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Full Length Research Paper

Effects of Rangeland Restoration Techniques on Herbaceous Vegetation and Grazing Capacity in Dallo Mana district, Southeast Ethiopia

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Abstract

This study aimed to evaluate the restoration of highly degraded rangelands through the integration of various restoration treatments and the reseeding of native grasses in the Dallo Mana district of Bale Zone, southeast Ethiopia. Rangeland degradation is a serious problem in the semi-arid regions of the Bale Zone, negatively impacting the productivity of the rangelands and the livelihoods of pastoralists. The study site was fenced to exclude both human and animal interference, and fifteen 4 m x 4 m plots were laid out to apply 7 treatments in 3 replications, including control, mulch, cattle manure, mulch + cattle manure, ripping, semicircular bund, ripping + mulch, ripping + cattle manure, semicircular bund + mulch, semicircular bund + cattle manure, ripping + mulch + cattle manure, and semicircular bund + mulch + cattle manure, using a randomized complete block design (RCBD). The results showed that the total dry matter (DM) yield of all herbaceous samples, the DM yield of grasses with intermediate desirability and less desirable grasses, and the basal cover and litter cover of dominant grasses were significantly (p<0.05) higher in the restoration sample site compared to the degraded areas, and the overall grass range condition score ranged from 16.1 (poor condition) to 33.4 (good condition), with the total dry matter yield decreasing considerably from 126.85 g m-2 in the good condition within the restoration sample site to 11.40 g m-2 in the poor condition along the open-grazed areas, with the data analyzed using analysis of variance (SAS, 2012).

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1. Introduction

1.1 Background

Rangelands are globally important ecosystems of great significance to human welfare and economies (Sankaran *et. al*., 2005).They account for about 41% of the global land surface cover (Washington-Allen *et al*., 2008). East African range lands represent a unique geographical region, comprising a great diversity of ecosystems, cultures and human environment interactions (Ayana and Oba, 2008).Unique ecological aspects of East African range lands include: spatially extensive grazing systems, changing landscapes, unique human-wildlife-livestock interactions and environmental consequences (Sankaran *et al*.,2005).

Rangeland degradation is one of the challenges among countries of Sub-Saharan Africa that results in chronic poverty and livelihood crisis. The majority of pastoral and agro-pastoral communities in the Horn of Africa are at risks of food insecurity. Previous studies (Ayana and Oba, 2008) have shown that range land ecosystems in the HOA are very susceptible to the impact of climate change, and that pastoralists are the most vulnerable group. Land degradation and poverty associated with natural and human induced devastation persist in East African rangelands (AyanaandOba, 2008). For example, the United Nations Environmental Program (UNEP)(1998) has identified among others, land degradation as a primary factor contribute in to high impact problems that could result in human environmental disasters. The problems caused by natural and man-made factors and the depletion of natural resources have adversely affected the conventional livestock based livelihood options. The restoration of degraded rangelands has been proposed as a possible approach to strengthening resilience to climate change (Houghton *et al*. 1999). This will further contribute to strengthening resilience and reducing vulnerability among pastoral and agro-pastoral communities, while addressing the global demand for ecosystem service and carbon markets.

The arid and semi-arid lands of Ethiopia account for over 60% of the total land cover, and are home to 12% of the human population who make a living from an extensive form of livestock production (Coppock, 1994). Rangelands are the main sources of forage for grazing animals in arid and semi-arid environments. Here, more than anything else, forage availability from the rangelands dictates livestock production, survival, and milk and meat supply, and hence the socio-economic welfare of the human population. Range lands in good state of health do also play a central role in the protection of the environment including the sustenance of stable supply of water across the land scape; improve carbon sequestration and biodiversity conservation (Davies *et al*., 2012).

During the last five decades, rangelands in most pastoral areas of Ethiopia have undergone un precedent changes that manifested in terms of marked deterioration of conditions. Across all the pastoral areas, appreciable proportion of the once healthy and productive rangelands have either been reduced to bare ground or completely taken over by invasive plant species of no or low feeding value. This situation has undermined the adaptive strategies and resilience of the pastoral communities heavily relying on livestock production (Bruke and Tafesse, 2000; Coppock, 1994; Gemedo, 2006). Many initiatives have been taken to identify the root causes of the rangeland deterioration and implement actions that help restore the productive state of degraded rangelands.

