Traditional rangeland resource utilisation practices and pastoralists' perceptions on land degradation in south-east Ethiopia

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Abstract

A study was conducted to examine rangeland resource utilisation practices of pastoralists and rangeland degradation in Rayitu district, south-east Ethiopia. A single-visit survey method was used to gather data through a structured questionnaire (90 households), group discussions and direct observations. Free grazing of communal land (100%), use of enclosures (89%), division of herds based on species and class of animal (59%), migration (79%) and seasonal assessments of the condition of rangeland were the basic traditional rangeland management practices. About 91% of pastoralists indicated that the condition of their rangelands was poor. The most dominant use for woody plants was for construction (91%), followed by browse (68%) and medicinal purposes (25%). More than 86% of the respondents considered that their grazing lands now carried more bushes and shrubs than they did 30 years ago. Feed and water shortages and drought were identified as current challenges for pastoralists, with migration the main coping strategy, in spite of the hardships it entails. Rejuvenating the existing rangelands requires the development of a rangeland management strategy involving pastoralists and other stakeholders, with all participants fully committed to a successful outcome. A reduction in livestock numbers must be an essential component of any future strategy.

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Introduction

Pastoral communities usually have a detailed knowledge of their grazing lands, acquired through extensive observation and continuous herding practice (Oba and Kotile 2001; Mapinduzi *et al.* 2003). Despite the existence of such knowledge, researchers and development policy experts have previously overlooked community-based knowledge when evaluating rangelands. Turner *et al*. (2000) concluded that traditional knowledge of indigenous people was fundamentally important in the management of local resources. Other studies (*e.g*. Fernandez-Gimenez 2000; Ayana and Fekadu 2003; Amaha 2006; Ayana and Oba 2008) also showed that documenting indigenous knowledge of rangeland resources can provide useful information for the development, sustainable utilisation and conservation of natural resources. Additionally, community-based knowledge may provide new insights for improving existing scientific knowledge and a basis for designing appropriate research and development policies. In most parts of Ethiopia, the indigenous knowledge of pastoralists is not adequately documented (Gemedo 2004; Amaha 2006).

Rayitu district is located in the lowlands of Bale, where pastoralism and agro-pastoralism are the main land use systems and livestock are the main assets of the community. The knowledge of pastoralists on current rangeland condition and utilisation practices, water management and woody plant use in this region has not been documented. This study was initiated to document the traditional rangeland utilisation practices of pastoralists and their perceptions about rangeland degradation in Rayitu district of the Bale zone of Ethiopia.

Materials and methods

Description of the study area

The study was conducted in Rayitu district, located in Bale zone of the Oromia Regional State, Ethiopia. It covers an area of 6140 km^2 at an elevation of 500–1785 masl. The climate varies from hot to warm submoist plains (Sm1–1) in the subagro ecological zone. The rainfall pattern is bimodal (March–June and September–October) with erratic distribution. The average annual rainfall is about 450 mm (PADS 2004). The main production system in the district is pastoral (PADS 2004). Of the total land area, woodland vegetation accounts for 75%, pastureland 20%, cropland 2% and settlements 3% (Phaulos *et al.* 1999). Solancharks, fluvisols and xerosols are the main soil types of the district. The grazing livestock population in the area is estimated to be about 22 100 to 37 600 cattle, 31 000 goats, 10 900 sheep, 6700 camels, 4400 donkeys, 110 horses and 64 mules (Phaulos *et al.* 1999; CSA 2003).

An assessment of traditional rangeland utilisation practices

Data were gathered using a single-visit formal survey method (ILCA 1990). Prior to the actual survey, visits were made to the district and secondary information relevant to the study was gathered from all possible sources. Informal surveys and group discussions were made to gather information about the district and to get insights from community members who were directly or indirectly involved in the production system. Group discussions were held with elders, key informants, development agents working on the sites and district administrative officers. These discussions focused on livestock populations, feed resources, rangeland condition and management, woody vegetation and its use, bush encroachment, water resources, rangeland use conflict and drought. The information gathered through the above process was summarised and used as a basis to design other data-collection instruments.

A structured questionnaire was designed to obtain data on rangeland condition and management and bush encroachment. The questionnaire included both closed (single response) and open (multiple responses) questions. A pre-test of the questionnaire was made before the actual data collection, and appropriate modifications and corrections were made. Interviewers were recruited and trained in an attempt to improve the accuracy of answers to questions.

