



Inter-connection between land use/land cover change and herders'/farmers' livestock feed resource management strategies: a case study from three Ethiopian eco-environments



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ABSTRACT

We assessed land use/land cover changes from remotely sensed satellite imagery and compared this with community perceptions on availability/use of livestock feed resources and feed deficit management strategies since the 1973s in three districts representing the pastoral, agro-pastoral and mixed crop-livestock eco-environments of Ethiopia. We found that land use/land cover changes are proceeding in all eco-environments and that transitions are from grasslands, and forest lands to bush/shrub lands and crop lands in the pastoral site (Liben), from bush/shrub lands and grasslands to crop lands in agro-pastoral site (Mieso) and from bush/shrub lands, forest lands and grasslands to crop lands in the mixed crop-livestock site (Tiyo). The changes significantly affected livestock feed resources and feed deficit management strategies available to households. Over the last 30–40 years, grazing resources available to livestock keepers have been declining with resultant increase in the contribution of crop residues and other feeds from crop lands (weeds and crop thinnings) as compared to feeds from grasslands. The feed deficit management strategies of households are also changing significantly from mobility to herd management and feed conservation in the pastoral areas; from mobility to feed conservation and purchasing of feed in the agro-pastoral areas and from transhumance to feed conservation and purchase of feed in the mixed crop-livestock areas. Hence feed resources and their availability vary with time and eco-environments indicating the need for the development of eco-environment/site specific feed management strategies in order to support productive stock in the study areas and similar eco-environments.

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1. Introduction

Ethiopia while located in the tropics has wide eco-environmental settings that range from arid and semiarid tropical lowlands to cool afro alpine highlands and mountains. The warm and drier lowlands in the south east, eastern and north eastern part of the country are constrained by low and erratic rainfall for reliable crop production and are thus used for extensive pastoral livestock production (Coppock, 1994). On the other hand, the

highland plateau and mountains above 1500 m asl constitute less than 40% of the total land mass of the country and are under extensive mixed crop-livestock production. In between these two systems there are transitional areas known as agro-pastoral areas that share the properties of both pastoral and mixed crop-livestock systems.

Across these eco-environments, numerous studies have been carried out to identify land use/land cover changes in relation to drought vulnerability (Biazin and Sterk, 2013) and community perceptions (Oba and Kotile, 2001; Oba and Kaitira, 2006; Beyene, 2009; Garedew et al., 2009). Many of these studies, however, focused on analysis of drivers of the changes (Reid et al., 2000; Amsalu et al., 2007; Tsegaye et al., 2010; Meshesha et al., 2012; Biazin and Sterk, 2013), and only a few studies have dealt with

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consequences (Reid et al., 2000; Meshesha et al., 2012) and none have dealt with land use/land cover change in relation to availability and management of livestock feed resources.

Feed is an important component of livestock farming. The supply of feed both in quantity and quality determines productivity and profitability of farms (Sarwar et al., 2002). In Ethiopia, livestock feeds are derived mainly from annual foraging over large areas of grazing lands. Substantial amounts of feeds are also derived from crop residues, agro industrial by-products and other non-farm and farm products (Ibrahim, 1999; Habte, 2000; Mengistu, 2005; Tolera et al., 2012). The proportional contribution of these feed resources, however, is subject to variations in agro-ecosystem, farming system, and the type of animals reared (Aregheore, 2000; Rahman et al., 2008). Largely irreversible human activities over land surfaces including the clearing of forest, cultivation, overgrazing, settlements, industrialization, urbanization and other forms of land management (Meyer and Turner, 1992; Reid et al., 2000; McCusker, 2004; Luoga et al., 2005; VanWey et al., 2007; Garedew et al., 2009; Lambin and Meyfroid, 2011) are causing changes in land use and land cover patterns (Homewood et al., 2001; Feddema et al., 2005) with resultant change in livestock feed resource composition, feed deficits and feeding management strategies. Because of these dynamic changes, traditional feed resources, and existing feeding management strategies are no longer adequate to sustain a productive livestock population (Benin et al., 2002; Sarwar et al., 2002).

