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Effect of reseeding of Rhodes Grass on the Restoration of Degraded Rangeland of Borana, Southern Ethiopia

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Research Paper

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ABSTRACT

The degradation of semiarid rangelands in Borana can be traced back to the three to four decades, which is remains today harming rangeland productivity. Hence, we conducted study that evaluates different restoration methods on highly degraded rangeland in Dugda Dawa district. There were six treatments and replicated three times. The treatments were: (T1) no hoeing + seeding Rhodes grass, (T2) hoeing + seeding Rhodes grass, (T3) hoeing + mulch + seeding Rhodes grass, (T4) no hoeing + manure + seeding Rhodes grass, (T5) hoeing + manure + seeding Rhodes grass and (T6) hoeing + mulch + manure + seeding Rhodes grass. The study was carried out over the course of two rainy season March–June 2007 and 2009. Data were collected from emergence to seed yield within four months of experimental period. Accordingly, the result showed as variation observed among treatments to recover degraded rangeland. The highest dry matter yield, plant cover, germination, height and seed yield were observed for Hoeing + manure + mulch + seeding Rhodes grass and hoeing + manure + seeding Rhodes grass. Moreover, during group discussion and field day demonstration on experiment site, the grass cover was appreciated by the local community and really proved to be a possibility for rehabilitating degraded rangelands through reseeding grasses. Hence, in the context of this work, options for rehabilitating and improving the recovery of highly degraded rangelands will be through simple tillage (hoeing), manure application and reseeding grasses. Moreover, a promising techniques (hoeing + manure + seeding) stimulated as substantial promise as cost of restoration technique was low.

Key words: Rehabilitation methods, Native grass, Simple tillage

INTRODUCTION

Rangeland degradation is a major problem in the semi-arid areas of Sub-Saharan Africa. Fighting rangeland degradation is essential to ensure the sustainable and long-term productivity of the semiarid lands (Kevin et al., 2010). The degradation of semiarid rangelands in Borana can be traced back to three to four decade. The ecological degradation remains today and continues to harm rangeland productivity. On other hand, like other arid and semi-arid rangelands of the world, Borana rangelands provide a diversity of uses, including forage for livestock, wildlife habitat, medicinal plants, fuel wood, and recreational activity for many years (Coppock 1994). For last decades, a growing body of literatures indicates that the increasing degradation of Borana rangelands (Bille and Eshete, 1983; Oba et al., 2000; Gemedo, 2004; Sintayehu et al, 2006; Angasa, 2007; Daniel, 2010), but limited measures has been taken to reverse the situations. The major range degradation indicators are forage shortage, elimination of desirable range species, soil erosion, increased runoff and reduced infiltration and reduction of perennial plant cover (Assefa et al. 1986, Smith 1988; Coppock 1994; Alemayehu 1998).The land degradation problem can be partly reversed through revegetation. Grass reseeding technology has been used successfully as a means of rehabilitating degraded rangelands in East Africa (Jordan, 1957; Bogdan and

Pratt, 1967; Musimba et al., 2004). However, there were no tests of reseeding on degraded rangeland before this study in the study area. Still many of these rangelands have potential for improvement by using grazing management practices, natural recovery of vegetation and artificial re-vegetation at suitable sites coupled with better grass species. It indicated that ecosystem rehabilitation needs to be fostered through tilling, if necessary combined with planting and reseeding (Visser et al., 2004) of indigenous grasses. Thus, this research was designed (i) to see the effect of reseeding in the rehabilitation of degraded rangeland by native germplasm and (ii) to create awareness as to how to rehabilitate degraded rangelands.

MATERIALS AND METHODS

Study area description and site selection

The Borana area located at 4-6N and 36-42E sloping gently from 1600masl in the North-East to about 1000masl in the extreme South that borders Northern Kenya and about 1780masl in the central vicinity. Borana rangelands occupied almost entirely by pastoral populations. Rangeland uses largely communal, though with crop cultivation and private enclosures that appear to be increasing in recent decades. Rainfall delivery is bimodal; with the long rains accounting for 60% of the total rainfall falling between March and May and the short rains comprising of 27% of the total rainfall falling between September and November. There is spatial and temporal variability in both the quantity and distribution of rainfall with an average annual rainfall varying from 353mm to about 900mm per annum (McCarthy et al., 2002).