1.2 Statement of problem

In Bale including but not limited to Dallo Mana woreda, rangeland conditions are steadily degrading from time to time (Daniel, 2010).As a result many interacting factors including severe over-grazing, and expansion of encroaching bushes and weeds are among the major problems in the area. Moreover, bush encroachment is transforming potential open savannas grassland into thick bushes and shrubs (Abate *et al.,* 2010), indicating the degree in severity of arid and semi-arid rangelands. Besides, the rangelands are also subjected to frequent and recurrent droughts resulting in massive livestock mortalities and impacting famine and poverty by pastoral households. Research and development in rangeland improvement schemes is therefore an important investment in order to reverse the negative impacts of different rangeland degradations caused by biotic and/or biotic factors.

Range improvement is defined as special treatment(s), development(s) and structure(s) used to improve the forage productivity potentials of rangeland types with the aim of promoting livelihood quality of pastoral communities through production of quantity and quality range-feeds and their uses by grazing livestock species. In this context, rangeland improvement include: i) to restore depleted rangelands to higher levels of productivity, ii) control of bush encroachment and replacing undesirable range plants with desirable productive species and iii) reclamation of severely degraded and wasted lands and converting them in to *in-situ* drought period feed conservation sites (Holechek *et al.*, 2000).

These rangeland improvement programs are global perspectives, however, where the complex situation of rangeland is high like in semi-arid and arid region, it needs to test each and/or combination improvement techniques. Some of the possible range improvement techniques indicated includes enclosures, over sowing, control of undesirable range plants, burning, fertilization, improvement of grazing systems and stocking rates, application of soil moisture conservation techniques, seeding and re-seeding, plantation of drought tolerant succulents (Solomon *et al.*, 2005).

These methods can be applied individually or in various combinations to get best results. Some of these improvement techniques were not seen in development/research. Studies of Bedasa *et al* (2014) indicated as possibility of reseeding of native grasses on highly degraded rangelands. Moreover, the efforts made by Mohammed, (2018) entitled the "Effect of mechanical and chemical control methods of bush control on rangeland vegetation in lowlands of Bale range land Rayitu woreda, Southeast Ethiopia". But his work lack to look into range land restoration techniques that may play significant role in enhancing herbaceous plants on degraded land. Furthermore, the work done by Mohammed, (2018) in Dallo Mmana woreda just focus on the evaluation of only improved forage and only under irrigated condition. Hence, this study aimed to investigate the effect of range land restoration techniques on herbaceous plants using the native grasses on highly degraded rangelands and grazing capacity. To combine the reseeding activities and manure fertilization with soil and water conservation practices that assess the recovery potential of degraded rangeland, increase the vegetation covers on bare ground and increase the production potential of the rangeland for higher grazing capacity of domestic livestock and create awareness within the community on how to restore degraded rangeland.

1.3. Significance of the study

- Following the determination of effects of rangeland restoration techniques on herbaceous vegetation and grazing capacity in Dallo Mana district, Southeast Ethiopia. The general public will be benefited in such a way that if effects of rangeland restoration techniques on herbaceous vegetation and grazing capacity is well known, awareness creation will be made on its restoration by the study group to reduce the negative effects posed by the rangeland degradation,
- The pastoral office, especially the rangeland and natural resource sector will get information that will be implemented while developing their plan,
- The generated information will be used as a base for researchers, policy makers and range managers to formulate recommendations on how to restore degraded rangelands and implement appropriate management strategies in areas of the country where rangeland degradations are problem.

1.4. Objectives of the study

1.4.1. General objective

- To investigate the effects of rangeland restoration techniques on herbaceous vegetation and grazing capacity in Dallo Mana district, Southeast Ethiopia

1.4.1. Specific objectives

- To assess the effects of rangeland restoration techniques on herbaceous vegetation in Dallo Mana district, Southeast Ethiopia
- To evaluate the effects of rangeland restoration techniques on grazing capacity in the study area.

1.5. Research Hypothesis

- The range land restoration techniques will enhance herbaceous vegetation in Dallo Mmana district.
- The rangeland restoration techniques have an effect on grazing capacity in the study area.

1.6. Scope of the study

The study was to examine the effects of Rangeland restoration techniques on herbaceous vegetation and grazing capacity in Dallo Mana district, southeast Ethiopia. The study utilizes twelve treatments in three replications. The study was conducted in Dallo Mmana district, lowlands of Bale zone from November, 2019 to July, 2020.