Six of the 19 district Pastoral Associations (PAs) were selected based on accessibility, representativeness of grazing land and livestock potential. From the selected PAs, a total of 90 households were chosen at random and interviews were conducted, with community leaders as facilitators. Prior to the interview, the objective of the survey was explained and discussed with the informants in order to ensure their cooperation.

Statistical analysis

The collected household data were summarised and analysed using Statistical Package for the Social Sciences (SPSS, Version 10, 1996). Descriptive statistics such as mean, percentage and standard deviation were used to present the results.

Results

Household profile

The household survey showed an average family size of 9.45 ± 5.94 (± SD). All respondents were male and Muslim, as males were the head of the family and strong cultural practice prevented females responding on behalf of the family. The age range was 27–77 years (mean 48 ± 9.56). About one-third of the respondents had no formal education with only 2% being educated past 6th grade.

Evolution of agro-pastoralism

Historically (30 years earlier), livestock production was practised by 94% of families and the inhabitants were totally pastoralists. Livestock and livestock products played a major role and the rangelands were used mainly for grazing. Currently, only 36% are purely livestock producers, with 63% combining livestock and crop production (agro-pastoralists). Most of the fami-

lies (73%), who commenced growing crops, did so during the period 1974–1991, with 13% doing so before that time. Reasons for adopting an agro-pastoral lifestyle included: the need to diversify household income (81%); human population pressure (49%); expansion of settlements (19%); and a decline in livestock numbers per household owing to drought (12%). Consequently, pastoralists started to cultivate small plots of land to grow cereal crops in situations which were marginal for cropping. About 94% of the respondents had increased the area of land devoted to cultivation at the expense of grazing area. Maize, sorghum and teff (*Eragrostis tef*) were the major crops grown.

Livestock production systems

Livestock have been the main assets of pastoralists, with an average livestock holding per household of 10.3 Tropical Livestock Units (TLU = 250 kg non-lactating animal; ILCA 1991) (Table 1), of which 5.9 TLUs were cattle. Most households indicated that livestock management was traditional with a free-ranging, extensive system. Ninety-eight percent of respondents derived income from livestock, selling small ruminants and dairy products, with some selling crops (46%), honey (17%) and timber products (3%) to cover expenses.

Livestock were also used as sources of food (mainly milk from cattle, goats and camels, and occasionally meat), as well as for social functions and transportation and to supply draught power. Camels and cattle have been used in society as a 'savings account', while small ruminants constitute liquid assets, often being sold during emergencies and at the time of crop failure. In the study area, manure was rarely used for fuel and crop production. Based on the results of the group discussions and responses of the sampled households, drought (86%) ranked as the primary constraint to livestock production, followed by shortage of feed (62%), availability of water (53%), health problems (45%) and wild animal attack (12%).

Table 1. Mean livestock holdings per household in Rayitu district (n = 90).

Livestock class	Herd size (TLU[1])	SD
Cattle	5.9	2.50
Sheep	0.5	0.44
Goats	1.1	0.57
Camels	2.4	4.25
Equines	0.4	0.27
Total	10.3	0.62

[1] Tropical livestock unit.

Feed resources and traditional rangeland management

Feed resources. Natural pastures, woody plants and crop residues were the major feed resources for livestock in the study area (Table 2). Although the availability of crop residues was low, straw from maize, sorghum and teff was fed mainly during the dry season. As most of the land was covered with woody vegetation, trees and shrubs were important sources of livestock feed throughout the year. Some of the most important browse species mentioned by pastoralists were: *Acacia bussie, A. mellifera, A. senegal, Combretum collinum, Commiphora erythraea, C. kua, Grewia arborea* and *G. tenax*. Grazing was the main form of feed utilisation, and grazing lands were communal and grazed continuously throughout the year. Natural pasture was available to animals for about 6 months, mainly from March to June (main rainy season) and September to October (short rainy season). During the dry season, natural pasture, browse plants and standing hay were important (Table 2). All households experienced a critical feed shortage during both the short and long dry seasons. Strategies for coping with feed shortages included: migration (December–February); and use of alternative feed sources like browse trees, enclosures and crop residues. Pastoralists supplement all classes of livestock, especially cattle, with mineral soil called Haya, usually during the wet season. The supplement was considered to make livestock fat and stimulate cows for reproduction, as well as having medicinal value.

