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Review Paper

Rangeland Degradation and Restoration in Semi-arid Areas of Southern Ethiopia:- The Case of Borana Rangeland

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Abstract
Rangelands are geographical regions dominated by grass and grass like species with or without scattered woody plants. The rangelands cover over half of the land areas in Africa and Ethiopia in particular. The rangelands of southern Ethiopia comprise 7.6-12.3% of the area of the country. Borana rangelands comprise about 95,000km². In many countries, more than 50% of their rangelands were degraded. Before four decades, the Borana rangelands were known as the best rangeland in east Africa. But yet by the early 1990s it has been observed that productivity of the Borana was in decline. The aim of this paper is to review the concepts of rangeland degradation, its causes, effects and restoration techniques based on the studies so far done. To meet the objectives data and literatures were collected from different libraries and internet sources and reviewed. The literature review mainly addresses concepts of rangeland degradation, major causes in tropics and Ethiopia particularly in Borana rangelands, impacts of rangeland degradation, principles of rangeland restoration and common restoration techniques. The major factors that cause rangeland degradation are anthropogenic in origin. Of all bush encroachment is becoming the major threat to Borana rangelands. To restore areas those are encroached by bushes, bush clearing showed satisfactory result in Borana rangelands.

Key words: *Degradation, Overgrazing, Rangeland, Restoration,*

Introduction

Rangelands, as defined by Purdon and Anderson (1980), are geographical regions dominated by grass and grass-like species with or without scattered woody plants. The same authors indicates that in the developing countries of Africa, rangelands comprise over half the land area and support a large human population dependent on grazing livestock. Rangeland covers about 62% of total land area of Ethiopia (Alemayehu, 1998). The range lands of Ethiopia are estimated to cover area of 78 million hectare and most of them are found at an altitude below 1500m of elevation and generally classified as arid and semi-arid (Dawit Abebe, 2000).The rangeland of southern Ethiopia, which includes Borana ranageland is an important area of cattle production. The Booran are the dominant pastoralist group and they have been living in the region before the 13th century (Oba *et al,* 2000).

Rangelands are extremely important to society for the goods as well as the ecological services they provide. In China, rangelands form the largest terrestrial ecosystem and one of the three most important food producers (Li, 1997). To pastoralists in the Horn of Africa, livestock serve as wealth accumulation, social prestige, social security, drought bridging mechanism, for marriage gifts and debt payment (Amaha, 2006). According to Allen-Diaz (1996), rangelands play an important role in sequestering atmospheric carbon especially through the large size of these rangelands.

Because of the global climate change and the intensive human activities, desertification / land degradation has become the most serious problem in the modern society, particularly in the ecologically sensitive arid and semi-arid areas. Rangeland degradation implies a reduction in rank or status, which includes a loss of top-soil, a change to a simple floral/ fauna composition or a transition from one organic form to a lower organic form, and continuous reduction of productivity/biomass of the ecosystem (Barrow 1991). In the view of ecology, degradation can be treated as retrogression of an ecosystem. Generally speaking, a lower biological diversity is supposed to occur in a degraded rangeland, but there is still much research work to be done for the issue. Once rangeland has been degraded, it is often possible to rehabilitate it and thus restore it to a level of utility, possibly not as its original state, but better than it was in its damaged state (Barrow 1991). Rangeland degradation is the most extensive types of current land use problems and few countries have less than 50 percent of their pastoral lands degraded (Dahmed, and Yazman, 1994). In the past 50 years, evidences

showed that savannas throughout the world are being altered by a phenomenon known as 'bush encroachment' (Li, 1997). Bush encroachment is the suppression of palatable grasses and herbs by encroaching woody species often unpalatable to domestic livestock (Kauffman et al., 1997). Therefore, bush encroachment reduces the carrying capacity for livestock. Overgrazing by livestock is the principal land problem in the arid and semi-arid regions, coupled with land use change to cultivated farmland in the many countries (Barrow 1991). The rangelands of southern Ethiopia until four decades ago were considered as the finest rangeland in East Africa (Coppock, 1994). Yet, by the early 1990s it has been observed that the Borana system of pastoral production was on decline. The reason given was the human and livestock demographic growth (Coppock, 1994). This notion has not considered the effects of history of land alienation and interventions that upset the traditional patterns of land use (Oba *et al.,* 2000). Changes in natural vegetation dominated by the grass layer, leading to dominance of woody cover and increase in unpalatable forbs are considered as a threat to range conditions in Borana (Oba *et al.,* 2000).