We selected the site at Jegesa “Peasant Association (PA)” of Dugda-Dawa district, which is found to the North part of Borana plateau. Dugda-Dawa district is one of the highly degraded (compacted, loss total vegetation) areas in Borana zone. This site was selected by conducting reconnaissance survey and through discussion made with the local communities and pastoral development offices. The study was carried out over the course of two rainy season March–June 2007 and 2009. In 2008 year, no treatments applied because of drought occurrence in Borana zone.

Design and measurement

Half hectare was demarcated on highly degraded rangeland and fenced firmly with local materials. Rhodes grass (*Chloris gayana Kunth*) was purchased from Elfora (at Hawassa). There were six treatments viz; no hoeing + seeding Rhodes grass, hoeing + seeding Rhodes grass, hoeing + mulch + seeding Rhodes grass, no hoeing + manure + seeding Rhodes grass, hoeing + manure + seeding Rhodes grass, hoeing + mulch + manure + seeding Rhodes grass. These treatments were laid out in a Randomized Completely Block Design and replicated three times.

The plots’ size was 6 m x 4 m ($24m^2$). Land preparation and seeding were carried out soon after the long rainy season commences (beginning of March to mid-march).

The hoeing was done using a hoe. Mulch was done using grasses that had not set seed and thickness of the mulch was 15cm on plots.

Cattle manure stored as pile for many years around their encampment in pastoral area of Borana zone was used as fertilizer. Cattle manure application was at rate of 10t ha^{-1} and grass species seeding rate was 8kg ha^{-1} and broadcasted by mixing with soil uniformly on plots.

Ten representative tillers of Rhodes grass were randomly selected from each plot and measured for height.

The average height of ten tillers per plot was used for analysis. Cover assessed using quadrate (0.5m x 0.5m) by randomly placing in the plots. An area of 0.25 m^2 was selected for detailed assessment, and divided into halves.

One of these was further divided into quarters, one of which divided into eighths. All Rhodes grasses in the selected $0.25m^2$ per plot was cut, transferred while kept together, and drawn in the eighth part to facilitate visual estimations of basal covers of living parts.

The rating of basal cover was considered ‘excellent’ when the eighth was completely filled (12.5%) or ‘very poor’ when the cover was less than 3% (Baars *et al.* 1997). Then, each percentage multiplied by four to convert to out of 100%.

The germination of Rhodes grass assessed by randomly placing three quadrants (visual within plot) on the 7 days after seed sown by giving the scores of (3.5-4= poor germination; 3-3.5= fair germination; 2= good germination; 1= excellent germination) for each plot.

A score was considered germinated when the radicle length was 2mm or above.

A three 0.5m × 0.5m quadrat were placed randomly in every plot, and the aboveground Rhodes grass within the quadrat clipped at 5cm above the ground when the grass was 50% in flower.

Dry matters of grasses were determined after oven drying at 105 ℃ for 24 hours at Yabello Pastoral and Dryland Agriculture Research Centre.

Data analysis

Data were subjected to the analysis of variance using SAS version 9.0 (SAS, 2002). Least significance differences (LSDs) at 5% level of probability were computed to delineated significant differences among treatment means.

Table 1. Mean±SE of different parameters of Rhodes grass seeded in 2007 and 2009.