Traditional rangeland and herd management practices

Clan leaders in Rayitu had no control over communal rangeland management practices. About 88% of respondents conserved feed as standing

Table 2. Ranking of feed resources during the wet and dry seasons. Values are the percentage of respondents (n = 90) who rated that feed type as the 1st, 2nd, 3rd or 4th most common type.

Feed type	Wet season				Dry season			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Natural pastures	89	11	3	-	56	27	16	6
Browse	11	73	28	9	31	32	15	28
Crop residues	-	9	44	91	6	30	30	18
Standing hay	-	7	25	-	8	11	39	49

hay by establishing enclosures called Hogga, where standing hay was surrounded by thorny bush fences. About 98% of these enclosures were owned privately, while the rest were communal enclosures, accessible to all members of the community. Private enclosures provide greater control by the individual in managing that piece of rangeland to ensure conservation of forage for his animals and for the cultivation of more land. Enclosures were usually located around the homestead and farmlands and were used mainly for dry season feeding of lactating cows, calves, draught oxen and weak and sick animals. This rangeland management practice was a recent innovation. Drought (*i.e.*, shortage of rainfall), bush encroachment, poor productivity and lack of proper management of enclosures were considered major constraints to production. Splitting of livestock species was common. Fifty-eight percent of respondents split their herd into village-based and satellite herds. Village-based herds such as calves and small ruminants were kept around the homestead, as were animals under production (lactating cows), sick animals and calves during the dry season. Satellite herds (bulls, heifers, dry cows and camels) utilised pasture and water remote from the homestead. Of the respondents, 71% were transhumance, moving their livestock seasonally in order to exploit areas remote from their permanent settlement sites. The entire villages rarely moved with the herd and only 6% (5) of the respondents were nomadic, while the remaining 23% were sedentary. The extent and direction of movements depended on the availability of rainfall, water, feed and security. In the dry season (December–February), livestock, mostly cows, bulls, heifers, goats, sheep and camels, were moved to a remote location where water and feed were abundant and stayed as godaantu (migrants). Household heads and boys above the age of 15 years were responsible for migration. According to 63% of respondents, the frequency of migration has decreased over time, owing to settlement, decline in livestock ownership per household, human population pressure, conflict and government policy (encourages settlement, education and water points). The remaining 37% indicated that the intensity of migration has increased in the study district because of shortage of rainfall (*i.e.*, drought conditions), feed and water. Problems associated with migration were: wild animal attack 88%; death of livestock 73%; water shortages 46%; feed shortages 14%; conflict 12%; theft 4%; and human disease 2%.

Rangeland condition and degradation

There were differing opinions on the current condition of the rangeland as compared with 30 years ago. Ninety-one percent of respondents indicated that the condition of rangelands was poor with drought, overgrazing and bush encroachment being the major constraints (Table 3). The communities were well aware of the extent of degradation that has been occurring in the rangelands and listed bush encroachment (83%), reduction of livestock numbers (90%), reduction of livestock output (90%), change in the proportion of perennial to annual species (81%), change in vegetation cover (93%) and soil erosion (93%) as indicators of rangeland degradation. Periodically, pastoralists assessed the condition of the rangelands, either individually or on a group basis, using mainly the following criteria: availability of grasses and water, freedom from animal and human disease, suitability to the different livestock species and security of the herders. In the past, when grasses were abundant, pastoralists used fire as a management tool, but recently the use of fire has been banned.

Table 3. Possible causes of poor range condition and rangeland degradation as ranked by the responses of the sampled households in Rayitu district (n = 90).

Causes	Current range condition	Rangeland degradation
	(%)	(%)
Drought	90	87
Overgrazing	49	45
Bush encroachment	34	25
Population pressure	52	36
Increased settlement	11	27
Decrease in livestock mobility	-	33
Limited knowledge of rangeland management	37	27
Soil erosion	-	18
Lack of burning	1	7

Use of woody plant species. Pastoralists used woody plant species for a wide range of services, the primary use being for construction purposes (91%), followed by use as livestock feed (68%), for medicinal purposes (25%) and to some extent for timber (14%), food (30%), shelter (6%) and fragrance (3%). *Acacia bussie* and *Combretum collinum* were important for use for house and fence construction. Some trees and shrubs were commonly used as traditional medicines for livestock and humans.

