

# Herder Perceptions on Impacts of Range Enclosures, Crop Farming, Fire Ban and Bush Encroachment on the Rangelands of Borana, Southern Ethiopia

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**Abstract** This study focuses on community-based knowledge to analyze the impacts of range enclosures, crop farming, fire suppression and bush encroachment on the communal rangelands of Borana, southern Ethiopia. The knowledge of local herders is the basis for decision making in the utilization and management of grazing lands. We used Borana oral history associated with the period of the *gada* system to reconstruct environmental change that spans a period of 48 years. Our results show that the use of communities' perceptions as a basis for evaluating the impacts of land use change on the environment makes an important methodological contribution. Communities' responses to changing land use resulted in the development of range enclosures, the expansion of crop farming and the fragmentation of the communal rangelands, while the suppression of fire contributed to the expansion of bush encroachment. The overall impact was forage scarcity and greater vulnerability of stock during drought years. We conclude that policymakers could use communities' knowledge of environmental change to improve the use of the rangelands. We propose that sustainable use of the southern rangelands in the future will require a greater focus on regulating the expansion of enclosures, crop farming and ranching, as well as reintroducing fire where necessary, to control the expansion of bush cover.

**Keywords** Bush encroachment · Community perception · Environmental history · Fire ban · Land use Policy · Rangeland development

## Introduction

Pastoral communities usually have a detailed knowledge of the environment of the grazing lands. This knowledge is gained through continuous herding (Bollig and Schulte 1999; Oba and Kotile 2001; Mapinduzi *et al.* 2003) and is supplemented by the knowledge accumulated from historical land use (Oba 1998; Reid *et al.* 2000; Sheuyange *et al.* 2005; Oba and Kaitira 2006). Community-based knowledge in assessing environmental change (e.g. Berkes 1998; Berkes *et al.* 1998; Calheiros *et al.* 2000; Fernandez-Gimenez 2000; Gadgil *et al.* 2000; Olafsdottir and Juliusson 2000; Mackinson 2001; Oba and Kotile 2001; Huntington 2000) would complement ecological methods (Fernandez-Gimenez 2000; Oba and Kotile 2001). In this paper “community knowledge” is described in terms of the sum total of knowledge pool representative of the whole community sharing the same resource.

According to the World Bank report (1998), community-based knowledge represents a principal component of global knowledge on the development and use of natural resource management. Community-based knowledge could improve our understanding of local conditions and provide useful expertise with regard to activities designed to help the local communities. Additionally, communities' knowledge may provide new insights for improving existing scientific knowledge (Calheiros *et al.* 2000; Oba and Kotile 2001). Huntington (1998) argued that community-based knowledge is more practical and relevant to environmental issues and ecological impact assessments than many other

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sources of information. Thus, the recognition of community-based knowledge may contribute to an improved understanding of local conditions with regard to reducing environmental degradation, as well as becoming important to scientific research and land use policy (World Bank 1998; Calheiros *et al.* 2000).

In this paper, our use of the term “land use policy”, when applied to our study area (of southern Ethiopia), differs from the usual goals associated with the term that are often aimed at achieving specific development objectives. Without exception, clear policies on grazing regulations are lacking in grazing lands where the traditional pastoral system is the dominant form of land use (e.g., Niamir-Fuller 1999). Past attempts to implement grazing-pastoral developments were rejected by the pastoralists (e.g., Smith 1992; Majok and Schwabe 1996). Thus, when we use the term “land use policy”, we are referring to *ad hoc* activities by government departments (e.g., the Ministry of Agriculture) that are intended to promote specific land use (e.g., crop farming). These activities appear to function as policy. Most activities of this type are rarely evaluated to see how the policies affected traditional systems of land use and impacted on the environment.

The alternative is to link land use policies to the knowledge held by local communities in terms of understanding environmental change (see also Scoones and Graham 1994; Oba and Kotile 2001; Angassa and Beyene 2003; Davis 2005; Mapinduzi *et al.* 2003; Homann 2004; Kamara *et al.* 2004; Ashenafi and Leader-Williams 2005; Wezel and Lykke 2006) in response to development-related activities. Such activities include the provision of water, the establishment of semiprivate resource tenure in the rangelands (e.g. ranches and semiprivate enclosures), crop farming in former communal grazing lands, and banning the use of range fire. The trend towards the semiprivatization of the communal rangelands through the introduction of alternative land use, such as semiprivate and communal range enclosures and crop farming, has fragmented the grazing lands and seriously impacted on traditional grazing systems. Fire is a key environmental driver that controls the function of savanna ecosystems (e.g. Bloesch 1999; Hudak 1999) and performs an essential ecological role in shaping the structure and composition of vegetation (e.g. Walker *et al.* 1981; Kull 2004; Moreira 2000; Laris 2002). The indirect consequence of fire suppression is the increase of bush encroachment (e.g. Sheuyange *et al.* 2005).

In this paper, our focus is on the understanding of how changes in land use in response to *ad hoc* policies have impacted on the environment of the Borana rangelands of southern Ethiopia. Due to the direct and indirect links between land use policy drivers and changes in resource tenure, as well as shifts in vegetation from open savanna to bush encroachment, we preferred to address the changes in

land use associated with the development of semiprivate range enclosures, ranches, crop farming and the impacts of the suppression of fire on shifts in vegetation as a single topic. We first briefly introduce the Borana pastoral land use system and then describe the past and present official policies and their implications for the rangelands. We consider the impact the policies have on environmental change before describing the contributions this study makes with regard to the better understanding of community-based knowledge of environmental change.

### Land Use Change in the Borana Rangelands

Two decades ago, Cossins and Upton (1987) characterized the Borana rangelands of southern Ethiopia as one of the most sustainable systems of traditional pastoral lands in East Africa. The past success may be related to the traditional system of range management, where the decision-making process on resource management at the local level rests with the *Ardaa* (smallest neighborhood settlement units) or *Madda* (water sources) (Hogg 1990). Access to the rich and diverse rangelands comprising of subhumid, semiarid and arid ecosystems also accounted for past successes (Coppock 1994). A functional indigenous institution of resource administration under the responsibility of the *gada* system (Legesse 1973) ensured equitable access rights to grazing and water sources. More importantly, every eight years, the Pan Borana *Gumi-Gayo Assembly* (Huqqaa 1996), which is the highest authority among the Borana for decision-making, developed and revised regulations for the management of grazing lands and water resources (Watson 2003).

Traditionally, the Borana land use system was based on extensive livestock production (Coppock 1994; Desta 1999; Kamara 2001; Homann 2004) based on settled home herds (*warra*) and the mobile *fora*-herd management system. The *fora*-herds include dry cows, bulls, immature males, oxen and heifers, while the *warra*-herds consist of milking cows and calves. Furthermore, the traditional system of land use is subdivided into grazing reserved specifically for calves (*laaf seera yaabi*) near settlements (Oba 1998). During the dry season when the availability of forage became scarce in the *warra*-herds' grazing lands, the surplus animals were sent to the *fora*-herds (Oba 1998). The *warra*- and the *fora*-rangelands were also subdivided into wet and dry season rangelands. In the dry season rangelands, both the *fora*- and *warra*-herds converged on the deep *tula* well rangelands in the central plateau of Dirre (see Helland 1980), while in the wet season the *fora*-herds dispersed into the waterless rangelands, relying on temporary rain pools (Oba 1998). These traditional patterns of land use have been under pressure since the 1960s because of changes induced by the

government's official and unofficial policies on land use. Major changes in land use included the development of pond-water, range enclosures, crop cultivation and the establishment of ranches.