	2007					2009				
Treatments	***Germination (scores)**	**Cover (%)**	**Dry matter yield (ton/ha)**	**Seed yield (kg/ha)**	**Height (cm)**	***Germination (scores)**	**Cover (%)**	**Dry matter yield (ton/ha)**	**Seed yield (kg/ha)**	**Height (cm)**
No hoeing + seeding	4.0±0.0[a]	5.3±0.3[d]	0.13±0.04[cd]	38.3±1.7[d]	60.7±5.8[d]	4.0± 0.0[a]	21.7± 3.3[c]	0.2±0.0[d]	40.0± 0.0[c]	15.0±2.9[d]
Hoeing + seeding	3.3±0.7[a]	12.3±1.7[c]	0.05±0.08[d]	48.0±3.5[cd]	84.0v3.5[c]	3.3±0.3[a]	15.0± 2.9[c]	0.7±0.1[cd]	73.3±12.0[c]	52.0± 11.0[cd]
Hoeing + mulch + seeding	2.0±0.0[b]	53.3±1.5[b]	0.31±0.04[cd]	93.3±6.7[c]	122.7±3.2[b]	3.3±0.7[a]	26.7±7.3[c]	1.2±0.0[c]	113.3±12.0[c]	72.3±10.4[bc]
No hoeing + manure + seeding	3.7±0.3[a]	6.3±0.3[d]	0.33±0.02[c]	43.0±1.5[d]	113.3±3.3[b]	3.0±0.6[a]	15.0± 5.0[c]	0.4±0.1[d]	60.0±11.5[c]	38.7± 9.8[cd]
Hoeing + manure + seeding	1.0±0.0[c]	92.0±3.5[a]	3.5±0.14[b]	543.3±12.0[b]	144.3±3.2[a]	3.0±0.0[a]	56.7±7.3[b]	5.5±0.3[a]	210.0±20.8[b]	108.3±18.3[ab]
Hoeing + Mulch + Manure +seeding	1.0±0.0[c]	92.3±2.3[a]	3.8±0.10[a]	646.7±33.3[a]	151.0±1.5[a]	1.0±0.0[b]	76.7±7 6.7[a]	3.9±0.4[b]	313.3±58.1[a]	137.7±15.7[a]

[a-d] means with different superscripts letters along column differ significantly ($p<0.05$); *Germination (3.5-4= poor; 3-3.5= fair;2= good; 1= excellent)

RESULTS

Effects of treatments on dry matter yield, seed yield, basal cover and height of Rhodes grass

Variations of dry matter yield, cover, height and seed yield of reseeded Rhodes grass were observed among treatments across years. Both experiments' results highly demonstrated that as disturbance/hoeing of soil have the key concern for success of restoration. Very good germination of Rhodes grass was observed when the combination of hoeing with manure and mulch in each year (**Table 1**). Where no hoeing applied, the germination and cover of plots by Rhodes grass was very poor. Highest coverage of Rhodes grass was observed where manure, hoeing and mulch were applied in combination. Dry matter yield and seed yield was significantly the highest ($P<0.05$) for the combination of hoeing, mulch and manure; while hoeing plus manure application was the next highest dry matter and seed yield ($P<0.05$) than other treatments. The study of Chambers (2000) and Daehler (2003) indicated that seed protection (mulch and hoeing) has been emphasized as favorable condition for seedling establishment. From the combination of hoeing and manure treatment of first and second year experiments, about 3.5 t ha^{-1} and 5.5 t ha^{-1}dry matter yields of Rhodes grass was observed, respectively.

However, where no hoeing applied regardless of manure application or seeding, less than 0.5 t ha^{-1} was observed. Maximum height of Rhodes grass was observed for hoeing + manure, and hoeing + mulch + manure than other treatments in both years (**Table 1**).

DISCUSSIONS

Dry matter yield, seed yield and height of Rhodes grass

This study was designed to investigate the relative importance of hoeing, seeding, mulching, manure application and their combination for the restoration of severely degraded (denuded) rangelands in semiarid Borana rangelands. The result indicated high possibility of reseeding to regain highly degraded rangeland of Borana. Moreover, during group discussion and field day demonstration on experimental, the grass covers were appreciated by the local community and really proved to be a possibility for rehabilitating degraded rangelands through reseeding. The dry matter yield obtained from hoeing + manure + seeding increased about eight times than no hoeing applied regardless of manure application or seeding. Plot cover, seed yield and height of Rhodes grass were lowest for no hoeing treatment for both years. This was pointed during group discussion by pastoralists that currently, most of soil surface of the degraded Borana rangelands often are crusted, and may lead to high runoff flows (Figure 1). Soil erodibility (wind and water) is relatively high, which was associated with poor soil structure and high runoff over bare rangelands (no vegetation cover), possibly due to heavy grazing. Moreover, it also indicated by community that in the area where this research has been conducted, it had been without vegetation cover (degraded) for about 33 years and yet no better option have been seen on this degraded rangeland for better usage until this study was undertaken. It also indicated as degraded rangelands are characterized by a lack of vegetation cover and increased soil erosion (Oba et al, 2000). Evidences of heavy grazing, which resulted in wind erosion, soil sealing and hard settings (**Figure 1a**) are indicators of the