Some tree species were also used as indicators of potential locations for wells during drought. Respondents perceived that *F. sycomorus* probably required large amounts of moisture and usually grew near underground streams, where the water table was shallow. While fuel wood was the major source of household energy, only dry and dead wood was used for fuel, as living trees were not cut as a fuel source. Charcoal making and marketing was rare in the area owing to government controls, prohibition of marketing charcoal and poor access to market.

Bush encroachment. About 86% of the respondents indicated their grazing land carried more bushes and shrubs than 30 years ago, while 83% of households perceived bush encroachment to be an indicator of rangeland degradation and blamed drought (56%), overgrazing (44%), uncontrolled livestock movement (42%) and lack of burning (9%) for triggering bush encroachment in the area. However, 17% of the respondents failed to give any reason for bush encroachment. According to the respondents, reduced production of herbaceous vegetation, mainly the grass layer (84%), difficulty in herding (54%), damage by wildlife (50%) and bloating (3%) were the major problems associated with an abundance of trees and shrubs. *Acacia bussie* and *Commiphora* species were the major encroaching bushes.

Poisonous plants. Poisonous plants were increasing in abundance but were not a major problem for livestock production in the district. In the pastoral areas, livestock were traditionally kept under free-ranging conditions on rangeland that was frequently denuded by drought, overgrazing and bush encroachment, so that animals could eat poisonous plants, which they would normally avoid. Ninety-three percent of respondents knew poisonous plants, both herbaceous and woody, which affected their livestock. The most common was *Tribulus terrestris* (kumudu), an herbaceous plant found during the wet season. Pastoralists considered it caused bloating in cattle at early growth stages and indicated that it was introduced from other areas. Grass species such as C*ynodon nlemfuensis* (kecha) were also reported to be poisonous for cattle, along with *Achyranthus aspera*.

Water resources. Availability of water resources has been a major threat and key determinant for the movement and migration of pastoralists in the study district, with 96% of households indicating that both quality and quantity of water were major problems. Intermittent rivers (26%) (Calcal, Jaban and Laantaa), ponds (63%) and rainwater (96%) were the major sources of water for livestock during the wet season, while ponds (27%) and permanent rivers (99%) (Wayib and Waabee) were the main ones during the dry season. However, these rivers flow on the southern border of the district, so were of limited benefit for the whole district.

In the Rayitu district, traditionally shallow ponds and wells were dug, with most belonging to the community, while some were owned individually. Strict rules applied to usage of water from the ponds, and ponds and wells were regulated, fenced and guarded by elders in the village. Some ponds were utilised only during the dry season and remained closed until this time. Pond water was used mainly for humans, calves and weak animals. About 54% of respondents reported that animals and humans might use the same sources of water. About 59% of respondents travelled more than 20 km in a round trip during the dry season to provide water for their animals, while a further 23% travelled 6–10 km.

Watering frequency of livestock depended on season, type of livestock species and distance from watering points. During the dry season, 10% of respondents watered cattle daily and 87% every second day, while 80 and 88% of pastoralists watered sheep and goats, respectively, every second or third day. Most (91%) watered camels every 4–7 days. To cope with water shortages, 52% of respondents would migrate to watering points, 6% used conserved water by digging ponds and 42% used a combination of the two. During the dry season, pastoralists dug shallow wells called eela at the side of intermittent rivers. The other form of water supply in the district was ground water, which was dug by a non-government organisation (NGO) called Water-aid.

Rangeland use conflict

The term 'conflict' in the context of this study refers to the ongoing disputes between various groups over access to scarce range resources (Table 4). As far as rangeland use was concerned, 58% of respondents recognised that there was conflict between pastoralists over utilisation and ownership of territory. About 96% of respondents considered that the conflict was between the Oromo and Somali ethnic groups.

There were different opinions as to whether the intensity of conflict over rangeland resources has increased over the last 3–4 years or not. Many pastoralists (85%) suggested a decrease in intensity, mainly due to an increase in conflict between the Somali ethnic groups such as Ogaden and Shiekal (Shekistan) around the border of Oromia and Somali National Regional State (SNRS), which reduced the tension between Oromo and Somali ethnic groups. A further reason for reduction in conflict was government interference. In contrast, 15% of respondents suggested that the intensity of conflict escalated during this period, mainly as a result of livestock feed shortages during the dry season. During the time of feed shortage, Somali pastoralists from the neighbouring SNRS created pressure on rangeland resources and were a cause for conflict. However, most respondents agreed that conflicts were managed and mediated by clan leaders, community elders, religious leaders, respected individuals (Jarssa biya) and government and non-government bodies.