2. Material and Methods

2.1. Description of the study area

Location and Area Coverage

The study was conducted in Delomena district which is located in Bale zone, South Eastern Ethiopia. It lies between latitudes 5˚51'N and 6˚45'N, and longitudes 39˚35'E and 40˚30'E. It is bounded by MaddaWalabu district in south, Goba district in North, Harena Buluk district in west and south west, Berbere district in North East and Gura Ddamole in the East direction. It has an area of 4833 km2 (483300ha) and distance of 125 km from capital Bale zone called Robe and 555 km from center of the country and the region called Addis Ababa.

Until 1984, Dello Mmena was considered as part of Dello Awraja. But from 1984-1988 E.C Dell Momena has its own administrative district. Again from1988–Mid 1998 Dello Mmena and Harena Buluk district merged together and form Mena Angetu woreda by assigning Dello Mmena as a capital of the district. Lastly, at mid-1998 onwards the two district s split each other and forms their own administrative district by assigning Mena and Angetu as a capital town of Dello Mmena and Harena Buluk district respectively. Mena town was founded in 1940 E.C but the town got municipalities plan since, 1956 E.C(BZPEDO, 2015). A total population of the woreda is approximately 120,000 inhabits the. About 91% of the inhabitants are engaged in agriculture; of which 28% conduct crop production, 18% cattle rearing and 45% mixed farming (BZPEDO, 2015).

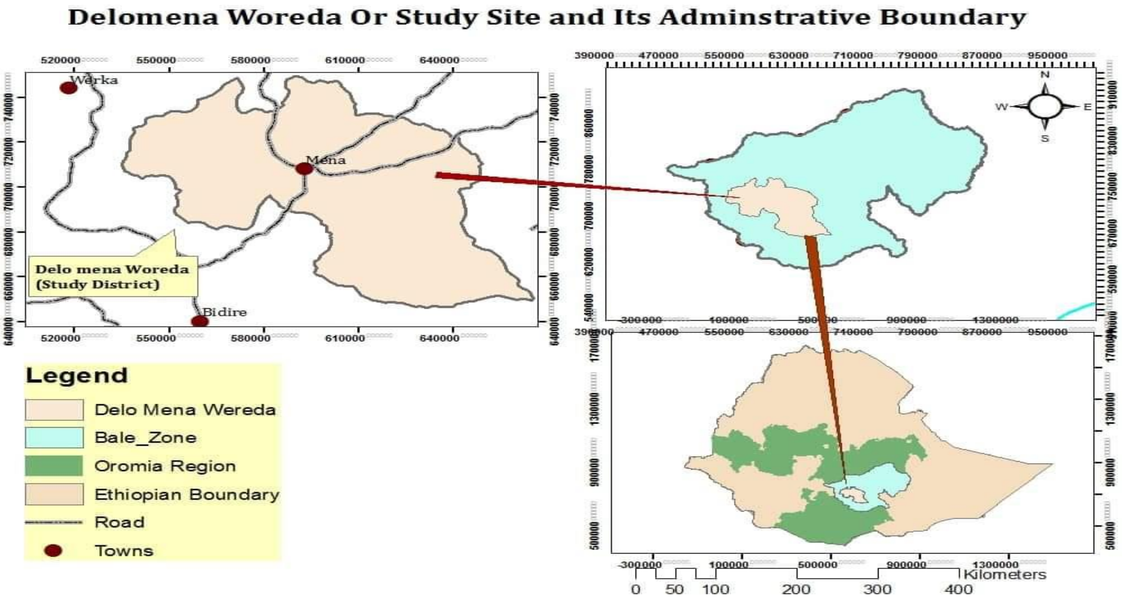

Fig.1 Map of Dello Mena (source, BMNP Geo database, 2007)

2.1.2. Climate

In the district the amount of temperature that receives is greatly modified by latitude and longitude range. Based on altitude the districts are classified in to three-agro climatic regions namely: High land, Semi High land and lowland (BZPEDO, 2015).

2.2. Site selection and field layout

A bare area with no desirable vegetation cover was selected from Dallo Mmana district and fenced to exclude both human and animal interference. The identified site has a size of 72mx72m. This was divided into sub-plots and different restoration treatments will be randomly applied in each sub-plot.