Restoration attempts to return an ecosystem to its historic trajectory. Intact ecosystems are important reference sites, where restoration advocates may seek to emulate in their restoration endeavor (Kauffman *et al*. 1997). The goal of restoration is usually to develop self-sustaining communities (Parker, 1997). Restoration action on the other hand is the ultimate goal of ecosystem management. In the rangelands, the most common objective is to encourage palatable, productive perennials, as they are good for animal performance and to maintain a healthy environment (Saco *et al*., 2006). The present review was undertaken to assess concepts of rangeland degradation by giving due emphasis to Borana rangelands from data available from different studies; To address major causes of rangeland degradation as a whole and in the Borana rangeland ecosystem and to review the common possible methods so far used to restore degraded rangelands.

Rangeland Degradation

Ecosystems that are liable to species richness reduction lose important resources for their function. de Queiroz (1993) suggested that the reference point for rangeland degradation when measured in terms of beef that it can sustain, is the potential natural community that provides the highest grazing value for beef cattle production. This indicates that one major aspect of rangeland degradation is reduction in the capacity of the ecosystem to support livestock production and productivity. Fenoteselem (2005) also pointed out that the reference point of rangeland degradation with respect to ecosystem processes is the ability of ecosystem to cycle nutrients, process energy and to conserve the soil. Change in the pattern and state of vegetation or structure, as defined by patchiness and biodiversity in semi-arid regions, are the main indicators of the state of land degradation (Saco *et al*., 2006) and it gives useful information for monitoring.

Rangeland is considered degraded when pastures are getting unattractive by livestock and support only low stocking rates (Rischkowsky *et al*., 2003). Thus, degradation in general manifests a decline in productivity and affects the capacity of rangeland to sustain grazing animals. The major threats in the Borana rangeland were loss of perennial grasses and the increase in annuals, unpalatable forbs and bush cover (Oba and Kotile, 2001).

Causes of Rangeland Degradation

Human activities, including timber harvesting, infrastructure construction, grazing, mining, and water diversion, have decreased the species diversity and changed the function and productivity of ecosystems (Dahmed, and Yazman, 1994). These actions have degraded the future integrity, value and reduced the use of different rangeland ecosystems (Kauffman et al., 1997). Rangelands are also degraded when they are infested by weed, the soil is eroded, and when their pasture quality deteriorated. Milton *et al*. (2003) indicated that rainfall, fire, and grazing are the main driving forces of change in vegetation of semi-arid rangelands from perennial, drought-tolerant grasses and shrubs to annual, drought-sensitive plants. Other activities including burning, cropping and management of grazing animals conducted by humans have influences on vegetation cover, structure of vegetation communities, soil characteristics, and on biogeochemical cycles that may lead to the invasion of alien plant species (Fratkin, 1994). Baruch *et al*. (1996) also revealed that the biodiversity reduction in the South American savanna communities is due to the colonization of African species, which led to a progressive loss of native species from the communities. The majority of the threats were due to loss of perennial grass cover and increase in annuals, unpalatable forbs and bush cover (Oba and Kotile, 2001).

1. Overgrazing

Setting stocking at higher density has commonly resulted in a decline in the most palatable perennial species and an increase in less favorable species (Oba and Kotile, 2001). Because livestock is the major user of primary production in the semiarid and arid regions, degradation has always been attributed to this sub-sector (Sidahmed and Yazman, 1994). UNEP singled out human impact specifically, livestock grazing as being the cause of irreversible degradation which prevailed during the past two decades. According to the World Resource Institute (WRI, 1992), overgrazing is the most pervasive cause of soil degradation. In arid and semi-arid regions Africa and Australia, overgrazing causes 49 and 80 percent for soil degradation respectively.