Droughts

Frequent and prolonged drought has been the most important natural threat that impacted on the livelihood of pastoralists, remaining a major cause of famine in Rayitu district for many years. Respondents differed in their perception of the frequency of drought, 43% suggesting droughts occurred every year, 32% every 2 years and 10%

Table 4. Conflict situations in survey area. Values are the percentages of respondents in the study district who gave that answer (n = 90).

Conflict		Percent
Ethnic group	Oromo-Somali	96
	Oromo-Oromo	4
Intensity over the last 3-4 yr	Decreased	85
	Increased	15
Cause for conflict	Grazing land utilisation	2
	Grazing land ownership right	15
	Grazing land and water utilisation	37
	Grazing land, water utilisation and settlement	31
	Grazing land, water utilisation, settlement and ownership	15

every 3 years. Pastoralists have become largely dependent on food aid.

During drought years, pastoralists migrated to localities where resources were relatively more available. Moreover, they adopted strategies such as supplementary feeding (browse trees and conserved feed), herd management (maintenance of female-dominated herd structure, herd diversification), use of wild fruits, destocking and accepting assistance from various sources such as government bodies and NGOs.

Discussion

This study has provided a wealth of information on current management systems in the Rayitu district of Ethiopia, which will be invaluable in developing sustainable management strategies for use by pastoralists. The development of agro-pastoralism resembled that in other pastoral areas in Ethiopia (Ayana and Gufu 2008), reflecting a change from the traditional pastoral lifestyle of much of the 20th century.

The average family size in the study district (9.45) was higher than reported for Afar and Kereyu pastoralists of Ethiopia (6.74) (Abule *et al*. 2005) and Hamer and Bena-Tsemay (7.3) (Admasu 2006), but lower than that reported for the Borana pastoralists of south-east Ethiopia (13) (Alemayehu 1998). The higher family size might be associated with the cultural practice of polygamy by most pastoralists of the study area. The low level of education observed in the survey is common to many pastoral areas of Ethiopia (Abule *et al*. 2005) and might impede efforts to achieve technology transfer to the local population.

Like many pastoral and agro-pastoral communities in other pastoral areas of Ethiopia and east Africa (Coppock 1994; Ndikumana *et al*. 2001), households kept more than one species of livestock to secure their livelihood, with a predominance of female animals. Retaining two or more species with different feeding habits can make more effective use of vegetation and often be more profitable. In addition, different livestock species can serve different roles (Scoones 1995; Amaha 2006), with sale of livestock and livestock products providing the main source of income (Ndikumana *et al*. 2001; Abule *et al*. 2005). As elsewhere in Ethiopia and other pastoral areas in east Africa, communal grazing was the main traditional land-use management system in the study area. Productivity of the rangelands was influenced by availability of desirable plant species and adequate rainfall (Oba *et al*. 2000), with drought causing feed shortages in terms of season of use (Oba and Kotile 2001) and grazing capacity (Abule *et al*. 2005).

As opposed to other pastoral areas of Ethiopia like the Borana, south Ethiopia (Gemedo 2004) and Afar middle rift valley of Ethiopia (Abule *et al*. 2005), no communal rangeland management practice was controlled by the clan leaders in Rayitu district. However, the utilisation of rangeland areas by establishing enclosures was similar to that practised by the Borana pastoralists of south Ethiopia (Coppock 1994; Ayana and Oba 2008) and part of the middle Awash (Abule *et al*. 2005). Unlike the Borana pastoralists, most enclosures (98%) of Rayitu pastoralists were owned privately. According to the pastoralists, the establishment of range enclosures was the communities' way of responding to seasonal feed shortage, providing conserved forage for their animals and enabling the cultivation of more land. Establishment of additional enclosures in the study area could provide an opportunity to develop a more intensive grazing land management and could help in reducing grazing pressure on communal lands, creating access to fodder banks and improving restoration of soil for successful rangeland development. The problems associated with enclosures in the study area were similar to those reported by Oba (1998) and Gemedo (2004) in southern Ethiopia Borena. In contrast, Admasu (2006) reported that enclosures in Hamer and Bena-Tsemay districts were found to be in good condition with no bush encroachment. The allocation of grazing lands for wet and dry season use in the study area was not as well developed as that of the Borana pastoralists.