2.3. Experimental Design and Treatments

The experimental design was RCBD was used with 12 treatments and replicated three times separately for each grass species (*Chloris gayana Kunth* and *Cenchrus ciliaris*). The experiment was applied at the beginning of the main rainy season during November, 2019 to July in 2020. The treatments were; control, mulch, cattle manure, mulch + cattle manure, ripping, semicircular bund, ripping + mulch, ripping + cattle manure, semicircular bund + mulch, semicircular bund + cattle manure, ripping +mulch +cattle manure, semicircular bund + mulch + cattle manure. Since the study area being moisture stressed, treatments of in-situ moisture conservation techniques was considered. The structures suggested in this experiment are semi-circular bunds and ripping. Semi-circular bunds are earthen bunds in the shape of a semi-circle to accumulate runoff water in front of the bund, where plants are grown. The diameter or the distance between the two ends of each bund and height of the bunds is 1m and 30-50cm as stated by Theibet.al. (2000).

Ripping is a cultivation action with a one tine-sub-soiler implement to a depth of at least 20-25cm and 10cm wide as indicted by Breebaart et.al (2006). This was used to break the hard compacted crust of the surface soil and to create furrows in order to increase water infiltration for promoting seedling establishment. The application of cattle manure at a rate of approximately 88kg/100m^2 increases carbon content of the soil and also helps in the aeration and retention of water of the degraded soil (Van der Merwe, 1997, De wet, 2001). The grass mulch application will facilitate maximum plant establishment by retaining soil moisture and reducing impact of raindrops (Van der Merwe, 1997; De wet, 2001).

2.4. Vegetation measurement

The plot cover, dry matter yield, seed yield and height were measured for each grass types in each sub-plot. The plots' size was 6 m x 4 m ($24m^2$). Land preparation and seeding was carried out soon the long rainy season commences (beginning of March). Seeding rate is 8kg/ha. The hoeing was done using a hoe. Mulch was done using grasses that had not set seed and thickness of the mulch will be 15cm on plots. Ten representative tillers of *Chloris gayan a*and *Cenchrus ciliaris* was 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 *Chloris gayana* and *Cenchrus ciliaris* 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 will be completely filled (12.5%) or 'very poor' when the cover is less than 3% (Baars*et al.* 1997). Then, each percentage multiplied by four to convert to out of 100%. A three 0.5m × 0.5m quadrant was placed randomly in every plot, and the above ground *Chloris gayana and Cenchrus ciliaris* within the quadrant clipped at 5cm above the ground when the grasses are 50% in flower. Dry matters of grasses were determined after oven drying at 105 °C for 24 hours.

2.2.3. Biomass and Grazing capacity measurement

At the end of the growing season, the different plots was harvested at 5cm above the ground using hand sickles and sorted into grass, and non-grass components. Furthermore, they was sorted into different species using field guide (Abule et al., 2017) and experienced technician from Adami Tulu research center, Ethiopia. The sorted materials wasoven-dried at 65°C for 72 hours at MaddaWalabu University.

The formula proposed by Moore et al. (1985), modified by Moore and Odendaal (1987) and (Moore, 1989), is used for grazing capacity estimation by taking in account the grass and total biomass yields.

The equation is as follows: Y= d/(DM x f)r where Y is the grazing capacity (ha TLU^{-1}), d the number of days in a year (365), DM the grass and total biomass DM yield (kg ha^{-1}), f is the utilization factor, r the daily grass DM required. The grazing capacity was calculated using tropical livestock unit (TLU) which is an animal weighing 250 kg and consuming 2.5% of its body weight. Thus, each TLU consume 6.25 kg of forage dry matter daily and utilization factor of 0.5 (50%) is used (Abule et al., 2017).

2.4. Data analysis

Data was subjected to the analysis of variance using SAS version 9.0 (SAS, 2002). Least significance differences (LSDs) at the 5% level of probability was computed to declare significance of differences among treatment means.Proportional data are arcsine transformed to meet the assumption of normality and homogeneous variances. Descriptive statistics such as mean, percentage and standard deviation will be used to present the results.

3. Results

3.1. The Effect of restoration techniques on Range Condition

The effect of restoration techniques on range condition parameters is presented in Table 1.

Grass species composition for the restoration sample site was not significantly (P>0.05) different from degraded grassland (Fig 2). The restoration sample site had a significantly higher (P<0.05) score values for basal cover, litter cover of dominant grasses than the open-grazed areas across the sites (Fig 2). The over degraded grass range condition score was in the range of 16.1 (i.e., under poor condition) to 33.4 (good condition) and the difference was significant (P<0.05) (Fig2).