The study in china indicated that in some cases low-lying prairie rangelands face increased salinization as a result of overgrazing (Blench & Florian, 1999). In overgrazed land the animals clip the vegetation to the bare ground, causing starvation and death of the root system (Purdon and Andreson, 1980). The effect of grazing on the vegetation of grasslands is often measured by changes in composition, cover and yield (Dahmed, and Yazman, 1994). Grazing above carrying capacity reduces the amount of regeneration and pushes the vegetation farther away from climax, while reduced grazing allows the system to move back along the succession pathway (Blench & Florian, 1999). Africa, the Middle East, Central Asia, the Northern part of the Indian subcontinent, Mongolia and most of the Northern China have lost billions of dollars in livestock production capacity as a result of overstocking land with cattle, sheep and goats (Blench & Florian, 1999**).** Overgrazing can increase soil erosion, reduced soil depth, soil organic matter and soil fertility; and also hurt the land's productivity. When grazing fields are heavily grazed (particularly at flowering and seed set times) they produce fewer seeds, decreasing recruitment of new individuals into the population. Moreover, compacted soil inhibits establishment of grasses (Purdon and Andreson, 1980). Figure 1 shows that overgrazing was always considered to be the most important factor affecting land degradation.

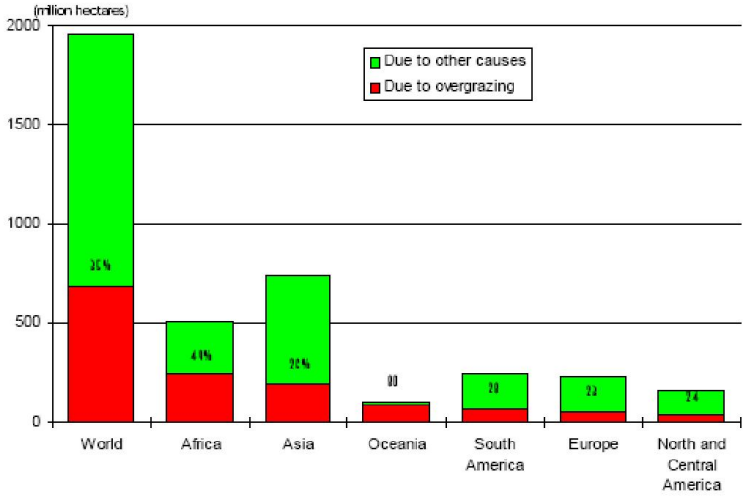

Fig.1 : Rangeland degradation since 1945
(Source: World Resources: 1994 – 95)

2. Sedentralization

The effects of overpopulation and government policies on agriculture, food availability and increased poverty have contributed to the sedentarization of pastoralists (Alemayehu, 2005). This has lead to concentrations of people, livestock, farming and other type of land use centered on permanent water supplies (Herlocker, 1999 in Alemayehu, 2005). These sites become centers of overuse of rangeland resources and subsequently resulted in rangeland degradation and reduced biodiversity. Causes of environmental changes linked to growing bush cover are presently associated with episodic climatic events as well as recent and historical land and water alienation in developing countries.

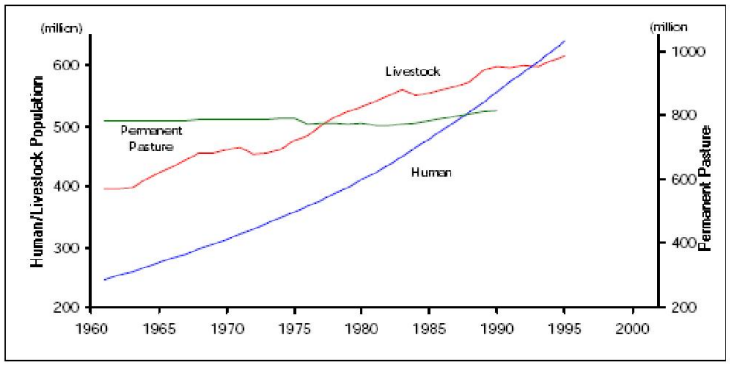

Figure 2: Trends in human/livestock population and permanent pasture in 36 arid/semi-arid development (SORDU, 1990).
(Source: FAO, 1996)

3. Encroachment of Rain Fed Agriculture in Rangelands.

Population in East Africa has been growing high during the last three decades. According to Fratkin (1994), most of the population increase has taken place in the higher potential agricultural areas of the region. Because of this, migration took place to high potential rangelands; areas formally occupied by habitats of various plants and animal species. Moreover increased populations put pressure on readily available resources and thus have widespread overexploitation of rangeland resources (Herlocker, 1999).

