achieved a 50% reduction in animal numbers and an increase in net incomes (Kemp & Michalk 2011). The feed requirements of animals could also be better managed by changing lambing / calving times to late spring. This was initially shown with models, then tested on demonstration farms, and is now a practice being implemented in some districts; herders are given a payment to participate in this change.

A further change in China, arising from herders being given responsibility for specific areas of land, is that some herders now rent their land to others. Those renting the land then often obtain a similar net income to what they achieved with livestock. The remaining herders then have larger areas of land and the larger the land area the lower the average stocking rate (Figure 2). This effect is driven by herders having a desired number of animals, rather than a desire to have a constant stocking rate across all the land they use (Kemp 2020, Chapter 5). While this seems to be a desirable trend, the problem has emerged that any rented land tends to be used for grazing in summer and generally that is being over-grazed, while the herders 'own' land is kept for winter, has limited grazing in summer and is generally now in better condition.

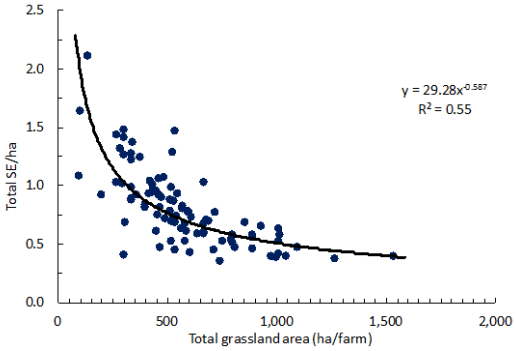

Figure 2. Relationship between stocking rate and farm size for 93 households on the desert steppe in Inner Mongolia

Changes in markets in China, have meant that herders can now obtain higher prices for animals with greater quantity and quality of meat per head, achieving a desired level of income with moderate numbers of animals. In the desert steppe area of Inner Mongolia, in 2012/13, herders considered about 400 sheep were enough to have a good income, whereas across the border in Mongolia on the same grassland, herders needed 1000 sheep, to make the same income due to poorer market prices. Poor market prices add to the grazing pressure on grasslands.

In Mongolia where common grazing is practised, the areas grazed in summer tend to be overgrazed as many herders congregate there, especially around waterpoints. In winter herders have the option of registering a winter shelter for their use, which then provides informal grazing rights to the registered herder, helping to lower the grazing pressure, especially where local officials specify a minimum distance between camps. At this stage, not all herders take up the option of registering a winter grazing area, though the benefits are noticeable. These results also highlight the point that herders think about stocking rate in terms of the total number of animals they wish to have (Kemp 2020, Chapter 5) rather than number per hectare.

Non-Mongolian government organisations have heavily invested in the establishment of Pasture User Groups (PUGs) as a mechanism to improve grassland management (Densambuu 2018). Within target districts, grasslands are mapped and facilitation and financial support provided to local herders to encourage group decision-making around grazing. The nature and role, of local pasture user groups in pastureland governance is complex and contested (see Upton 2020) but early research suggests that where active PUGs have been established, they have provided significant social benefits (Fernandez-Gimenez et al. 2015, Ulambayar et al. 2017). An important social benefit is *dzud* resilience; PUG herders can have greater adaptive capacity than non-PUG herders, linking social capital and greater access and exchange of information and knowledge (Fernandez-Gimenez et al. 2015). Mixed grassland condition benefits have been noted in more productive steppe regions (Angerer et al. 2015, Reid et al. 2015) although benefits have not been found in desert steppe regions (Addison et al 2013, Angerer et al. 2015) possibly because in drier regions it will take some years for benefits to be evident (Kemp & Michalk 2011). Irrespective of their impact on grassland condition to date, pasture user groups may provide a pragmatic governance mechanism for targeting the changes in management needed to improve ecosystem services (Upton 2020).

To survive the cold winters, warm sheds have been introduced across China. These sheds vary from modified shelters through to new purpose built sheds. Often half the roof is plastic or glass and some have heating stoves. In effect, the sheds partially replace the lack of fodder which helps to reduce the rate of weight loss through the long cold season. Herders have noted that animals kept in these sheds lose less weight than those taken out to graze each day. Animal weight loss can occur from 5°C and below, reflecting the poor quality and quantity of fodder available (Kemp 2020, Chapter 3). In general Government programs are needed to fund adequate sheds as herders are continually in debt to provide household needs. Removing animals from grazing in winter does result in better outcomes for the grassland (Kemp 2020, Chapter 8). In Mongolia only open shelters, with dung on the ground to provide some insulation, are available for most of the livestock. These shelters only reduce some wind chill.

Discussion

Herder livestock and grassland management practices are changing in both Mongolia and China, in response to changing socio-economic conditions, to markets and to the recognition that the grassland condition has

degraded to varying degrees, below the state desired. Herders can do things, as shown here, that are financially viable and provide the opportunity to improve the environmental services provided by grasslands. Government policies need to build upon practices that develop efficient, viable, grassland management practices that improve household incomes, and rehabilitate grasslands under lower stocking rates.

Lower stocking rates does not necessarily mean less animals. A better practice can be to manage grazing pressures on the grassland by monitoring herbage mass. The implications from the work done to date are that grazing in summer should not start until the herbage mass is above a critical value and that critical value should be used to decide when to move animals to new grazing areas through summer and early autumn (Kemp et al, 2018). Waiting until the condition of animals is visibly declining before moving them, usually means that the grassland gets overgrazed. For each of the main grassland types it is important to decide on the critical values for herbage mass below which grazing should not continue (Kemp 2020, Chapter 10). Grazing in winter can damage the grassland, restricting growth in the next summer (Kemp 2020, Chapter 8) and animals are better kept in warm sheds.

To achieve better grassland environmental outcomes, there needs to be a willingness to pay, but as shown (Brown 2020, Chapter 8) the extent that herders will respond to various programs is not always as great as the grasslands require. Later papers in this panel session will demonstrate more detail on the options. The strategies discussed in this session are preferable to the direct regulation of livestock numbers.

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