The traditional range and livestock management practices observed in this study of splitting livestock herds based on species, type and productivity, migration and free ranging of communal land were similar to those reported from other east African countries (Oba and Kotile 2001) and for Borena pastoralists (Gemedo 2004). Mobility and opportunistic resource utilisation characterised the pastoral production system. It was a very important strategy of pastoralists to exploit scarce vegetation and water resources in dry lands and was in harmony with the harsh environment. The extent and direc-

tions of movements, trends of migrations and the problems facing pastoralists in the current study were similar to those reported by Scoones (1995), Abule *et al.* (2005) and Amaha (2006). Pastoralists associated the spatial diversity and abundance of bush and shrub vegetation with free movement of livestock in the communal grazing land, resulting in dispersal of seeds of different plant species.

The poor current range condition and rangeland degradation documented in this study were similar to those found in the Borana rangeland of southern Ethiopia (Oba 2001; Ayana and Fekadu 2003), middle Awash areas of Ethiopia (Abule *et al*. 2005) and Hamer and Bena-Tsemay districts of south-west Ethiopia (Admasu 2006). The seasonal assessment of range condition and the criteria used by pastoralists in the study district are vital for the future of the rangelands. The wealth of knowledge generated by pastoralists in assessing range condition will be invaluable in generating future grazing management plans. It is also essential in restoration of rangelands and prevention of further rangeland degradation and conservation of resources.

The importance of woody plants to households in the study area was highlighted by the broad range of uses to which they were put. While construction represented the most widespread use, the importance of trees and shrubs as forage sources for livestock cannot be overstressed. The use of plants for medicinal purposes was their major benefit for most indigenous rural people (Rossato *et al*. 1999), but this was their third-ranked role for Rayitu pastoralists. In general, herbal medicines are very important in Ethiopia because most modern medicines are unavailable or unaffordable for most inhabitants. Pastoralists, in particular, depend heavily on these traditional herbal medicines because they live in remote areas where health care centres are rare. In addition to their current uses, these plants are potential sources for developing new drugs in the future. Since the population relies so heavily on woody species, it is not surprising that over-utilisation can result in the loss of woody vegetation cover (Amaha 2006) and alter the ecosystem. While improved livestock production must be achieved to sustain the pastoral production system in semi-arid ecosystems of the Rayitu rangelands, the sustainable use and conservation of woody plant resources need to be addressed by development programs, since pastoralists depend so heavily on woody plants with their multiple uses. Hence, communities must be involved in the planning, design and implementation of development projects. Moreover, to avoid the negative outcomes of excessive use of woody plants, integrated and participatory efforts that involve all stakeholders should be made.

In contrast, bush encroachment and the expansion of invasive plant species represent significant problems as occurs elsewhere in the rangelands of Ethiopia (Oba *et al*. 2000; Abule *et al*. 2005; Ayana and Oba 2008). Smit (2002) suggests that the causal factors for bush encroachment are complex and have been a contentious issue in rangeland ecology. Pastoralists in the study area considered that drought, overgrazing, livestock movement and absence of fire were major factors triggering woody encroachment, in agreement with reports by Abule *et al.* (2005) for the Awash Rift Valley of Ethiopia, Herrmann and Hutchinson (2005) for the Sahelian belt of Africa, Twine (2005) for South Africa, Gemedo (2004) and Ayana and Oba (2008) for the Borana zone of southern Ethiopia and Amaha (2006) for the Somali zone of eastern Ethiopia. In semi-arid ecosystems, these issues are some of the major factors that cause conversion of grasslands to woodlands (Archer 2003). There is also ample evidence in the literature that bush encroachment causes a decline in rangeland condition and the respondents in this study supported this view. The control of bush encroachment will require a proper understanding of invasive species, the degree of encroachment, the mechanisms leading to their increase and the population dynamics of the invasive species, which would be used to develop a long-term community-based control program.

The results of the present study reinforce the fact that water is clearly the most limiting resource affecting productivity of rangelands. Pastoralists have developed strategies to cope with this by digging ponds and wells to supply drinking water, with traditional rules and regulations in place for utilisation of watering points as reported for east African rangelands (Ndikumana *et al*. 2001). In addition, regulating the frequency of watering livestock allows better utilisation of both water and forage resources. More efforts should be devoted to developing and improving access to surface and underground water sources and strengthening traditional water management systems.