Aside from a brief spell of experimentation with crop farming, which oral sources place during the *gada* Morowa Abbay (1680–1688), the Borana rangelands have been used exclusively for livestock grazing. Local history claims that those who conducted crop farming during the *gada* Morowa Abbay period were severely punished for the violation of the *gada* laws that prohibited the digging of land for subsistence (Oba 1996). During this period, the Borana probably adopted crop farming from neighboring communities of traditional crop farmers, such as the Konso in the southern highlands of Ethiopia (Watson 2004). After the *gada* Morowa Abbay, there were no reports of crop cultivation until Menelik II conquered the Borana region in the late nineteenth century. The settler soldiers (“*Neftanya*”), and later the immigrant farmers from the Ethiopian highlands, introduced crop farming culture to Borana (Helland 1997b). The settlers cultivated the humid areas of Borana, where the climate was relatively favorable for crop farming. The subhumid zones that traditionally served as dry season and drought year grazing reserves were lost to cropping starting from the nineteenth century (Oba 1998). In the other areas of the rangelands, the expansion of crop farming was gradual, while donor-funded large-scale rangeland development projects were sporadic.

The framework for developing the Borana rangelands was laid down in the AGROTEC/CRG/SEDES study conducted from 1972–74. The justification for the proposed rangeland development project was that the traditional land use system was destructive to the natural vegetation. It was wrongly believed that the intervention would promote environmental conservation (Oba 1998). The modernizing program was expected to increase the productivity of the Borana herds by instituting proper stocking rates. It was argued that the development of infrastructure and pond-water in strategic areas would reduce pressure on the rangelands. The overstocking of the dry season rangelands and the understocking of the wet season rangelands were considered an unacceptable failure of range management (AGROTEC/CRG/SEDES Report 1974). However, it was recognized that in order to achieve this goal, the natural balance that the Borana pastoral production system maintained would be altered:

“...stock-raising, ... and agriculture are competing in the utilization of the natural resources...in the framework of a centuries-old ecological balance...(where) mortality, diseases, natural cycles and the calamities were the balancing factors... This ancient balance is soon going to be modified by a series of events; (a)

demographic explosion, (b) an external pressure due to higher rate of utilization of livestock and natural resources and (c) the immigration into the area from the...agricultural highlands...(Consequently) “shifting agriculture could destroy its natural defences and lead to its impoverishment, the taking--over by poorer and poorer vegetal species, [leading] to its slow transformation into [bush encroachment]” (p.17).

Despite this warning, developments in infrastructure were aimed at reorganizing pastoral grazing so that movements would be effectively controlled and the sedentarization of the population was encouraged. The new grazing model presumed that the availability of water in the wet season grazing areas would ensure rational use of the land and prevent the concentration of livestock in the dry season rangelands. Using heavy earth-moving equipment, the Southern Rangeland Development Unit (SORDU) constructed semiperennial ponds. The introduction of free water, easier to exploit than the traditional water sources of the deep *tula* and labor intensive shallow wells, attracted permanent settlements (Oba 1998).

These programs were implemented following the 1975 land reform of the socialist government (1974–1991) that established systems of state ranches in the pastoral areas of Ethiopia (Helland 1997a). Prior to the Land Reform Proclamation, the major land tenure regimes included land under communal use (kinship based), land owned by the church and state, and the private land distributed by the state to individuals such as officials and loyal servants of the imperial government (Dessalegn 1984). The radical land reform of 1975, which transformed all rural lands into state property, introduced preconditions for access to plots of land that depended on membership in peasant associations (Helland 1999). For the southern rangelands of Ethiopia, the role these development policies played in transforming the Borana pastoral economy has been extensively discussed (e.g. Upton 1986; Cossins and Upton 1987, 1988; Coppock 1994; Hogg 1997; Helland 1997a; Oba 1998; Desta 1999; Desta and Coppock 2002, 2004; Kamara 2001; Kamara *et al.* 2004; Angassa and Oba 2007). However, the impact on the environment of range enclosures, crop cultivation, and the ban on fire have been only sparsely reported (Oba *et al.* 2000; Tache 2000; Kamara 2001).

In response to policy driven land use, the Borana transformed their mode of land use allocations. Their adoption of range enclosures in particular showed the gradual adoption of land use changes, from the traditional communal calf pastures (*laaf seera yaabi*) to the semi-privatization of grazing land. The range enclosures also served as the precursors to semiprivate crop fields. Furthermore, the suppression of range burning resulted in the replacement of the historical grasslands with bush encroach-

ment (Oba *et al.* 2000). Two decades ago, 40% of the southern Ethiopian rangelands had been encroached by the bush (Eshete *et al.* 1986; Coppock 1994), while recent estimates put the encroachment at 52% (Gemedo-Dalle 2004).

To understand the impact of land use on environmental change in terms of the trend in range enclosures, crop farming and the fire ban, we lacked long-term empirical data related to vegetation changes. Therefore, we used traditional methods of reconstructing the social environmental history of the Borana, based on the *gada* timelines, to understand the changes (Legesse 1973). Each *gada* period covers eight years, and is named after the *gada* leader (*abba gada*). A period of 48 years (i.e., six *gada* periods) was used to reconstruct changes in land use and vegetation. Generally, this article represents a start towards acknowledging the way in which pastoral herders are responding to land use changes externally induced by development policies and the role that local perception can play in understanding important environmental changes taking place in southern Ethiopia. The objectives of the study were to understand: (1) the communities' perceptions of general trends of land use including the adoption of (a) range enclosures and (b) crop farming; (2) the history of the traditional use of fire, the banning of fire and its consequences on range vegetation dynamics; and (3) the consequences of the proliferation of bush encroachment on the composition of grass species.

## Study Area

The study was conducted in southern Ethiopia in the Borana zone of Oromia Regional State in the districts of Arero, Dirre and Yabello (4–4°57.383'N and 36–42°E), and sampling was done across nine Peasant Associations (PAs). Three PAs per district were selected (from Arero we selected Halona, Fuldowa, Kafara, from Dirre we selected Dubluk, Madhacho and Melbana and from Yabello we selected Did-Hara, Daritu, Hara-Wayu). The areas receive a bimodal rainfall, with the main rains (*ganna*) falling between March and May, and the lesser rains (*hagaya*) between September and November. The rainfall is variable with the coefficient of variability ranging from 18% to 69% (Angassa and Oba 2007). Droughts occurred every five years (Oba 1998). The human population of the three districts was estimated at 39,600, divided into 8000 households (Borana Zone Administration, personal comm.). The main economic activities are, in order of importance, livestock production with cattle, small stock, camels and equines (Kontoma 2000). The total livestock population (i.e., all species) of the nine PAs was estimated at about 156,000 head (SORDU vaccination census, unpublished.).