In developing countries, particularly in Africa and Middle East, traditional pastoral societies have lost their relative influence within the new national states of the dry lands, where political and economic powers tend to be in the urban and agricultural sectors (Thurow, 2000). Recent encroachment of rain fed cropping into the better pasture land can be understood as a response to newly created national policies for increased food production and increased emphasis on cash crops as producers of foreign exchange (FAO, 1993). Thus valuable grazing lands have been lost and important traditional exchange relationships between pastoralists and farmers have broken down. This type of range degradation is widespread in the Near and Middle East and in Africa, particularly in East and South East Africa, where agriculture and pastoralism in the past were in balance with environmental conditions.

The accelerated rangeland degradation should be considered in part as a reflection of unequal economic development and access to resources at national and local levels; and also linked with poverty, inadequate resource management and poor infrastructure (Raj, 2005). Loss of these high potential rangelands concentrates growing populations of pastoralist and livestock on smaller areas of less productive rangelands, leading to increased competition for resoureces and overexploitation (such as overgrazing) of rangelands (Alemayehu, 2005).

4. Frequent Drought

Pratt, *et al.* (1997), suggests that a draught can be said to occur when rain falls below half of the long term average or when rain fall in two or more successive years falls 75% below average. The Society for Range Management (1991), also defines drought as prolonged dry weather generally when precipitation is less than three quarters of the average rainfall. Agricultural drought is the stress that causes plants to wilt or die and results in lower production. These attributed to not only amount and distribution of rainfall, but also function of other influential factors such as temperature, soil characteristics and management of the land. The frequent drought in many parts of the world's dry lands and notably in Africa is a prominent factor, which has contributed to range degradation. The crisis in the pastoral production systems of the Sahel in the early 1970s showed the great repercussion of this sequence of dry years on rangeland degradation. When there is drought and overgrazing together, the effect on the productivity of the rangeland is double barreled (Herlocker, 1993). Pastoralists suggested that the Booran rangelands are periodically perturbed by episodic events such as droughts that result in mass livestock mortality (Oba and Kotile, 2001). Prolonged drought including a shortage and erratic rainfall can cause serious range degradation. Rainfalls during drought is hardly adequate to allow grasses to grow and unable to fill the surface water ponds (Alemayehu, 2004). Poor rainy seasons or droughts followed by years with above-average rainfall with frequent rainfall events have probably made a substantial contribution to the problem of bush thickening (Raj, 2005).

Mobility remains the most important pastoralist adaptation to spatial and temporal variations in rainfall, and in drought years many communities make use of fall-back grazing areas unused in ‘normal’ dry seasons because of distance, land tenure constraints, animal disease problems or conflict (Blench & Florian 1999). But encroachment on and individuation of communal grazing lands, and the desire to settle to access human services and food aid, have severely limited pastoral mobility.

5. Bush Encroachment

This type of vegetation degradation occurs where indigenous shrubs and trees encroach onto former grassland areas and changing them to various forms of shrubbed grasslands. On the other hand, the density of trees and shrubs may increase into thickets or various wooded types and reduce the relative amount of grass and therefore livestock production (Raj, 2005). Increase in domestic livestock (grazers) and a decrease in game animal numbers (browsers) results in increased pressure on the grass layer. The competitive advantage of a vigorous perennial cover declines and more favorable environment is created for the woody plant components. Invader bushes have started to produce seeds in abundance and so create opportunities for the establishment of new generations of bushes (Blench & Florian, 1999). In some instances woody encroachment is speculated due to a lack of foraging by livestock and lack of fire. Thus both overuse and underuse have been implicated in affecting vegetation dynamics (Herlocker, 1993)

Table1: Differences in mean yield of grass species composition between encroached (Encr) and non-encroached(Non-encr) rangelands in Borana.