Prolonged droughts have been the most important natural threat to the livelihood of the pastoralists, as found in many other studies (Ndikumana *et al*. 2001) and were ranked as the major factor responsible for degradation of rangeland in the study area. In meteorological terms, Pratt *et al*. (1997) suggested that drought occurred when rainfall was below half the long-term average or when rainfall in two successive years fell 75% below average. According to Coppock (1994), drought can be defined as 'when two or more consecutive dry years occur in which the length of the growing period (LGP) is less than 75% of the mean, i.e., a drought is driven by several consecutive rainy seasons in which deficient rainfall has a determinant effect on the production system.' Historical evidence indicates that natural climatic patterns produce cycles of drought, followed by periods of relatively higher rainfall. However, Snyman (1999) reported that the effects of low rainfall can be intensified by injudicious grazing practices or overgrazing, which can lead to 'man-made droughts'. Degradation of the rangeland ecosystem, accompanied by soil loss, can increase the intensity of management-induced droughts, which are usually localised, as was the case in the study district. Even in normal rainfall years, parts of the grazing lands could suffer from localised drought, which could have been the underlying reason for the responses of some participants regarding the frequency of drought. People with degraded rangelands create their own droughts and increase the intensity and frequency of climatic droughts (Snyman 1999). Pastoralists have developed comprehensive knowledge and skills to cope with drought in its various forms, resorting to strategies such as migration, supplementary feeding (browse trees and conserved feed), herd management (maintenance of female-dominated herd structure, herd diversification), use of wild fruits, destocking and assistance from the government, non-government organisations and relatives. With predicted patterns of climate change as a result of global warming, the frequency and severity of drought periods are forecast to increase and more drastic measures will be required to prevent an increase in the rate of rangeland degradation. Reduction in livestock numbers will be an integral part of any coping strategy.

Studies conducted in parts of Ethiopia and the horn of Africa have indicated that pastoralists are challenged with multi-dimensional conflicts (Hogg 1997) as a result of competition for resources, changing patterns of resource use and the weakening of traditional mechanisms governing resource management and conflict resolution (Hussein *et al.* 1999). In our study, the main reason for the escalating conflict was perceived to be livestock feed shortages during the dry season. Mohammud (2003) reported that interclan conflicts have often been resolved using traditional social organisation and suggested that traditional social institutions could have a key role to play in resolving conflicts regarding management of natural resources, bringing sustainable development to pastoral areas. Hence, a strengthening of the traditional institutions and formulation of a conflict management policy would be crucial for successful development programs.

Conclusions

One of the major conclusions to be drawn from this study is that the current communal grazing system for rangelands is not sustainable. Since the problems facing pastoralists have emerged over many years, the solutions will also require time to implement. It is essential that degradation of rangelands be halted and the current condition of communal rangeland be improved through rangeland rehabilitation, conservation and improved management. This would involve resting of communal grazing areas, controlled grazing management, strengthening of privately owned enclosures as well as establishment of community-based enclosures in some key sites. The traditional goal of almost all livestock owners using communal rangelands is to maximise their animal numbers, which can lead to overgrazing. This culture is unsustainable and pastoral communities must be educated to reduce their livestock numbers to sustainable levels. This would involve the provision of local information on the enhanced performance of livestock when stocking pressures are reduced, resulting in greater productivity from reduced numbers of livestock. Furthermore, it is essential to focus on strengthening of the traditional resource management system, and provision of both technical and technological support to pastoralists. All stakeholders must be involved in the planning and execution of management strategies with full participation of pastoralists and government and non-governmental organisations.

Critical elements of any plan would include the conservation and management of desirable trees and shrubs for sustainable use. To this end, the indigenous knowledge of pastoralists about range-livestock management and their environment should be incorporated in the planning and implementation of developmental interventions.

Since drought (extended dry periods) has such an impact on pastoral production systems, minimising its effects will have significant direct impacts on the livelihood of pastoral communities. As a result, strengthening early warning systems, and developing coping and disaster-response mechanisms incorporating both indigenous and scientific knowledge should be a matter of priority. Furthermore, establishment of community-based grazing reserves in some key range sites for use during drought periods is essential.

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