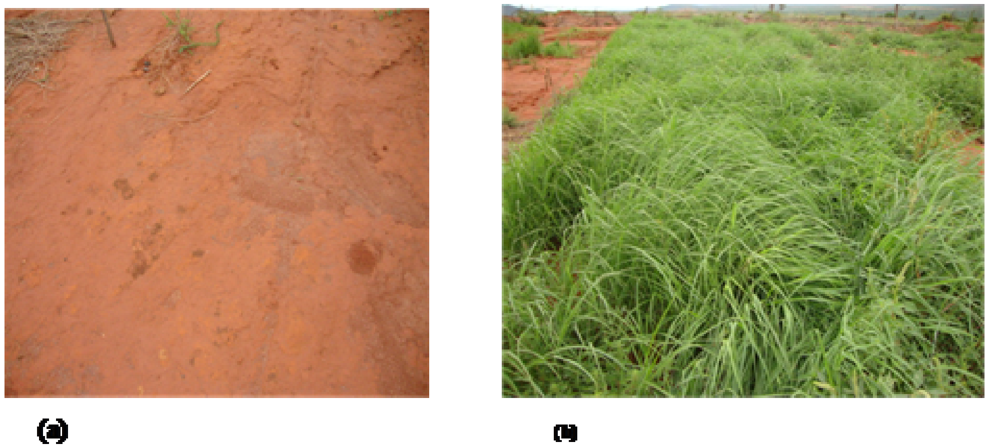

Figure 1. (a) before treatment and (b) after treatments (manure, mulch and hoeing).

rangeland degradation that were reported during the study. Thus, better dry matter yield of Rhodes grass obtained where reseeding combined with hoeing and manure application **(Figure 1b)**. This indicates that simple tillage and manure application is a better option for establishment of Rhodes grass on highly degraded rangeland in short term. Similar study indicated that reseeding on highly degraded rangeland is an option to significantly improve pasture productivity (Hamadeh, 2002). Variation observed on seed yield and height of Rhodes grass between years may be due to erratic nature of rainfall in semi-arid rangelands. Like this area, to be opprutnstic worthwhile, once grasses established in the main rainy season, it is possible to capture the short rainy season for better dry matter yield. Moreover, land preparation before main rain season comes has paramount importance for the success of reseeding with this grass. Germination and plot cover of Rhodes grass were high for hoeing + manure + seeding Rhodes grass. Some studies in line to this result as good site preparation is important for easy establishment and success of reseeding and removing soil capping, enhance soil water infiltration and incorporate seeds into the soil (Mnene, 2006). It also underlined as reseeding on highly degraded rangeland with different techniques may be an option to increase forage production in Borana rangelands. The dry matter yield obtained from this study ranged from 3.5 to 5.5 t ha^{-1} that integrated with tillage and manure application. Similarly, Chaudhry et al, (2010) indicated that reseeding of grasses on degraded rangeland produces more forage production. Ontitism et al. (2000) have also suggested that the productivity potential of Rhodes grass (*Chloris gayana*) was high. Considering that an animal can consume dry matter equivalent to 3% its body weight, dry matter yield of Rhodes grass from one hectare of the treatment (manure + hoeing) can support 15 Tropical Livestock Units for about 31 days. This raises question like as to how this can mitigate the feed shortage during warm dry season in the area, where the rangeland is highly degraded; this result demonstrated that reseeding with native grasses is an option for restoration of degraded Borana rangelands with depleted soil seed bank. In line to this, Verdoodt et al, (2010) suggested that rehabilitation of the rangelands is largely dependent on reseeding and tree planting rather than on natural regeneration where the top soil seed banks are depleted through erosion.

Conclusion and recommendation

Restoration of degraded rangeland showed variation among the treatments. A combination of hoeing + manure and seeding depicted higher potential of dry matter production, ground cover and better performance of growth parameters, such as height and seed yield for Rhodes grass (*Chloris gayana Kunth)*. The study recommends that there is a high possibility of restoring degraded rangeland with reseeding of Rhodes grass (*Chloris gayana Kunth)* in Borana rangelands with simple tillage and manure application. Minimum (one time) tillage and manure application on highly degraded rangeland has paramount importance for good establishment of grasses. Moreover, a promising techniques (hoeing + manure + seeding) stimulated that substantial promise as cost of restoration technique was low. Alternatively, pasture production through reseeding from other grass species also needs future evaluation.

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