Crop farming is increasing in terms of the space it occupies (Kontoma 2000). By the 1990s 2–3% of the grazing lands were already under crop cultivation (Coppock 1994), but as the current study will show, cropping has since expanded throughout the study area (see the [Results](#) section).

## Sampling

The three districts represented different histories of development intervention, settlement patterns, the adoption of range enclosures, the intensification of crop farming, the historical use of fire, and the expansion of bush cover. The districts represent the core of Borana pastoralism and the cultural sites of the *gada* system. The establishment of ranches and the development of pond water were also the greatest in these districts. Two-stage surveys were conducted between 2002 and 2003. First, region-wide interviews with oral historians and the elderly were conducted in order to reconstruct the environmental history of changes in land use in Borana. Desta and Coppock (2002, 2004) report that the use of oral recall among the Borana is a fairly reliable method of data collection. Secondly, in 2003 a sample of 245 households (3% of the total households) was randomly selected from lists of all existing households and was interviewed using structured questionnaires. Desta (1999) considered a sample of 336 households (4.8% of the 7,000-target population) in southern Ethiopia. Of the total respondents, 17% were female-headed households and the rest were male-headed households. The age of respondents ranged from 45 to more than 60 years. Pastoralists were interviewed in their villages by six well-trained local enumerators. Due to the detailed nature of the questionnaire, each enumerator interviewed 41 households on average, with each interview lasting approximately 120 minutes. The interviews were conducted over a period of 35 days. All the interviews were conducted in *Afaan Oromo* (the Oromo language). Different issues (see the [Data Analysis](#) section) were used to capture the responses of the local people about changes in land use, the impact on the environment, and environmental history (see below).

## Data Analysis

The data were organized under specific responses related to range enclosures, crop farming, the oral history of range burning, the official fire ban and bush encroachments and the impact on vegetation. All data related to enclosures, crop farming, and the historical uses of fire were organized by region (i.e., districts), while responses related to bush encroachment and changes in the composition of grass species were organized by local PAs. (1) The data related to

the general change in land use were in terms of enclosures (*kalo*), i.e., types of enclosures (communal vs. semiprivate), periods of establishment, size of enclosures, trends of communal enclosures (i.e., enclosures managed by community members of one or more villages) and the landscape types (i.e., uplands or bottomlands) used for establishing range enclosures. Relationships were also determined between the size of enclosures and the number of calves in each enclosure. Responses were analyzed in terms of the relationships between enclosures and the traditional calf-grazing reserves (i.e., *laaf seera yaabi*), and the effects of enclosures on communal rangelands and semiprivatization of communal grazing lands. (2) The data on farm holdings for crop cultivation concerned the history of crop farming, the allocation of land for cropping and landscape types under crop cultivation. Additionally, the total years involved in crop farming, the reasons for cultivation and the effects on communal rangelands were considered. (3) The data on historical fire use addressed the reasons for traditional range burning practices, the specific time of burning, the frequency of burning, precautions taken in range burning practices, and the effects of official bans on the use of fire. We analyzed the responses related to pastoralists' comments on the use of fire, changes in vegetation in their lifetimes, reasons for the expansion of bush encroachment, the impact of bush encroachment on livestock productivity, and the environmental impact in terms of changes in the composition of grass species.

## Results

### Change in Land Use Patterns

Two hundred and forty-five households were successfully interviewed about their knowledge of the impact of changing land use on the rangelands in southern Ethiopia. From the interviews, it was apparent that the trend towards semiprivatization of communal grazing areas was increasing (Table 1). Among our sample, 98% of the households reported that they had access to range enclosures, with more than 94% participating in the management of communal enclosures and the rest participating in semiprivate enclosures (i.e., owned by individual families) (Table 1). In general, both communal and semiprivate enclosures served as the dry season calf-grazing reserves. Communal enclosures were open to all members of the community (comprising families in the same settlements) when feed resources were depleted in communal grazing areas during the long dry season. The semiprivate enclosures were owned by individual families but access was granted to their social relations for grazing their calves. Generally, calves and sick or weak animals were allowed to graze in

**Table 1** Pastoralists' Perceptions of the Different Attributes Related to Range Enclosures in Borana (n=245)

Attributes	% Av.	$\chi^2$	District response
Had access to range enclosures	98	8	*
Had no range enclosures or access	2	3	NS
Participated in the management of communal enclosures	94	24	**
Participated in the management of private enclosures	6	24	**
Perceived communal enclosures were larger	96	20	*
Number of calves vs. size of enclosure limited	36	91	**
Number of calves vs. size of enclosure unlimited	63	61	**
Access of individuals to communal enclosures in more than one area	7	12	*
Trends of communal enclosures increasing	75	33	**
Trends of communal enclosures decreasing	25	33	**
Enclosures adversely influenced communal grazing lands	58	77	**
Oppose subdivision of rangeland into range enclosures	95	4	NS
Perceived semi-privatization of communal rangeland is increasing	65	4	**

All responses were rounded to the nearest whole number

\* $P < 0.05$ , \*\* $P < 0.01$ , <sup>NS</sup> $P > 0.05$ , Chi-square test by district for attribute vs. respondents' perceptions

enclosures for a period of 3–4 months during the dry season. On average, the size of enclosures varied between 30 and 300 hectares. The respondents had mixed views on the relationship between the size of enclosures and the stocking rates of calves (Table 1). In most cases, the community in general perceived that development of semiprivate range enclosures was the precursor of semiprivate farmlands. Whereas the Borana discouraged the semiprivate grazing enclosures, conversion of semiprivate enclosures into crop farming were acceptable forms of land use. Thus, we were informed by the herders that individuals who established semiprivate enclosures had “called them” crop lands.

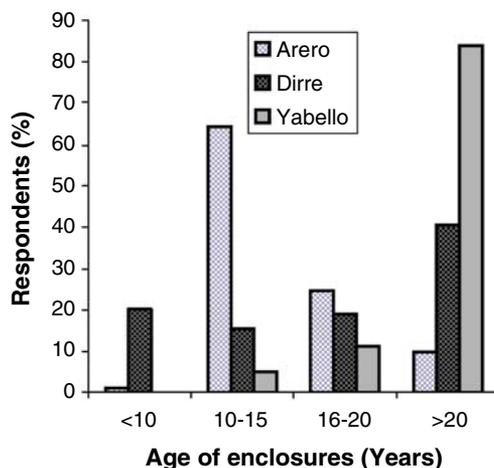
Generally, 96% of the households reported that the communal enclosures were larger than the semiprivate enclosures (Table 1). In our sample, approximately 16% of the households had access to communal enclosures in more than one place. Both the communal and semiprivate enclosures expanded during the previous decades (Table 1). In response to changes in land use, the Borana revised the traditional system of calf-grazing reserves (*seera yaabi*), which were usually open pastures in key grazing landscapes such as hill tops and bottomlands. These were set aside for calf and weak animal grazing through consensus on when they were to be used and by what types of animals (e.g., the age of calves allowed). Among our samples, 55% of

the households reported that they converted traditional calf-grazing reserves into range enclosures or croplands, while 45% of the households additionally maintained the traditional calf-grazing reserves. According to 87% of the respondents, the management rules for calf-grazing reserves were similar to those of the communal enclosures. The difference was that both the communal and semiprivate enclosures were protected by perimeter fences, while the traditional calf pastures were not fenced. There was agreement among the interviewed households (95%) that the expansion of enclosures had had a profound effect on the communal rangelands. The communal and semiprivate enclosures were mostly located in the upland landscapes, while the bottomlands were mostly used for crops (see below).