Species name	Species yield as percentage of total yield					
	Medhecho		Dubluk		Did-Tuyura	
	Encr	Non-encr	Encr	Non-encr	Encr	Non-encr
Aristida adscensionis	2	7	17	18	1	**2**
Chrysopogon aucheri	18	23	13	23	21	**15**
Cenchrus ciliaris	33	31	10	2	13	**11**
Panicum coloratum	1	2	12	15	14	**16**
Pcnnisetum mczianum	9	1	13	1	3	**1**
Pennisetum stramineum	8	2	9	1	9	**6**
Others	29	34	26	40	39	**49**
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: *Ayana, 2005.*

Environmental changes linked to growing bush cover in Borana rangelands are presently associated with episodic climatic events as well as recent and historical land alienation (Bassi, 1997) and water development (SORDU, 1990). National policies against fire in the rangelands have facilitated woody encroachment to detriment of rangeland productivity and pastoral carrying capacities in Ethiopia (Alemayehu, 1998). Land alienation began following political perturbations caused by the Anglo-Italian war (1931- 1936) and subsequent ethnic conflicts, which displaced the Booran from over 60 percent of their traditional grazing lands (Oba and Kotile, 2001). The displaced population was compressed into a fraction of the former grazing territory where land use became more intensive as opposed to the traditional system. Added to the pressure caused by water-development was the alienation of a total of 54,000 ha of grazing lands for demonstration ranches in the Liban and the Dirre production systems (SORDU, 1990). The reduction in size of grazing land and over stocking aggravated overgrazing and replacement of perennial grasses with bushes.

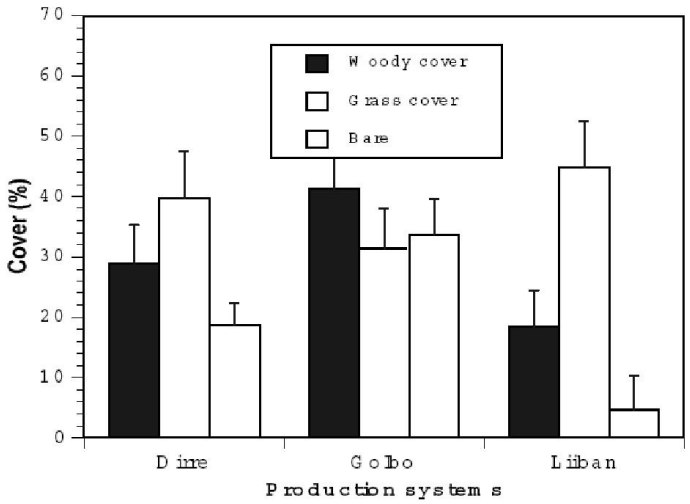

Figure 3: Regional level potential grazing capacity as a percentage of total landscapes in Liban, Dirre and Golbo production systems. *Source: Oba and Kotile,2001.*

The ecological succession in the Borana rangelands indicates that the potential of the grass land is threatened by bush encroachment in many areas (Alemayehu, 2004). Overall woody vegetation reduces grass cover through increased competition for available water and nutrients (Thurrow, 2000). In addition to competing with grasses, noxious woody plants are commonly thorny and thicket-forming so that grasses produced for grazing capacity of the rangeland is extremely reduced (Alemayehu, 2004). Gamedo *et al. (*2006), also states that besides quantitative data on the impacts of woody plants encroachment on herbaceous biomass, the soil nutrients are lacking. Prohibition of bush burning undoubtedly exacerbated the problem of bush encroachment which in turn is indicative of the low range carrying capacity and degradation (Schlesinger, *et al.,* 1999). Blaxter (1994) in Alemayehu (2004), stated that continuous expansion of the settler in the better pasture lands and their takeover of permanent water sources has pushed pastoralists more and more into arid zones depriving them of their dry season fall back areas and thereby greatly increasing their vulnerability to climatic uncertainties and leading to over utilization and degradation of their resources.

Table2: Means ± SE mean yields of grass species composition (% dry matter) for encroached versus non-encroached rangelands

Species	Encroached	Non-encroached
Aristida adiscensionis	6.6 ± 1.76[a]	**8.8 ± 1.76[a]**
Cenchrus ciliaris	18.5 ± 4.95[a]	**14.3 ± 4.95[a]**
Chrysopogon aucheri	17.6 ± 1.70[a]	**20.3 ± 1.70[a]**
Eragrostis papposa	1.9 ± 0.34[a]	**2.4 ± 0.34[a]**
Lepthotrium senegalensis	0.9 ± 1.24[a]	**5.5 ± 1.24[a]**
Panicum coloratum	9.0 ± 2.86[a]	**10.4 ± 2.86[a]**
Pennisetum mezianum	7.8 ± 2.81[a]	**0.9 ± 2.81[a]**
Pennisetum stramineum	**8.8 ± 1.19[a]**	**2.9 ± 1.19[b]**

