Livestock Production from Grasslands with Improved Management Compared to Traditional Management

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ABSTRACT

The value of traditional versus improved management systems for grassland is discussed. The set target is the persistence of the ecological, economic and social multifunctionality of grasslands and the increase of food output from these areas without increasing parallel requirements for arable crop or energy inputs. Based on the fact that historically traditional systems were stable and sustainable in many cases, while severe damage is faced nowadays, it is argued that lot of improvement should be based on the acknowledgment of successful traditional practises. The challenge might rather be to define improvement as a contemporary development of traditional techniques. The specific role of human labour in the context of grassland management appears to be a key question. Regarding management measures, intensive management of grazing as well as forage conservation are particularly important and require efforts in research and development.

Keywords: Feed conservation, Grassland management, Herding, Human labour, Transhumance

Introduction

The global grasslands, which make up approximately two-thirds of worldwide agricultural areas (O'Mara, 2012; FAOSTAT, 2013), provide a broad range of functions (Boval and Dixon, 2012), which may contribute partial solutions to key contemporary global challenges. Most important appear to be the contributions to the ecological equilibriums and to food security. Three main functions are: a) the high biodiversity of flora and fauna in many grassland ecosystems (Rook and Tallowin, 2003; Hadjigeorgiou *et al*., 2005; O'Mara, 2012), b) the particularly high actual and potential climate-relevant carbon sink (O'Mara, 2012; Taube *et al.,* 2014), and c) the considerable source of high-value animal products, which grasslands provide, if they are efficiently exploited with herbivore production systems (O'Mara, 2012; Boval and Dixon, 2012; Leiber *et al*., 2014).

Nonetheless, grassland systems are globally severely threatened and their area is continuously decreasing by very different reasons. With the loss of intact grasslands, the main above mentioned functions are lost as well. Three main reasons for the loss of grasslands are a) abandonment followed by encroachment with shrubs and trees, b) overstocking with too high animal numbers and inadequate grazing management, and c) conversion to arable land (Taube *et al.,* 2014; Shang *et al*., 2014). All mentioned reasons are related to management, thus underlining its importance for sustaining the multiple grassland functions.

Abandonment is a very frequent phenomenon for example in different European regions, where labour for animal management became too expansive and merely attractive because grasslands are too remote, too steep, or soils are too poor for efficient production

within the framework of contemporary food economics. Examples are many of the European mountain regions like the Alps and the Balkan, but also large parts of western Russia and Ukraine or other former Soviet countries (Brinkert, 2012; Prischchepov *et al.*, 2013) where soils are poor and intensive migration into the cities took place. Enormous amounts of hectares of grassland as well as arable land have been lost within these regions during the past two decades. This is not always (Baur *et al.*, 2007) but often followed by encroachment and losses of floral and faunal biodiversity (Sarateanu *et al.*, 2009; Brinkert, 2012; Koch *et al.*, 2015).

Overstocking is a main problem in the large Chinese grasslands of the Tibetan plateau (Shang *et al.*, 2014) and the Inner Mongolia (Briske *et al.*, 2015). A complex interaction of traditional, political and sociological driving forces caused a dramatic increase of households and animals in these regions. Globally, too high grazing pressure is also a problem in other grassland regions. The first consequence can be loss of biodiversity (Baur *et al.*, 2007), followed by sward damages and soil erosion (Shang *et al.*, 2014).

Conversion into arable land takes place globally, wherever efficient cultivation is possible. Drivers can be of clear economical nature but also politically induced, for instance in Germany, where the introduction of subsidies for maize silage for biogas production significantly fostered the conversion of grassland to cropland (Taube *et al.*, 2014).

All the mentioned changes in grassland utilization affect its important ecological functions: too intensive as well as too extensive exploitation of grasslands lead to decreases in biodiversity (Mikhailova *et al.*, 2000; Hadjigeorgiou *et al.*, 2005; Fraser *et al.*, 2015); and in particular land use change towards arable utilization causes high releases of carbon stocks from the soils Vellinga and Hoving, 2011). A major issue of concern should be, however, the loss of very large sources for animal products, which could be produced without competition to crop food (Wilkinson, 2011) if grasslands would be properly utilized. Taking the Chinese example, the demand for meat products in this country is continuously growing (FAOSTAT, 2013). However, from the large grassland areas in the west and the north only very small amounts of ruminant meat reach the markets in the large cities (Shang *et al.*, 2014). As a further example, also the landscapes of north-western Russia are capable to produce large amounts of ruminant products – an opportunity which is going to be lost in near future.

The significant contemporary loss of these important functions of grasslands – which is happening rather than any increase – should give reason to reflect about the meaning of "improved management" compared to "traditional management", the latter including those forms of management under which the grasslands with their mentioned values developed.

The main question of this paper will be, how an optimum of grassland production intensity can be reached, which would maintain ecological values and at the same time increase the output of food. This question will be discussed regarding the potentials and constraints of both, traditional and modern ("improved") management approaches. Such a discussion also requires a reflection on terms like "improvement", "efficiency" and "intensification".