Other subdivisions of the rangelands were ranches (16,550 ha) and crop farms. Our respondents perceived that subdivisions of the rangelands into range enclosures, ranches and croplands fragmented the grazing lands and disrupted livestock movements, while the remaining communal grazing lands were put under greater pressure (Table 1). From the sample population in the nine PAs, it was estimated that about 7,500 ha of the communal grazing lands were converted to range enclosures and an additional 5,600 ha were allocated to crop cultivation. From the sampled villages in the Arero, Dirre and Yabello districts, the ages of range enclosures were varied (Fig. 1). In the Dirre and the Yabello districts, the enclosures were introduced during the *gada* Liiban Jaldesa (1960–1968), while those in the Arero district were introduced during the *gada* Gobbaa Bulee (1968–1976) (Table 2).

### Crop Farming in Borana Rangelands

Table 3 summarizes the *gada* periods when crop farming activities were introduced into the districts of Arero, Dirre



**Fig. 1** The time since range enclosures were introduced in the districts of Arero, Dirre and Yabello in Borana, southern Ethiopia

**Table 2** Pastoralists' Perspectives on the Historical Timeline for the Establishment of Range Enclosures by District ( $n=245$ )

Gada	Years	% Response by district		
		Arero	Dirre	Yabello
Jaldesa Liiban	1960–1968		4	3
Gobbaa Bulee	1968–1976	4	1	1
Jilo Agaa	1976–1984	10	5	26
Boruu Guyoo	1984–1992	31	12	23
Boruu Madhaa	1992–2000	33	37	19
Liiban Jaldesa	2000–2008	18	16	26
No response		5	29	5

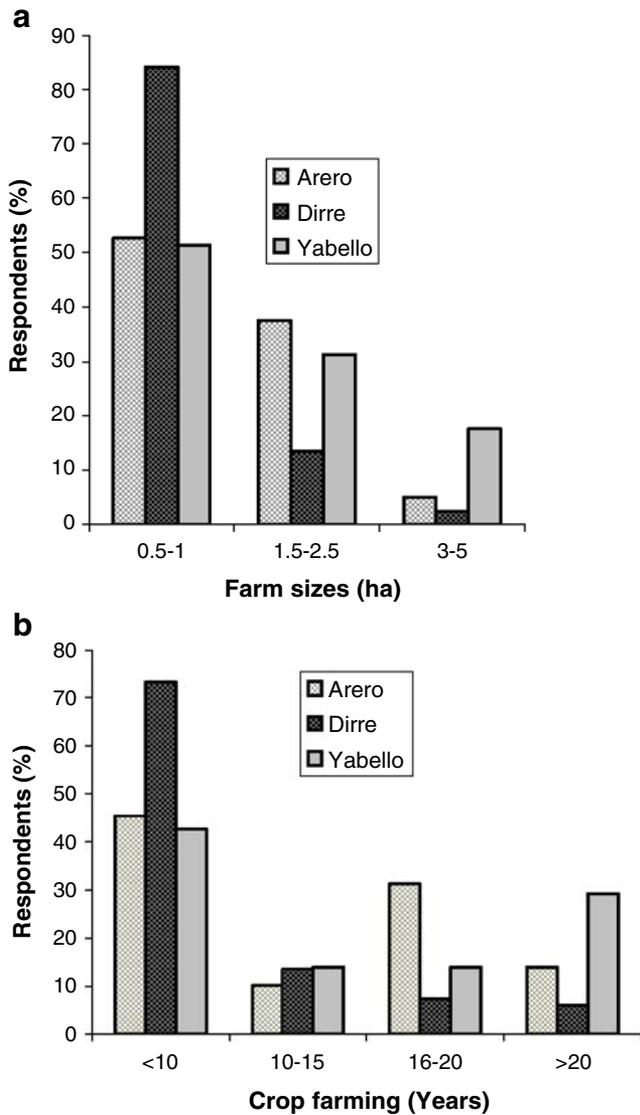
All responses were rounded to the nearest whole number  
 $df=2$ .  $\chi^2$  of 87 is significant at the 0.001

and Yabello. The pastoralists in our sample group generally began crop farming during the *gada* Jilo Agaa (14%), Boruu Guyoo (22%), Boruu Madhaa (29%) and Liiban Jaldesa (20%) compared to the period of *gada* Gobbaa Bulee when less than 4% of the households across the region practiced crop farming. A large proportion of the households interviewed were engaged in crop farming (87%), with only a minority reporting no activities related to crop farming (13%). The sizes of farm holdings for crop production were highly variable, ranging from 0.5 ha to 5 ha (Fig. 2a). A greater proportion of the respondents said that they cultivated the bottomlands (90%), as opposed to the uplands (10%), with wheat, maize and teff being the dominant crops grown by the sample households. The ages of crop fields varied from <10 years old (47%), 10–15 years (13%), 16–20 years (20%) and >20 years (20%) (Fig. 2b). The allocation of crop fields was divided by PAs, local institutions (e.g. *Ardaa* elders), PAs in collaboration with the local institutions, or was self allocated by individuals (Fig. 3). For the communities in the three districts, a common reason for pastoralists' involvement in crop farming was to improve food security that the declining herds alone could not guarantee. However, the main driver was the

**Table 3** Historical Timeline for the Adoption of Crop Farming by Pastoralists in Borana, Southern Ethiopia ( $n=242$ )

Gada	Years	% Response by districts		
		Arero	Dirre	Yabello
Gobbaa Bulee	1968–1976	4	1	1
Jilo Agaa	1976–1984	10	5	26
Boruu Guyoo	1984–1992	31	12	23
Boruu Madhaa	1992–2000	33	37	19
Liiban Jaldesa	2000–2008	18	16	26
No response		5	29	5

All responses were rounded to the nearest whole number  
 $df=2$ .  $\chi^2$  of 55 is significant at the 0.001



**Fig. 2** **a** Sizes of plots of cropland cultivated by the sample households in the districts of Arero, Dirre and Yabello in Borana, southern Ethiopia. **b** The time when crop farming started in the districts of Arero, Dirre and Yabello in Borana, southern Ethiopia