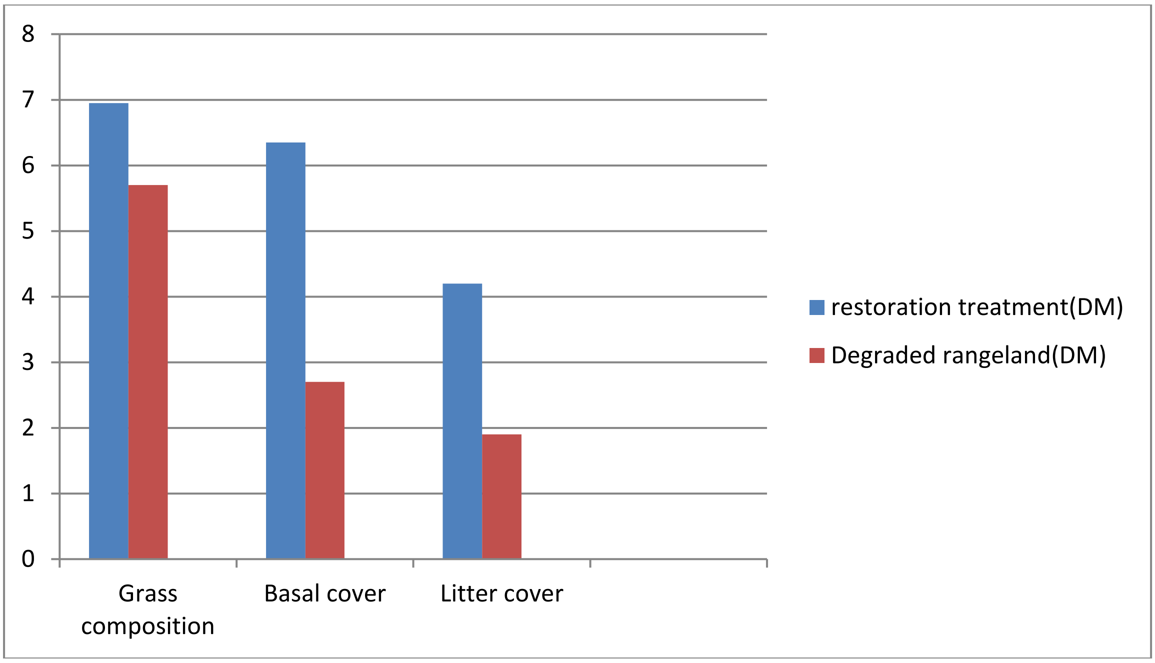

Fig2: Range condition scores of restoration vs.open-grazed areas in the site

4.2. The Effect of Restoration Techniques on Dry-matter Yield of Herbaceous Species

The total DM yield of all herbaceous samples and that of grasses were significantly (P<0.05) higher in the restoration sample site than in the degraded areas in the studied site (Table 1). Similarly, the DM yield of grasses with intermediate desirability and DM yield of less desirable grasses in restoration sample site were significantly (P<0.05) higher than open-grazed areas. The total dry matter yield was decreased considerably from 126.86g m-2 to 11.40 g m-2 as the range condition deteriorates from good within restoration sample site to poor condition along the open-grazed areas. Legumes and forbs did not significantly (P>0.05) differ between restoration sample site and open-grazed sites. Similarly, highly desirable grass species did not significantly (P>0.05) vary between restoration sample site and open-grazed sites (Table 1).

Table 1: Dry matter yield (g m-2) as sampled in the site in Delomena woreda

Parameter	Treatment site	Degraded grassland
Highly desirable grass	43.69	4.96
Intermediate desirable grass	27.05	0.09
Less desirable grass	67.37	2.22
Total grass	117.90	7.27
Legumes	1.97	0.84
Forbs	6.99	3.29
Total biomass	126.85	11.40

Mean in the same row for each parameter with different superscripts are significantly different (P<0.05)

3.3. Aboveground herbaceous biomass in restoration site

Aboveground biomass of significantly (P<0.05) increased following quantity and interactions of treatments being higher than in the degraded area

(Table 2). The same trend was also observed with percentage cover where restoration area and degraded respectively (Table 2).
Biomass of *Cenchrus ciliaris* significantly (P<0.05) increased in following treatment particularly in semicircular bund + mulch + cattle manure than in *Chloris gayana* on the same treatment (Table 2). Type of treatment significantly influenced aboveground biomass (P<0.05).