[a,b] *Different superscripts within a row show significant difference (P < 0.05).*
Source: Ayana, 2005

6. Government Policies

Pastoral development in the East African rangelands has been influenced by a widely perceived impression of environmental change such as decline in vegetation resources linked to overstocking of drylands (Ayana, 2007). The perception of pastoral development in the African rangelands lies in the essence of the tragedy of the commons following the introduction of the concept of range management into East Africa in the early 1960. Rather, recent debates on pastoral development emphasize that East African rangelands are heterogeneous in space and time. Therefore, traditional land use systems are the best way to make efficient use of the available forage resources. Any barrier to pastoralist ways of managing resources and loss of the communal rangelands to range enclosures, crop farming and ranching were found to be more likely to cause environmental change (Ayana, 2007). In Ethiopia, rangeland policies were designed on the basis of the ranch model as an alternative to the communal rangelands without understanding the consequences of changing land use on the environment. The Borana rangelands in southern Ethiopia have been substantially altered with the advancement of bush encroachment. The expansion of bush encroachment has been attributed to the official banning of fire due to the policy of forest land conservation in the form of enclosures to foster the regeneration of naturally occurring plant species. Fire was banned as a result of inappropriate management policy. The policy never considered the implications in terms of the threat of bush encroachment on pastoral production (Gemedo *et al.,* 2006). As a result, the density of bush encroachment has been increased to the extent that the capacity of grazing is reduced. The official banning of fire had previously assumed that the use of fire would be damaging to the rangeland ecosystems.

Restoration

Ecological restoration is becoming an increasingly important tool in humanity's attempt to manage, conserve and repair the world's ecosystems (Schlesinger, *et al.,* 1999). Many indicators of "landscape" scale dysfunction are structural, but functional once are critical for ecosystem functioning. Functional problems that require repair include soil erosion, plant-animal interactions, water connectivity, and production at some or all trophic stages (Thurrow, 2000). The function, as defined by resource retention of landscapes that are endowed by high cover of perennial plants, is effective in terms of runoff capturing and retention and utilization of nutrients (Saco *et al*., 2006). Conversely, the function of landscapes with low covers threatens the aforementioned functions because landscapes with large patches of bare soil that are deprived of perennial plants are dysfunctional (Ludwig, *et al*., 2000). As runoff and the concomitant

effects including erosion and nutrient loss from grasslands that are encroached by shrub are higher (Schlesinger, *et al.,* 1999), restoration of grasslands may clearly reduce sediment transport and retain grassland productivity (White *et al*., 2006).

Restoration aims not in the establishment of aboveground vegetation but in the return of a community that is dominated by native species. Rangelands as an ecosystem encompasses vegetation, herbivores, predators, invertebrates, and micro-organism and degradation refers to low overall biodiversity, where restoration will require restoring overall biodiversity (Blench & Florian, 1999).The difficulty and expense of restoration also depends on the goals set. It may be easier to achieve successful restoration, when the goal is to restore some degree of function and/or some of the species than when the goal is to achieve complete restoration of the ecosystem back to its original state (Schlesinger, *et al.,* 1999).

Restoration techniques

First, in order to restore an ecosystem, we need to understand how it worked before it was modified or degraded, and then use this understanding to reassemble it and reinstate essential processes (Blench & Florian, 1999). Passive restoration, as explained by Kauffman *et al*. (1995), is restoration of degraded habitats by ceasing anthropogenic perturbations that are causing degradation while active restoration refers to biotic manipulation that is practiced by reintroduction of animal or plant species that have been extirpated from an area (Kauffman *et al*., 1997).

Active restoration action may not be necessary in places where the damage is not too great. This is because natural succession alone may be capable of restoring equilibrium (Jackson *et al*., 1995). However, factors such as species extinction, exotic predators, and loss of hydrologic function can prevent ecosystems to attain natural dynamic system through passive restoration. In addition, ecosystems that are sufficiently degraded may not be restored to a state that would occur naturally by the implementation of passive restoration only, but need to be intervened by active restoration techniques (Kauffman *et al*., 1997; National Research Council, 1992).

1. Grazing management

The first step in any project is to ensure that grazing is managed well to reduce the risk of further degradation. In the past, set stocking has been the most common way to manage grazing. In some instances at very low stock densities this practice has been successful at maintaining but generally not improving rangeland condition. Set stocking at higher stock densities has commonly resulted in a decline in the most palatable perennial species and an increase in less favorable species. The second step is to realize that timely grazing management can have a positive impact on rangeland condition.