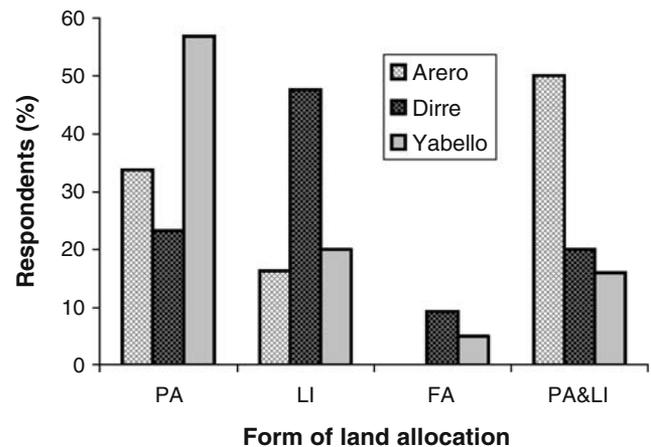
agricultural land use policy promoted by the Department of Agriculture and land privatization policy in the grazing lands. In the study area the herders reported that the ranches that were removed from the grazing lands were part of land alienations. Some of the ranches have already been sold to private enterprises against the wishes of the community. The Borana herders have been concerned about the radical changes in the land tenure from a communal regime where the tribe controlled land allocations to the state driven formal tenure regime that encouraged private investments in the rangelands. Individuals that participated in land privatization were mostly people from outside or from urban areas. The Borana in general had resisted exclusive ownership of former grazing lands by individuals.

### Oral History of Traditional Range Burning

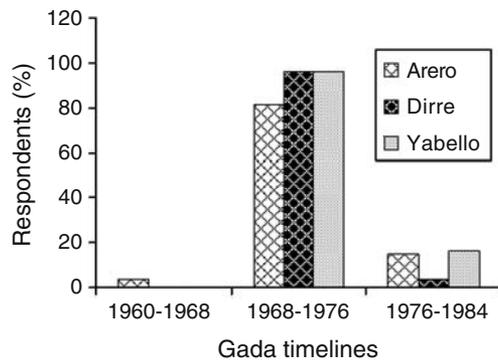
Historically, fire played an important role in the ecology of the savannas of southern Ethiopia. Fire was used to control the expansion of bush cover and ticks, to improve pasture quality and to facilitate livestock movements. The majority (99%) of the households reported that they were involved in traditional range burning in the past. Burning was during the long dry seasons (*bona hagaya*) before the commencement of the main rains (*gana*). Although traditional burning could not be compared to the prescribed and controlled fires practiced by range ecologists, the Borana pastoralists perceived that they avoided using fire when livestock feed was in critically short supply and they took precautions when using fire in settlement rangelands. The communities also mentioned that they regulated grazing of the post-fire growth. The frequency of fires in individual landscapes depended on past histories. The respondents reported that different villages practiced different fire frequencies, varying between two-year intervals (29%), three-year intervals (49%), four-year intervals (7%) and five-year intervals (10%). Annual range burning was least common (5%). Figure 4 is a summary of the oral historical timeline since the official ban on fire was enforced. The last time the majority of the respondents (94%) conducted range burning was during the *gada* of Gobba Bulee (1968–1976), almost 30 years ago (Fig. 4).

### The Impact of Bush Encroachment on the Rangelands

Our respondents (100%) perceived that the result of the official ban on fire was a shift in the composition of vegetation from perennial grassland to bush encroachment. At a regional level, the respondents said that the encroached



**Fig. 3** Institutions for cropland allocation in Borana rangelands in the districts of Arero, Dirre and Yabello in Borana, southern Ethiopia. PA=Peasant Association, LI=Local Institution (e.g. *Qaahuu* and/or *Gada*), FA=Free Access to Cropland and PA & LI=Peasant Association and Local Institution



**Fig. 4** Historical timeline for the official ban on traditional range burning practices in the districts of Arero, Dirre and Yabello in Borana, southern Ethiopia during the *gada* Jaldesa Liiban (1960–1968), Gobbaa Bulee (1968–1976) and Jilo Agaa (1976–1984)

conditions varied across the three districts. At a local level, they mentioned that the intensity of bush encroachment varied according to soil types. The opinion of the herders was that the bush encroachment problem had changed from a localized phenomenon to a broad-scale invasion of the Borana rangelands. The households in the three districts stated that the expansion of bush encroachment began during the *gada* Gobbaa Bulee (1968–1976), but that the expansion became severe during the *gada* Jilo Agaa (1976–1984), about two decades after the official ban of range fires (Fig. 5).

On a local level, the pastoralists regarded bush encroachment as a major threat to rangeland production. The shift towards bush encroachment changed the composition of the herbaceous layer in favor of annual grasses and unpalatable forbs. According to the households, there were also differences in the composition of invasive species (Table 4). The pastoralists suggested that species that were invasive in some localities might not be a problem in other areas. Thus, the same species could be categorized as either invasive or noninvasive (Table 4). Among the invasive woody species, reported by the pastoralists, *Acacia mellifera* (66%), *Commiphora africana* (61%) and *Acacia drepanolobium* (60%) were major threats. Table 5 summarizes the trends of herbaceous species, particularly perennial grasses divided into those that were increasing, those that were decreasing and those that had disappeared from local landscapes. The herders suggested that in terms of grasses, the rangelands were dominated by *Chrysopogon aucheri* (89%), *Pennisetum stramineum* and *P. mezianum* (56%), *Panicum coloratum*, *P. maximum* and *P. turgidum* (44%), *Heteropogon contortus* (39%) and *Cenchrus ciliaris* (33%). The species that were threatened with disappearance were *Cenchrus ciliaris* (16%) and *Leptothrium senegalense* (20%) (Table 6). The reasons given for the decline in perennial grasses were lack of range burning and bush encroachment (58%), the effects of drought (20%), increased

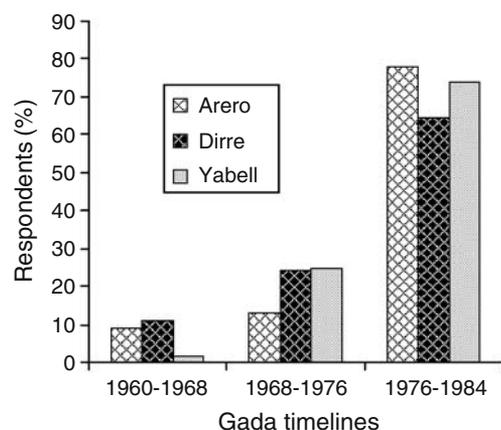
grazing pressure (13%), and the effects of termites (9%). The increasing grass species included *Aristida adoensis* (79%), *Pennisetum mezianum* (90%) and *P. stramineum* (78%) (Table 6).

## Discussion

### Changes in Land Use Patterns

The use of range enclosures was adopted from the sedentary Guji agropastoralists (Oba 1998). It has previously been estimated that 90% of the Borana settlements in the Dirre, Arero and Yabello districts have access to range enclosures (Coppock 1994). Range enclosures are less developed in the arid lowlands, where conditions are too dry, and in the Liban district in the east, where the population is more nomadic (Oba 1998). According to the households interviewed, the establishment of range enclosures was the communities' way of responding to the scarcity of feed for vulnerable herd classes, such as calves. A similar rule was applied to the managing of the *seera yaabi* system. The traditional calf-grazing reserves (*laaf seera yaabi*) were a communal resource managed collectively, "fenced by rules and regulations" (Oba 1998). Specific rules and regulations exist for the communities' use of range enclosures and traditional calf-grazing reserves, for example the age of calves was specified as 6–24 months. In the majority of cases, the stocking of the enclosures with calves was not regulated, the assumption being that since the pastures were grazed during the dry season and rested during the growth season, there was no threat of overgrazing.