Table 2 Response of aboveground biomass production to the restoration treatments

Treatment	**Aboveground Biomass**	
	Cenchrusciliaris(DM)	*Chlorisgayana(DM)*
Control	24	25
Mulch	30	31
cattle manure	29	28
mulch + cattle manure	31	31
ripping	28	24
semicircular bund	34	35
ripping + mulch	33	34
ripping + cattle manure	35	36
semicircular bund + mulch	33	33
semicircular bund + cattle manure	36	35
ripping +mulch +cattle manure	43	43
semicircular bund + mulch + cattle manure	43	31

3.4. Biomass Production and Grazing Capacity in the Woreda

Grass dry matter weight (P<0.05) in semicircular bund + mulch + cattle manure and ripping +mulch +cattle manure treatments plots of *Cenchrus ciliaris* increase than plots of *Chloris gayana* Compared with control application and ripping. Semicircular bund + mulch + cattle manure increase Grass production. Though it was a non-significant (p>0.05).
semicircular bund + mulch + cattle manure and ripping +mulch +cattle manure treatments plots of *Cenchrus ciliaris* significantly increased (P<0.05) (Table 3) total biomass production while the control was the latest in total biomass production, semicircular bund + mulch + cattle manure & ripping +mulch +cattle manures were compared in total biomass production
In study area the grazing capacity strongly fluctuate among control and other treatments but slight difference between single treatment and control. Consequently, the grazing capacity of *Cenchrus ciliaris* shows slight difference between mulch and control at x^2=3.42 df=1 p>0.05which does not show statically significance difference. However, there is significant difference among multiple treatments and control at x^2=17.66 df=1 p<0.05.
In case of *chloris guana* there is no statically difference of grazing capacity between Control and mulch at x^2= 3.28 df=1 p>0.05 but statically significance difference between control and multiple treatment(semicircular bund + mulch + cattle manure).
The grazing capacity of *cenchrus ciliaris* shows significance difference among multiple treatment and single treatment (ripping) at x^2= 18.33 df=1 p<0.05. Moreover, the grazing capacity of *chloris guana* shows slight difference among multiple treatment (semicircular bund + mulch + cattle manure) and single treatment (ripping) at x^2=4.66 df=1 p<0.05

Table 3: Application of deferent treatments on herbaceous dry matter production(kga^1) and grazing

capacity (ha TLU^{-1})

Treatments	DM of Cenchrus ciliaris	GC((ha/ TLU)	DM chloris guana	GC((ha/ TLU)
control	24	27.37	25	28.51
mulch	30	34. 22	31	35.36
cattle manure	29	33.07	28	31.93
mulch + cattle manure	31	35.36	31	35.36
ripping	28	31.93	24	27.37
semicircular bund	34	38.78	35	41.06
ripping + mulch	33	37.64	34	38.78
ripping + cattle manure	35	39.92	36	39.92
semicircular bund + mulch	33	37.64	33	37.64
semicircular bund + cattle manure	36	41.06	35	41.06
ripping +mulch +cattle manure	43	49.04	43	49.04
semicircular bund + mulch + cattle manure	43	49.04	31	35.36

4. Discussions

4.1. The Effect of Restoration Techniques on Rangeland Condition

Grass species composition did not show any si nificant difference between the restoration treatments and degraded area. The singe and interacted restoration treatments might also be another reason for the lack of significance differences between the two restoration systems. The result of the present study is in agreement with the report by Amsalu (2000). The highest score for rangeland condition was recorded within restoration. However, grass species composition did not show any significant variation between restoration and degraded rangelands. In the current study, the low values for basal cover, litter cover degraded of dominant grasses in the degraded sites could reflect the impact of continuous grazing and recurrent drought. Similarly, Van der Westhizen *et al*. (2001) argued that in semi-arid rangelands, these parameters are greatly influenced by the effects of gazing pressure, drought and rainfall variability.

Repeated grazing and prolonged drought might lead to a reduction in herbaceous species composition and diversity, which might accelerate decline in rangeland condition. As reported by Angassa (2014) heavy grazing pressure may reduce plant species composition and basal cover. On the other hand, the highest scores for basal cover, age distribution of dominant grasses and number of seedlings were recorded in enclosed sites reflecting the benefits of reduced disturbance such as the effects of heavy grazing, trampling and inappropriate management interventions (Amaha, 2006). In addition, continuous grazing affects the amount of plant litter at the soil surface and exerts indirect pressures on the germination and seedling establishment patterns (Amsalu, 2000; Teshome, 2007; Amaha 2006; Lishan, 2007; Desalew, 2008).