2. Destalking.

The accumulation of animals is a proven livelihood strategy, when the primary feed resource (grazing land) is commonly owned and in the face of periodic disaster which threatens to reduce the herd (Kauffman *et al*., 1997). Income from livestock assets in pastoral Africa is primarily in the form of products produced from the livestock themselves, rather than in cash obtained from the sale of livestock. Economic theory suggests they are likely to be held until their income generating value falls below their salvage value, which is likely to be well past their market prime (Blench & Florian, 1999).

Better physical infrastructure in some market locations, improved road access and better information on more distant markets, will not only enhance the access of pastoralists to markets in which to sell their animals, but will also improve their access to consumer goods and increase their integration into the larger market economy. The withdrawal of government regulatory agencies or marketing monopolies that add to the covert costs of trading, stifle competition and depress producer prices may be equally important (Behnke and Kerven, 1994).

3 Introducing Seeds

Areas suffering from prolonged vegetation decline are likely to have very limited supplies of seeds (Kauffman *et al*., 1997). In these instances seed needs to be introduced for regeneration projects to be successful in the short-term. Native grasses are well adapted to the harsh environment of semi-arid areas. Many exotic species, with the exception of buffel grass, generally fail to persist due to drought or infertile soils (Blench & Florian, 1999). Native grasses not only provide necessary habitat for many native animals, they provide a suitable pasture base for animal production and can perform well as exotic species under harsh conditions (Oba and Kotile, 2001).

4. Prescribed Fire

Prescribed fires are planned and conducted at the proper time, and in a safe manner, to meet specific management objectives **(**Schlesinger, *et al.,* 1999). Typically, desirable plants are dormant, soil moisture is sufficient to support plant growth after the fire, and

favorable environmental conditions ensure predictable fire behavior and simplify control. In contrast, wildfires are unplanned and usually due to lightning, human negligence or malice. Wildfires usually happen during extended dry periods when soil moisture levels are low and plants are severely stressed and result in reduced forage yields and other undesirable effects (Ayana, 2007). Timing of fires can be used to favor desirable grasses and suppress undesirable grasses plants that reproduce solely by seeds because seeds can be killed by fire if their growing points at the twig tips are exposed to lethal temperatures. In contrast, perennial plants that can reproduce vegetatively from subsurface buds are usually only top killed and initiate new shoots after fire (Behnke and Kerven, 1994). Prescribed fire can yield many benefits if it is used with other sound management practices. This fire can increase grass nutritive quality, palatability and availability because the fire removes dead plant material and improves access to new growth.

The fire is used at a certain time of the year and under specific levels of relative humidity, air temperature and wind speed to help control target weed species (Teka *et al.,* 2007). Burning when relative humidity is less than 25 percent, air temperature is above 80^{o}F, and wind speed is more than 15 mph causes intense, possibly dangerous fire behavior (Jackson *et al*., 1995). Planning is essential to safe burning and should be done well in advance of the proposed burn date (Ayana, 2007). The plan should cover objectives, what areas to burn, pre-fire management practices needed to meet the objectives, how to conduct the fire and any post-fire management practices.

Conclusion

Most of the rangelands in tropical countries have lost the productivity mainly due to wrong ways of resources exploitation. Overgrazing due to extensive livestock production is one of critical problems that resulted in deterioration of the rangeland condition in most tropical countries. Fertile Borana rangelands were converted to cropland and pastoralists were pushed to marginal area and this aggravated rangeland degradation. Traditional livestock production and rangeland management system was interrupted with change in land use and government policies. Nomadic way of life which causes little degradation was converted to sedentary life in most areas. The Borana rangelands are threatened with bush encroachment in the past few decades. Banning of use of fire as a management tool is a major cause of bush encroachment. Land that deprive resource conservation capacity are said to be in a poor condition and hence need restoration program that reverse the function nearly to the pre-existing status. The type of restoration techniques that can be used to restore a given rangeland vary with the problems observed in the rangeland. Restoration program with few or specific goal is more efficient to achieve complete restoration because of complexity of ecosystem. The use of bush or shrub clearing is important in the management and improvement of rangelands that are encroached by bushes and shrubs.

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