The decision to establish communal enclosures followed the proclamation of the Assembly of *Gumi Gayo* in 1988 (see Tache 2000). So far, the amount of land under enco-



**Fig. 5** Historical timeline for the establishment of bush encroachments in the districts of Arero, Dirre and Yabello in Borana, southern Ethiopia during the *gada* Jaldesa Liiban (1960–1968), Gobbaa Bulee (1968–1976) and Jilo Agaa (1976–1984)

**Table 4** Pastoralists' Perceptions on the Characteristics of 29 Species of Woody Plants in Southern Ethiopia ( $n=245$ )

List of woody plants		% Response				
Scientific name	Local name	Invasive <sup>1</sup>	Non-invasive <sup>2</sup>	No response	$\chi^2$	PA
<i>Acacia mellifera</i>	Saphansa	66		34	2	NS
<i>Acacia reficiens</i>	Sigirsoo	14		86	27	***
<i>Acacia tortilis</i>	Dhaddacha	2	96	2	10	*
<i>Terminalia brownii</i>	Birreessa	2		98	3	NS
<i>Grewia bicolor</i>	Harooressa		38	61	88	***
<i>Boscia coriacea</i>	Qalqalcha	27	73		42	**
<i>Commiphora africana</i>	Hammeessa dhiiroo	61		39	41	***
<i>Acacia brevispica</i>	Hammarreessa	24	7	69	88	***
<i>Acacia drepanolobium</i>	Fulleessa	60		40	2	NS
<i>Acacia nilotica</i>	Burquqee	19	32	49	67	***
<i>Acacia bussei</i>	Haloo	37	14	49	48	***
<i>Acacia etbaica</i>	Halliqabeessa	10	3	87	1	NS
<i>Grewia tenax</i>	Dheekkaa	2	22	77	56	***
<i>Rhus natalensis</i>	Daboobessa	4	7	89	17	**
<i>Acacia senegal</i>	Hidhaadhoo	5		96	3	NS
<i>Combretum molle</i>	Rukeessa	2		98	8	*
<i>Ormocarpum mimosoides</i>	Buutiyyee			100	2	NS
<i>Acacia seyal</i>	Waaccuu	9	1	90	35	***
<i>Balanites aegyptica</i>	Baddana		26	74	105	***
<i>Phyllanthus sepialis</i>	Dhiirii	28	1	72	180	***
<i>Pappea capensis</i>	Biiqqaa		23	77	89	***
<i>Acacia nubica</i>	Waangaha	7		93	14	**
<i>Commiphora crenulata</i>	Siltaachoo	5		96	17	***
<i>Commiphora rivae</i>	Agarsuu		2	98	2	NS
<i>Dichrostachys cinerea</i>	Jirimee	1		99	4	NS
<i>Lanena floccosa</i>	Handaraka	3	5	99	2	NS
<i>Cordia gharaf</i>	Madheera		36	63	77	***
<i>Grewia villosa</i>	Ogomdii		34	65	68	***
<i>Boswellia neglecta</i>	Dakkara	14	2	85	11	*

All responses were rounded to the nearest whole number  
 $*P<0.05$ ,  $**P<0.01$ ,  $***P<0.001$ ,  $^{NS}P>0.05$ , 1, 2=  
 Invasive species are area specific and respondents reported that one species was invasive at one site while not at another site, Chi-square test by PA for woody species characteristics vs. respondents' perceptions

tures is controlled by the general need to limit the loss of communal grazing lands. Among the settlements in the nine PAs, enclosures provide an opportunity to develop a more intensive communal resource management system in which the movements of calves between crop fields (see below), enclosures, and the open grazed rangelands mimic the former wet-dry season grazing patterns. By enforcing rules regarding the size of grazing lands allocated to enclosures, encroachment on the communal ranges was gradual (Oba 1998). The Borana response is cautionary. On the one hand, the Borana have coped well with changes in land use that promote semiprivatization, and on the other hand, they are conscious that the subdivision of communal rangelands could result in loss of viability for the pastoral production. Thus, despite communities' adaptive response to changing land use through the gradual semiprivatization of the rangelands, the establishment of range enclosures has fragmented the communal grazing areas. The threat comes from urban residents who desire to develop private enclosures for large-scale investments. In the view of the community, the semiprivatization of range enclosures is

likely to increase 'land grabbing', a process that has already begun in some areas (Oba 1998). Pastoralists perceived that the drivers of change in land use patterns related to semiprivate enclosures were from outside rather than an internal response by the community. The externally driven land use policy on changes in land tenure ignored the traditional land use laws (*aada seera laafa*) as defined by Borana customary rules and regulations (*aada seera Borana*). The consequence is that the traditional systems of land use regulations are upset by land use policies. In the view of the community the changes are likely to threaten the pastoral production in this drought prone region (Angassa and Oba 2007).

#### Crop Farming in the Borana Rangelands

According to oral historians, the Borana people only began to farm crops in the early 1960s. During the famine of the *gada* Liiban Jaldesa (1960–1968), farmers in the subhumid zones were the principal source of the grain needed by the pastoralists in the lowlands. Drought and civil insecurity

**Table 5** General Trends of Herbaceous Species as Reported by Pastoralists in Borana, Southern Ethiopia (n=245)

List of herbaceous species		Respondents' comments		
Scientific name	Local name	Increasing	Decreasing	Disappearing
<i>Aristida adoensis</i>	Biilaa	+		
<i>Bothriochloa radicans</i>	Bokkoolaa		+	
<i>Brachiaria</i> species	Unidentified		+	
<i>Chloris roxburghiana</i>	Billaa		+	
<i>Chrysopogon aucheri</i>	Alaloo		+	
<i>Cenchrus ciliaris</i>	Matguddeessa			+
<i>Cymbopogon commutatus</i>	Halchisoo			+
<i>Cynodon dactylon</i>	Sardoo			+
<i>Cyperus</i> species	Buridde		+	
<i>Dactyloctenium aegyptium</i>	Unidentified		+	
<i>Digitaria milanjana</i>	Unidentified		+	
<i>Eleusine jaegeri</i>	Coqqorsa		+	
<i>Eragrostis papposa</i>	Samphée/samphilee		+	
<i>Eragrostis sennii</i>	Unidentified		+	
<i>Enteropogon macrostachyus</i>	Unidentified		+	
<i>Enteropogon somalensis</i>	Unidentified		+	
<i>Heteropogon contortus</i>	Seerricha		+	
<i>Herbaceous legumes</i>	Hagaggaroo-ree'ee		+	
<i>Hyparrhenia hirta</i>	Gaaguroo			+
<i>Lintonia nutans</i>	Ardaa		+	
<i>Leptothrium senegalense</i>	Ilmogorii			+
<i>Panicum coloratum</i>	Hiddoo qaqallaa		+	
<i>Panicum maximum</i>	Lolloqaa		+	
<i>Pennisetum stramineum</i>	Lu'oo	+		
<i>Panicum turgidum</i>	Hiddoo-dabbasicha		+	
<i>Sporobolus pyramidalis</i>	Bukkicha		+	
<i>Themeda triandra</i>	Marra-saalaa		+	
<i>Pennisetum mezianum</i>	Hogoondhoo	+		