Traditions and improvements; Gains and losses

Grasslands are in many cases being grazed by livestock for very long timespans (Hadjigeorgiou, 2011; Shang *et al.,* 2014), thus they may be considered as cultural land in the full sense. This implies that the high biodiversity which is found in many of these landscapes (Long *et al.,* 1999; Mikhailova *et al.,* 2000; Baur *et al.,* 2007; Willems *et al.,* 2014), as well as other ecological functions are a result of long-term landscape-livestock interactions, which were always driven by various kinds of man-made grazing management. Biodiversity, soil stability and general sustainability of the systems must have been the basis for and result of grassland-based herding cultures which developed and sustained for centuries in different areas of the world. Taking into account the fast dynamics of grassland degradation which are happening in the recent decades (Hadjigeorgiou *et al.,* 2005; Shang *et al.,* 2014), it should be acknowledged how stable the systems must have been in the past leading to the fact of grassland existence and persistence at all. Thus, contrasting "traditional" with "improved" grassland management appears problematic. Rather, the positive aspects of both approaches need to be understood and combined in order to realise sustainable grassland management.

Grazing management

It appears obvious that as well too high as too low grazing pressure or production intensity impairs ecological and productive functions of grasslands (Hadjigeorgiou *et al.,* 2005; Baur *et al.*, 2007; O'Mara, 2012; Fraser *et al.*, 2015). The different aims of grazing management are a) optimal exploitation of the plant nutrient resources by the grazing animals, b) persistence of plant communities with high nutritive value, c) control of plants with low or no nutritive value, d) preservation and improvement of soil structures and soil fertility, and e) preservation of ecological functions of biodiversity. Some of these goals seem to be contradictory, for instance the highest nutrient density will be found in young regrowth, while persistence of plant communities needs reproduction, i.e. full ripening of the plants. An efficient method to achieve both seems to be the alteration of dense stocking on young grasses followed by a resting period for the pasture during which plants can flower and reproduce. Dense stocking further guarantees that the animals graze also unwanted plants and that urine and faeces are well distributed in the area grazed. Being only a short time at one place, animals will not destroy the sward and soil too much by trampling. It appears that the temporal alteration of very high (but short) stocking with resting of the land provides good conditions for a sustainable grassland development. This is, what traditional grassland exploitation does, which was/is very often nomadic, transhumant and/or herded (Bätzing, 2003, Hadjigeorgiou, 2011; Shang *et al.,* 2014). Passing through a landscape with a herd or flock of animals means continuously moving but at the same time keeping the animals densely together.

Traditional grassland utilization is/was very often based on permanent man-guided movement through landscapes in nomadic or transhumant systems or in herded livestock management (e.g. Bätzing, 2003; Hadjigeorgiou, 2011; Shang *et al.,* 2014). Often, a combination of such systems can be found. For example the traditional transhumant system in the Swiss alps comprised three main movements of the livestock during the season: the first movement from the valleys to pastures at altitudes of about 1500m a.s.l. in spring, then, the movement to the alpine summer pastures

(2000-3500 m a.s.l.) and finally the movement back to the valley villages in early autumn. During the stays at different altitudes, the animals were intensively herded, especially the dairy ruminants. The profession of the herder included knowledge about the various specific sward qualities and vegetation dynamics and the cows or goats were continuously moved in order to graze optimal mixtures of high and low quality swards and to graze every pasture at the right moment. The relationship between grass quality and milk quality and yield was highly acknowledged, in particular with respect to cheese making. The traditional Swiss transhumant system appears to be a very clear example of a system with high social, ecological and productive stability. It has to be acknowledged that the sophisticated herding systems were labour-intensive, and this is one of the main reasons why they are changing with increasing dynamics during the past few decades. Labour became too expansive, and the attractiveness of the herder's job significantly decreased on the background of the globalised and technically developed world.

In Switzerland, a comparably popular alternative form of alpine pasture exploitation instead of dairy cow systems became keeping of suckler cows for beef production. To save labour, these herds are no longer herded but rather kept free ranging in large areas. An important consequence, however, is that through the diurnal and spatial behaviour of the cattle and the distribution of eating and resting places, a significant reallocation of nutrients occurs (Jewell *et al.,* 2007) which leads to changes in botanical composition and loss of the overall ecological and nutritional quality of the pastures. This negative effect had been avoided by herding, formerly. Also in contemporary systems intensive pasture management improves swards, efficiency and sustainability (Kuusela and Khalili, 2002; Abrahamse *et al.,* 2008; O'Mara, 2012; Willems *et al.,* 2013).

