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Grazing systems expansion and intensification: Drivers, dynamics, and trade-offs

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ABSTRACT

Grazing systems dynamics are driven by a complex combination of socio-economic, political and environmental contexts. Although the drivers and dynamics can be highly location-specific, we focus on describing global trends as well as trends by agro-ecological, socio-economic and political contexts. Global grasslands have expanded in area over the last decades. A decreasing trend has however been observed since the 21st century. Grazing systems' management has also intensified. While these dynamics can have socio-economic and environmental benefits, they have often led to unsustainable systems, exemplified by deforestation and land degradation. Opportunities for land expansion without damaging forests and natural ecosystems are increasingly limited around the world and future increases in grazing systems production will need to mainly come from increases in productivity per animal and per unit area. We highlight some priority research areas and issues for policy makers to consider to help the movement towards more sustainable systems.

1. Introduction

The livestock sector is a high priority on the global policy agenda. The increase in human population from about 3 billion in 1960 to 7.3 billion in 2015 (UN, 1961; UN DESA, 2015), together with shifting dietary preferences and rapidly increasing incomes in emerging economies (Delgado et al., 1999), has placed an unprecedented demand on livestock products. This demand is projected to increase in the future, with a projected + 44% and + 55% more demand for ruminant meat and milk by 2030 compared to 2000, exceeding expected population growth (34%) and mainly due to dietary shifts in emerging countries (Havlík et al., 2014).

Increases in livestock production have been occurring in most parts of the world. In the past 30 years, world production of ruminant meat and milk has increased by about 43% and 55%, respectively (FAO, 2016a, period 1983–2013).

Livestock production increases in grazing systems come both from grazing land expansion and from intensification. These expansion and intensification dynamics can place pressures on the environment and compete for land with other uses (e.g. croplands, energy production, forests, urban areas), requiring socio-economic and environmental trade-offs to be made (Smith et al., 2010).

Considering the rapidity of the changes in global livestock demand and production, the large spatial extent of grazing systems (22% of the Earth's ice-free land surface is under permanent pastures, Ramankutty et al., 2008), as well as the impact of grazing systems dynamics on our society and the environment, there is an urgent need to influence the drivers of grazing systems dynamics to support more sustainable systems.

The aims of this review, whose framework is presented in Fig. 1, are 1) to identify the different drivers of grazing systems expansion and intensification around the world and their interactions with agro-ecological characteristics, 2) detail the recent past and projected future main dynamics of these systems in relation to their drivers, 3) assess some of the environmental consequences of these dynamics and 3) discuss priority research areas and issues for policy makers to consider.

While grazing systems are very diverse, ranging from nomadic pastoral activities in sub-Saharan native savannas to sedentary Dutch dairy farming on fertilised sown pastures, in this paper, we aim to describe major trends around the world, and do so by developing a grazing systems typology based on socio-economic, political and