+Pastoralists' perceptions about species trends

during the *gada* Gobba Bulee (1968–1976) impoverished a large number of Borana households who needed grain to survive. However, it was not until after the military government's Land Proclamation of 1975 and the droughts of the 1970s that the majority of the pastoralists began to cultivate their own crops. Currently, our Borana informants estimate that < 15% of Borana households rely directly on the products of their livestock alone. The majority rely on both grain and livestock. Due to unreliable rainfall, however, crop farming in Borana has not been very successful (Oba 1998).

Generally, successful harvests occur only once every three years. In years of unsuccessful harvests, the Borana rely on the local market for grain or relief food (Kontoma 2000).

Given the climatic obstacles to crop farming, the pastoralists might be better served both nutritionally and financially by selling their livestock and buying grain rather than directly consuming the protein-rich products of their herds (cf. Behnke and Kerven 1994). Since the communities' involvement in crop production is a response to food insecurity, the expansion of crop cultivation has transferred

**Table 6** Trends of Herbaceous Plant Species Reported by Pastoralists in Southern Ethiopia (n=245)

Lists of herbaceous species		%Response				
Scientific name	Local name	Increasing	Decreasing	Disappearing	$\chi^2$	PA
<i>Aristida adoensis</i>	Biilaa	79	21		33	**
<i>Cymbopogon commutatus</i>	Halchiisoo		100		8	NS
<i>Cynodon dactylon</i>	Sardoo		88	12	34	**
<i>Cenchrus ciliaris</i>	Matguddeessa		77	16	7	NS
<i>Hyparrhenia hirta</i>	Gaaguroo		91	10	9	NS
<i>Leptothrium senegalense</i>	Ilmogorii		79	20	8	NS
<i>Pennisetum stramineum</i>	Lu'oo	78	22		14	NS
<i>Pennisetum mezianum</i>	Hogoondhoo	90			30	*

All responses were rounded to the nearest whole number  
 \* $P < 0.01$ , \*\* $P < 0.001$ ,  
 NS  $P > 0.05$ , PA=Peasant Association, Chi-square test by PA for species trends vs. respondents' perceptions

parts of the communal grazing lands to semiprivate crop farms. The proportion of land used for cropping might still be low, but it is the prime bottomlands that are being converted into crop fields (Coppock 1994). The loss of the bottomlands to crop cultivation makes livestock vulnerable during droughts when the bottomland areas are in great demand for grazing. Among our sample households, almost 87% were involved in crop farming activities, compared to the earlier figures reported by Holden and Coppock (1992), who estimated that 33% of 108 households in Borana were engaged in crop cultivation. In another study, Coppock (1994) reported that 35% of 77 households were engaged in crop farming. Based on this baseline data, it is clear that crop farming is expanding in the southern rangelands of Borana.

The findings of this survey showed that the majority of pastoralists involved in crop farming were allocated crop fields by a number of institutions, but that the community's influence varied from one district to another. However, the evidence uncovered the fact that the Borana institutions are losing responsibility for land use allocations to the more formal institutions such as Peasant Associations. These changes have important implications for land use trends, particularly in response to the official land use policy for the rangelands. Until a few decades ago, policy-driven semiprivatization of resource tenure rights was an alien idea to the Borana, whose concept of territorial rights was defined in terms of the right to use the land, but not the right of land ownership by individuals. The land is communal. Such definitions of tenure rights differ from the official definition that places the ownership of land under the state (Oba 1998). Privatization of the communal rangelands by individual investors and state ranches drastically altered the indigenous systems of range management, contributing to the internal adjustments (communities' responses) to declining grazing resources by reallocating the communal rangelands to croplands and calf-grazing reserves.

Undermining the community's authority makes the indigenous institutions lose powers to regulate resource use. By contrast, if the decisions to allocate resources follow the indigenous model, then the process of resource privatization will be gradual and adaptive. Sudden resource alienation creates shocks that might lead to the breakdown of indigenous institutions. It may be concluded that developments that undermine a system that is already operating under tremendous pressure is likely to exacerbate the problem. More so, if the action of the community meant to alleviate poverty is incapacitated by administrative interventions. The breakdown of natural resource management in the lowlands is therefore not due to the inability of the Borana to cope with the fast evolving land tenure regimes. Rather, it is because the community has lost tradi-

tional rights because the land use policy failed to consult the indigenous institutions. However, economic justification of ranch development on communal rangelands with little knowledge of the ecology and little regard for the indigenous production system has not succeeded in better use of the rangelands. The local institutions, which are the strength of the indigenous management systems, have been weakened. Dependency is created and the system of self-help disabled. The justification for land alienation is often that the land will be put to a better use and that the community will be benefiting from the development that takes away part of their grazing land! No level of investment, e.g., water development on private ranches, crop farms and land privatization, would compensate for the opportunities forgone by losing the land (Oba 1998: 64).

#### Oral History of Traditional Range Burning

The Borana oral history of the environment was useful in analyzing the response of the rangelands to periodic burning and the impact of the official banning of range fires. Our informants state that the fire ban began in the early 1970s with the expansion of bush cover. The *gada* period was successfully used to reconstruct historical timelines of changes in vegetation in the southern rangelands over the following decades. The evidence showed that Borana oral history could be relied upon to understand the role played by fire in the savanna ecosystems of southern Ethiopia. For example, oral sources cite an incident following the rinderpest epidemic of the 1890s, when a fire that was started in Liban crossed the Daua River into Dirre and burned the ritual settlements near present-day Yabello town, some 280 km from the source (Oba 1998). The wildfire was caused by an accumulation of fuel that occurred after the reduction of the cattle population. Similar events were reported throughout East African savannas after the decrease in herbivore populations following the rinderpest plague (Kjekshus 1996).

The reason for the fire ban was the official conservation policy linked to the loss of forest cover in the Ethiopian highlands (Reid *et al.* 2000). The policy was applied to the rangelands without consideration being given to the ecological role fire played in range management (see also Desta and Oba 2004). Despite the government's concern about the careless use of fires, this study showed that the pastoralists are knowledgeable and careful about the application of fire. When using fire, the Borana avoided some areas for periodic burning. For instance, the Borana avoided settlement areas, while the "forward grazing areas" (*mataa tika*) were periodically burned. Burning removes moribund grass and kills tree saplings. The herders recognized that post-fire grass growth is nutritionally superior to the unburned grass. The absence of fire for several decades

has had a negative impact on the quality of the rangelands (Oba 1998). Pastoralists' observations suggest that following the official banning of fire, the woodlands have thickened and over-grown the herbaceous layer (see also Cossins and Upton 1988; Mbow *et al.* 2000; Laris 2002; Natcher 2004; Sheuyange *et al.* 2005). The absence of fire also meant that the threat of ticks infesting livestock had increased. The Borana believe that the ban on the use of range fire adversely affected the overall productivity of the rangelands and that fire remains an essential element in sustainable management of the rangelands of southern Ethiopia.