Regular and frequent cutting

In Inner Mongolia, the sward improving effect of at least a biannual cut of the swards has been experimentally proven (Schönbach *et al.,* 2011). Cutting is, however, not part of the local traditions. In the regions of western Russia and Ukraine often a tradition is met (of which is unclear whether or not it goes back to pre-soviet times) to cut the swards once in the later summer (mid of July). It is based on specific traditional organisation of labour, but also on the conviction "the more biomass the better". The resulting hay is highly lignified and of low digestibility. To balance for the poor nutritional value of these roughages, often high amounts of grain are fed to the ruminants. It is obvious that earlier mowing would result in higher quality hay and would allow for a second cut in late summer, thus improving the quantity and quality of forage and the productivity of the grassland. Mowing appears as a technique which can contribute to ecological stability and the productivity if it is applied at all and in the right frequency (Mikhailova *et al.,* 2000).

Feed conservation

An important improvement, which appears to be urgently needed in some "traditional" grassland systems, is forage conservation. Such techniques are the basis of other traditional systems under comparable conditions. One example is conservation of forages for the winter in transhumant systems. In the European Alps this is the backbone of the transhumant system: during summer, when livestock is grazing the alpine pastures, herded by specialised herdsmen, the farmers stay in their villages preparing hay and silages from the highly fertile lowland fields. This is

the basis for productivity and animal health during winter. Under comparable natural conditions, in the Tibetan Plateau, a similar transhumant dynamic is present. Here the whole family moves in a semi-nomadic way, and valley swards are not mowed during summer. They are kept growing to provide winter pasture for the yaks, which is then, however highly lignified and very poor in degradable nutrients. The consequences are severe weight losses of the animals during winter time (Shang *et al.,* 2014), in other words a negative productivity. It might be expected that a mid-summer cut of the valley swards would produce hay with comparably high protein and sugar contents. Additionally the regrowth could be used as winter pasture as well. Although less biomass might be expected for that winter pasture, its nutritive quality would probably be higher due to younger grass. A similar example are the cattle ranches in the Bolivian Chaco, where part of the population is not conserving feed during the rainy season and later facing problems of animal starvation and wood damage during the dry season, while the Mennonite minority is producing hay, successfully. These two examples show that the potential "improved management" in one traditional system well may be similar to the "traditional management" of another.

Intensification and the value of labour

Intensification may be defined as increase of output per unit of land or labour (Oenema *et al.,* 2014). Measures to reach the increase of output may be fertilization (nutrients can be imported in form of mineral N or in form of grain concentrate supplements to the grazing animals), genetic improvement of forage plants (O'Mara, 2012; Boval and Dixon, 2012) and, again, intensified and improved grazing management, which could be in future also based on systems like GIS-mapped precision farming (Leiber *et al.,* 2014). It appears to be appropriate in this context to distinguish between increased material/biological inputs like fertilizers or genetically improved grass species (often requiring higher nutrient inputs) or inputs of logistics, better adapted techniques and, anyway, labour. As has been indicated above the traditional systems relied on labour and logistics – improving these aspects with appropriate technical solutions would strengthen the typical characteristics of grassland management. Increasing material and biological inputs, however, may easily disturb the ecological and productive equilibriums of grassland systems. Further, if intensification requires external inputs (e.g. fertilizers or concentrates) in large amounts, the specific potential contribution of grasslands to provide human edible animal source food without competition about arable land (Wilkinson, 2011), may be reduced. In this respect, ecological and economical trade-offs of intensification have to be carefully defined, not only on the basis of higher outputs per area and labour unit.

The specific role of labour in this context remains to be discussed. The multifunctional characteristics of grasslands require and generate labour (Boval and Dixon, 2012). Oenema *et al.,* (2014) define intensification as increased output per area unit or per labour unit. The consequence of this kind of equation is often that the input of labour (and the input of less productive areas) has to be reduced, while outputs have to be maximised in order to gain a positive result. What seems to be a particular difference between traditional and improved systems is the aim to increase labour-efficiency which equals the reduction of labour within the systems. But, as the provided examples should indicate, a lot of the traditional systems' stability relied on labour, and it is by far not in all grassland systems

possible to replace the lack of human labour by higher inputs of other kind. The paradigm of labour-efficiency makes labour a factor that has to be decreased. In a global situation of huge rates of unemployment this situation appears to be rather paradox. Here, a key question has to be placed: how to achieve within in the contemporary economic systems the possibility that human labour as a central input to sustainable systems can be continued and saved from replacement.

Conclusions

Grasslands are a global multifunctional resource of enormous value. The utilisation systems which were often stable for centuries are getting increasingly imbalanced with the consequence that key grassland functions are damaged or lost. Keeping in mind that historically grasslands *developed* which are nowadays *lost*, a simple model of modern improvement versus ancient traditions appears to be inappropriate. Rather, many important aspects of traditional grassland management should be highlighted and adopted in order to develop sustainable contemporary grassland management. One particularly important aspect appears to be the high requirement for human labour, which is a specific challenge in the contemporary global economic frameworks. Regional solutions for grazing management and feed conservation require particular efforts in future research and development.

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