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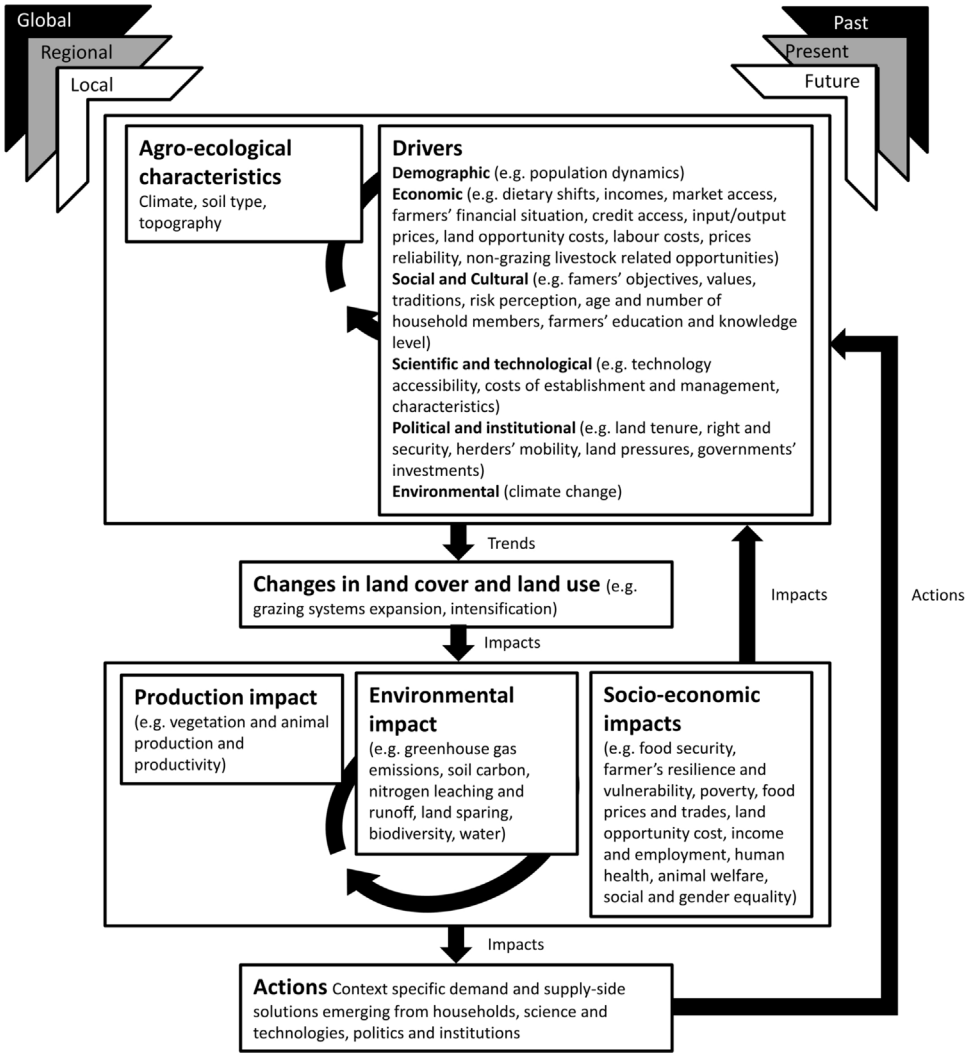

Fig. 1. Conceptual framework for studying the dynamics of grazing systems.

institutional contexts. The drivers of change must be put in the overarching agro-ecological characteristics (climate, soil type, topography) that shape and influence grazing systems dynamics by constraining the potential for production. They are not considered as drivers per se as they are rather stable factors (not withstanding future climate changes).

2. Drivers of change

Grazing systems dynamics are driven by a combination of interconnected and dynamic factors -demographic, economic, scientific and technological, cultural and social as well as political, institutional and environmental. These drivers emerge at local, regional and global scales and differ largely among regions, villages and households. Some are demand-side (or consumption-side) drivers as they place demand on agriculture to supply food (2.1.1). Others are supply-side drivers and refer to the production and availability of livestock products. This section aims to provide a general overview of drivers as well as of agro-ecological characteristics that trigger grazing systems dynamics. Indeed, their good understanding is essential to comprehend the past and project future changes in land cover and land use as well as to design policies using these drivers as levers for more sustainable systems (Fig. 1).

Some definitions

Grazing systems: Grazing systems are defined in various ways in the literature. In this review, we focus on the definition by Seré and Steinfeld (1996) which describes grazing systems as systems in which more than 90% of the dry matter fed to animals comes from rangelands, pastures, annual forages and purchased feeds, and less than 10% of the total value of production comes from non-livestock farming activities. In contrast with landless systems, in grazing systems more than 10% of the dry matter fed to animals is produced on the farm and annual average stocking rates are less than 10 temperate livestock units per hectare of agricultural land.

Grazing systems intensification: Shift towards grazing systems producing more of the desired product per unit of resource used (e.g. capital, labour, land). The emphasis in the article is given on intensification processes that aim at increasing food production per unit area due to the topical challenge of food security and land competition.

Grazing systems extensification: Shift towards less intensive grazing systems.

Grazing systems expansion: Increases of land area under grazing systems due to conversion of other land system types.