### Impacts of Bush Encroachment on the Rangelands

Oral sources suggest little evidence of region-wide bush encroachment before the *gada* Madhaa Galma (1952–1960). The spread of bush encroachment was only noticed after the *gada* Liiban Jaldesa (1960–1968). There is an anecdotal oral historical suggestion that links the cause of bush encroachment with the handing over of power from the *gada* Liiban Jaldesa to Gobbaa Bulee (in addition to other factors already mentioned)<sup>1</sup>, although this does not preclude the evidence that the Borana linked expansion of bush encroachment to the ban on the use of fire. In the absence of fire, bushes reduce grass production, creating feed deficits for livestock. Across the three districts that were surveyed, bush encroachment was a greater threat in Arero and Dirre than in Yabello. In the southern rangelands, 83% of the rangelands were threatened by a combination of

bush encroachment and unpalatable forbs. Only 17% of the rangelands were free from either bush encroachment or invasion by unpalatable forbs. Bush encroachment is in a climax stage in 24% of the rangelands at the regional scale. In the bush encroachment climax areas, the woody cover exceeded 60%, with the density approaching 2000 trees ha<sup>-1</sup> (Oba 1998). Earlier studies (e.g., Bille and Eshete 1983) suggest that bush cover expansion might have occurred in phases, first affecting some grazing areas and then expanding to others. For example, a comparison of aerial photographs of the area north of Yabello taken between 1967 and 1984 showed that woody cover had increased from 24.1% to 28.5%. The changes were localized as opposed to uniform (GRM 1989). The cycles of bush invasion were probably mediated by episodic climatic events and irregular use of fire. Oral sources suggest that the Borana rangelands have been disturbed by famine, heavy rainfall, and disease epidemics that caused episodic shifts in the vegetation structure during previous centuries (G. Oba and A. Angassa, unpublished).

The Borana pastoralists distinguished invasive from non-invasive woody species. Our interpretation of herder knowledge was that the invasiveness of particular species varied with specific localities. Species that expanded into new areas where they were not native were considered to be invasive, but the same species occurring in their native habitat were not considered as such. For this reason, the herder response for the same woody species was variable. Furthermore, pastoralists acknowledged other woody species in their rangelands that were non-invasive and therefore valuable as a source of livestock feed.

The loss of key perennial grasses was linked to bush encroachment. It is important, however, to verify the level at which herders made their deductions; plant species loss at local levels might not correspond with losses on a regional scale (Oba *et al.* 2003). Generally, herders referred to the regional scale. We interpreted pastoralists' responses in terms of the main economic goals of cattle management. The undesirability of bush encroachment is associated with the reduction of the grass layer. Consequently, the attitudes of the pastoralists were determined by the availability of grass fodder. However, this is not to suggest that the present trends in bush cover have not influenced the Borana pastoralists in other ways. As reported recently (e.g., Desta and Coppock 2002), the Borana responded to the increased bush cover by learning to herd camels, which are mainly browsers.

### Conclusions

The paper focused on the use of indigenous knowledge in understanding, analyzing and evaluating the impact of

<sup>1</sup> According to the Borana oral historian Borbor Bulle, there was a violation of the transfer of power (*baali*) from the outgoing Liban Jaldesa to the incoming *abba-gada* Gobbaa Bulee. According to *aadaa seera* (law), the incoming *abba-gada* takes power in a symbolic ceremonial handing over of an ostrich feather (i.e. *baali*). The emotionally charged ceremony (this is the only occasion when Borana carry arms during ceremonies) is related to concerns about what the future holds in terms of a better life, peace and political stability. For example, each *gada* class remains in power for a specific period (eight years), which begins and ends with a formal transfer of *baali*. The group which transferred *baali* to the future ruling *gada* class will not return to power until another 40 years has passed. According to the *aadaa seera* (law) of Borana, the outgoing *abba-gada* blesses the *baali* and hands it over to the incoming *abba-gada* who in turn blesses the event for successful achievements in the new era. According to Borana law, the transfer of *baali* is perceived as a transfer of what was good from one *gada* to the next and therefore symbolically concerns the well-being of the entire society. In this particular case, Gobbaa Bulee refused to take the symbolic ostrich feather. Not being allowed to stay in power, according to the *gada* laws, the outgoing *abba-gada* placed the symbolic ostrich feather on *Acacia tortilis* (*Dhaddacha*). The transfer of power from *abba-gada* to a tree was unprecedented. In the view of the Borana, Gobbaa Bulee took the *baali* from the tree and blessed trees instead of the Borana, which explains the expansion of bush encroachment.

range enclosures, crop farming, the ban on fire, and bush encroachment on the communal rangelands of Borana in southern Ethiopia. The use of communities' knowledge as a basis for understanding how changes in land use have historically impacted the rangelands provided an important methodological approach for evaluating communities' responses to changing land use. In the present study the basic assumption was that any change in traditional land use practices would have an impact on the dynamics of the rangelands. In the last few decades, the establishment of range enclosures and the expansion of crop farming resulted in the fragmentation of communal rangelands, while the official banning of fire resulted in the expansion of bush cover. These changes resulted in feed scarcity and greater vulnerability of stock, particularly during drought years. The ban on the use of fire has shifted the ecological balance between woody plants and grass species. Following the introduction of the government land use and fire ban policy, vast areas of the savannas of southern Ethiopia have experienced an expansion in bush encroachment and drastic declines in grass cover. Herders suggested that the deteriorating quality of the grazing lands, as a result of bush encroachment, posed a serious threat to livestock production. Given the failure of range development policies to preserve the local environment, the environmental knowledge of the herders may provide a logical guide for redesigning pastoral development policies. Considering that pastoralists are frequently observing and exploiting the local environment, the contribution of the local people to range management may be more efficient than policies imposed by the government. Besides recording traditional land use, studies addressing herders' indigenous ecological knowledge may play a beneficial role in developing a more effective land use policy. In the future, planners and policy-makers should consider communities' knowledge in an effort to design effective pastoral development programs. By considering herders' knowledge and involving them in the decision-making process for development, a more sustainable use of the local resources and a better future for pastoralists could be promoted. We suggest that sustainable use of the southern rangelands in the future will require paying greater attention to regulating the expansion of enclosures, crop farming and ranching, as well as reintroducing fire, where necessary, to control the expansion of bush cover. The new policy should recognize the importance of reintroducing fire for the management of bush encroachment and be linked to communities' fodder management strategies. In this regard, future management programs for the control of bush encroachment also need to understand the mechanisms of bush encroachment in relation to land use and the rehabilitation and management of bush-invaded rangelands.

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