The eroded and compacted soil in the degraded (i.e., sites with high grazing pressure) has low basal cover, higher bare ground cover and could lead to its compactness and loss of the soil. The observed low score for soil condition in some sampling plots could be attributed to many years of continuous grazing and loss of herbaceous species. Amsalu (2000) has reported that increased grazing pressure aggravates the hoof effect, which increases the soil bulk density resulting in reduced infiltration. Teshome (2007) has found low values for basal cover, litter cover, number of grass seedlings and age distribution in heavily grazed sites vs. the medium and light grazed sites reflecting the impacts of recurrent drought and grazing pressure in heavily grazed sites. This implies that decline in the rangeland condition in the open grazed areas have a direct negative influence on livestock production and livelihood of inhabitants in the district.

4.2. The Effect of restoration treatments on Dry-matter Yield of Herbaceous Species

The result of the current study has shown that the total DM yield and DM of individual grass species were higher in restoration treatments than in the degraded areas. The impact of restoration treatments factors may be the main reasons for the significant difference in terms of herbaceous biomass between the restoration treatments and degraded. The low DM yields of forage in the open grazed sites as compared to degraded areas corresponded with the reports of Teshome (2007), suggesting that rangelands in poor condition had low forage production with less desirable forage than those rangeland in good conditions. Similarly, the results of this study is in agreement with earlier reports (Amsalu, 2000; Amaha, 2006; Gemedo et al., 2006; Teklu et al., 2010; Shankute et al., 2011). Legumes and forbs were not significantly different between restoration treatments and degraded areas. This similarity might be due to the tolerance of certain species under increased grazing pressure. The findings of this study show that degraded site had low dry matter yield of herbaceous species, which might be attributed to the poor management practices, effects of recurrent drought and increased grazing pressure. The present finding is in line with the work of Gemedo et al. (2006), suggesting that rangelands in poor condition had low forage production with less desirable than rangelands in good condition.

4.3. Aboveground Herbaceous Biomass in Restoration Site

Higher biomass production and percentage cover of perennial grasses in the restoration treatment area could be as a result of improved land management due to the establishment of restoration treatments. The treatments are; control, mulch, cattle manure, mulch + cattle manure, ripping, semicircular bund, ripping + mulch, ripping + cattle manure, semicircular bund + mulch, semicircular bund + cattle manure, ripping +mulch +cattle manure, semicircular bund + mulch + cattle manure, ripping +mulch +cattle manure have been found to improve soil enhance the herbaceous vegetation. Aboveground biomass is positively correlated with the restoration treatment in degraded areas (Singh et al. 2011). Further, the above ground biomass in the restoration area could be due to restoration treatment in the sites.

5. Conclusions and Recommendations

The current finding showed that the status of rangeland in the degraded areas was in poor condition due to increased grazing pressure while the status of rangeland restoration techniques areas was in a good condition and has great contribution in enhancing herbaceous vegetation as a result of restoration treatments. From the result of this study, we suggest that restoration techniques are potential options for future rangeland improvement and conservation of key forage species. Generally, the compositions of herbaceous plants were greatly varied by restoration treatments and grass among species.

Therefore, urgent reaction from the government, policy, and decision maker is required. They are supposed to ease the existing grazing pressure and look for new restoration technique taking into account for human and animal population growth in the future. The new trend of protecting restoration technique is bringing a good result to secure grass to animals. Hence, we strongly suggest regional and federal government to support the practice in the district and expand it to other zones as a coping mechanism of drought and grazing land management.

6. References

Abate, T., Ebro, A., & Nigatu, L. (2010). Traditional rangeland resource utilisation practices and pastoralists' perceptions on land degradation in south-east Ethiopia. *Tropical grasslands*, *44*(3), 202-212.

Abule E., Snyman H.A., Smit G.N. 2007. Rangeland evaluation in the middle Awash valley of Ethiopia: II. Woody vegetation. Journal of Arid Environments, 70: 272-292.

Angassa, A. (2014). Effects of grazing intensity and bush encroachment on herbaceous species and rangeland condition in southern Ethiopia. *Land Degradation & Development*, *25*(5), 438-451.

Alemayehu, M. (2004). Pasture and forage resource profiles of Ethiopia. *Ethiopia/FAO. Addis Ababa, Ethiopia*, 19.