In many areas, the traditional rangeland-based nomadic pastoral systems where livelihoods are based on extensive movements over vast areas of land are under threat (Coppock, 1994; Bollig and Schulte, 1999; Gebru et al., 2003; Muller et al., 2007; Elias, 2008). Increased use of limited land for competing interests occasionally flares into conflicts among neighbors (Yemane, 2003; Beyene, 2009; Gizachew, 2012). As a result, as grazing resources decrease and the availability of by-products from farmland increase, changes are expected from grazing based feed deficit management strategies (mobility, transhumance, wet and dry season grazing) to non-grazing-based feed use and conservation strategies (purchase of feed, feeding of crop residues, use of agro industrial by-products) (Aerts et al., 2009; Dikshit and Birthal, 2010; Sarwar et al., 2002). In line with this, a study conducted in northern Ethiopia revealed that availability and use of communal grazing lands, private pastures, woodlots and forest areas as feed sources has significantly declined over the past decades and that this was mirrored by an increase in availability and use of crop residues and purchased feeds (Benin et al., 2002). Purchasing of feeds include agro-industrial by-products from market, crop residues, pastures and others from neighboring farmers who have no animals to feed or sales of feed to obtain cash for various purpose.

The inter-connections of changes in feed resource with land use/land cover change, however, is less understood. On the one hand, long-term monitoring of land use/land cover from remotely-sensed satellite imagery and GIS gives quantitative information on the surface coverage of different land use/land cover categories or classifications. Combining satellite and GIS based land use/land cover information with community observations and practices on the ground could give a fuller picture of the effects of land use/land cover changes on feed resource availability and herders' and farmers' practices of feed deficit management. Therefore, this paper firstly presents results of a land use/land cover monitoring exercise since the 1970s over three districts located in the three major eco-environments in Ethiopia. Secondly community perceptions on the relative availability of different feeds and feed deficit management strategies in response to changes in land use/land cover over the last 30–40 years were assessed. Thirdly we discussed implications of the temporal change in availability of different feeds and

feed deficit management strategies on capacity of land to support productive stock.

2. Materials and methods

2.1. Description of the study areas

This study was carried out across three eco-environments in Ethiopia. These were the pastoral, agro-pastoral and the mixed crop-livestock systems. The pastoral eco-environment constitutes a significant part of the low lands below 1500 m asl. It covers extensive areas of, Oromia, Afar, Somali and the Southern Nations Nationalities and Peoples Region (SNNPR) regional states of the Federal Democratic Republic of Ethiopia. The pastoral eco-environment is not suitable for reliable rainfed crop production unless supplemented with irrigation (Coppock, 1994; Abebe, 2000; Desta, 2000). It is inhabited by about 12% of the human and 24% of the livestock populations of the country (TECHNIPLAN, 2004). The highlands - dissected by the Great Rift Valley into western and eastern highlands - constitute the central part of the country where precipitation is sufficient both in amount and distribution for good crop production. Thus the major land use in the highlands is extensive smallholder mixed crop-livestock production (Gebru, 2001). The highlands with less than 40% of the land mass of the country is populated by over 60% of the human and 70% of the livestock population of the country (Gebru, 2001). The agro-pastoral eco-environment on the other hand, is intermediate between the more livestock-based pastoral and the crop-dominated highland systems. It is fairly widely distributed in a number of Ethiopia's regional states without having the clear spatial coherence and boundaries characterizing the pastoral and mixed crop-livestock eco-environments.

From each of these eco-environments, one district typical of the respective eco-environment was randomly selected. Accordingly Liben, Mieso and Tiyo districts were selected from the pastoral, agro-pastoral and the mixed crop-livestock eco-environments, respectively.

Liben district is found in Guji Zone of the Oromia National Regional State to the south east of Addis Ababa (Fig. 1). The district's capital, Negele-Borana, is located at 610 km south of Addis Ababa. The district lies between 4°38'55" and 5°33'7" N latitude, and 39°9'25" and 39°58'37" E longitude. It has a semiarid climate with two wet and two dry seasons a year. The main rainy season lasts from March to May followed by a dry season in June, July and August and then by a small rainy season in September, October and November followed by another main dry season in December, January and February. It is sparsely populated with a typical pastoral livestock production system where herding is the main livelihood. The climatic conditions are summarized in Table 1.

Mieso district is found in the west Hararge Zone of the Oromia National Regional State in eastern Ethiopia within the Rift Valley system of the country (Fig. 1). The district's capital, also called Mieso is located 325 km to the east of Addis Ababa. The district is situated between 8°47'33" and 9°19'15" N latitude, and 40°9'20" and 40°58'8" E longitude. It has two rainy and one dry season in a year. The main rainy season lasts from June to September followed by dry harvesting season from October to January and the second small rainy season from February to May. It has a semiarid climate with highly erratic rainfall. Due to unreliable weather conditions, crop production is an opportunistic activity complementing livestock husbandry. Farmers in the district grow sorghum, maize and haricot bean as major crops. The climatic conditions are summarized in Table 1.

Tiyo district is located in Arsi Zone of the Oromia National Regional State. The district's capital, Asela, is located 175 km south

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