Angassa, A., & Oba, G. (2008). Herder perceptions on impacts of range enclosures, crop farming, fire ban and bush encroachment on the rangelands of Borana, Southern Ethiopia. *Human ecology*, *36*(2), 201-215.

Gitau, G. K. (2009). Dryland Livestock Wildlife Environment Interface Project: Experiences And Lessons Learnt From Livestock-Wildlife Environment Interface Management In Kenya And Burkina Faso.

Baars, R. M. T., Chileshe, E. C., & Kalokoni, D. M. (1997). Range condition in high cattle density areas in. *Tropical grasslands*, *31*, 569-573.

Bale Zone Planning and Economic Development Office, 2000.The socioeconomic profile of ManaAngetu District.

Tebeje, B. E., Gilo, B. N., Kawo, S. T., & Liban, J. D. (2014). Effect of reseeding of Rhodes grass on the restoration of degraded rangeland of Borana, Southern Ethiopia. *Direct Research Journal of Agriculture and Food Science*, *2*(7), 102-106.

Bruke, Y., & Tafesse, M. (2000). Pastoralism and Agro-pastoralism: past and present. *Pastoralism and Agro-pastoralism which way forward*.

Butt, B., Turner, M. D., Singh, A., & Brottem, L. (2011). Use of MODIS NDVI to evaluate changing latitudinal gradients of rangeland phenology in Sudano-Sahelian West Africa. *Remote Sensing of Environment*, *115*(12), 3367-3376.

Coppock, D. L. (Ed.). (1994). *The Borana plateau of southern Ethiopia: Synthesis of pastoral research, development, and change, 1980-91* (Vol. 5). ILRI (aka ILCA and ILRAD).

JALETA, D., LEMENIH, M., & LEMMA, B. (2010). *Extent of Bush Encroachment and Its Impacts on Selected Soil Properties in Borana Rangeland, Ethiopia* (Doctoral dissertation, Wondo Genet College of Forestry and Natural Resources, Hawassa University).

Davies J., Poulsen L., Schulte-Herbruggen B., Mackinnon K., Crawhall N., Henwood W.D., Dudley N., Smith J. Gudka M. 2012. Conserving Dryland Biodiversity. IUCN, Nairobi. 84p.

Davies, J., Poulsen, L., Schulte-Herbrüggen, B., Mackinnon, K., Crawhall, N., Henwood, W. D., ... & Gudka, M. (2012). *Conserving Dryland Biodiversity. xii+ 84p*.

Holechek, J. L., de Souza Gomes, H., Molinar, F., & Galt, D. (1999). Grazing studies: what we've learned.

Mohammed, (2018) .Effect of mechanical and chemical control methods of bush control on rangeland vegetation in lowlands of Bale rangeland, Southeast Ethiopia. Unpublished Report submitted to Maddawalabuuniversity.

Moore, A., & Odendaal, A. (1987). Die ekonomiese implikasies van bosverdigting en bosbeheer soos van toepassing op 'n speenkalfproduksiestelsel in die doringbosveld van die Molopo-gebied. *Journal of the Grassland Society* *of southern Africa*, *4*(4), 139-142.

Moore, A., Van Niekerk, J. P., Knight, I. W., & Wessels, H. (1985). The effect of Tebuthiuron on the vegetation of the thorn bushveld of the Northern Cape– a preliminary report. *Journal of the Grassland Society of southern Africa*, *2*(4), 7-10.

Sankaran, M., Ratnam, J., & Hanan, N. P. (2004). Tree–grass coexistence in savannas re-visited–insights from an examination of assumptions and mechanisms in-voked in existing models. *Ecology letters*, *7*(6), 480-490.

SAS, S. (2002). User's Guide, Version 9.0 SAS Institute Inc. *Cary. NY*.

Solomon, T. B., Snyman, H. A., & Smit, G. N. (2007). Cattle-rangeland management practices and perceptions of pastoralists towards rangeland degradation in the Borana zone of southern Ethiopia. *Journal of environmental management*, *82*(4), 481-494.

Van der Merwe, J. P. A. (1997). *The development of a data base and expert system for rangeland reinforcement practices in southern Africa* (Doctoral dissertation, PU for CHE).

Washington-Allen, R. A., Ramsey, R. D., West, N. E., & Norton, B. E. (2008). Quantification of the ecological resilience of drylands using digital remote sensing. *Ecology and Society*, *13*(1).