EFFECTS OF GRAZING PRESSURE, ENCLOSURES, AND ALTITUDE ON RANGE CONDITION, HERBACEOUS BIOMASS AND SPECIES COMPOSITION IN SOUTH CENTRAL ETHIOPIA.

Mulugeta Gudisa, [1, 2*] Ayana Angassa, [1, 3] Aster Abebe, [1] Kenea Feyisa, [4]
PhD Scholars[1, 2*], Professor, [1, 3] Assistance Prof.[1], PhD scholars[4]
[1]School of Animal and Range Sciences, College of Agriculture, Hawassa University, Hawassa, Ethiopia
[2]School of Engineering and Technology, Sharda University, Greater Noida, UP India
[3]Botswana University of Agriculture and Natural Resources, Department of Animal Science and Production, Botswana
[4]School of Plant and Horticultural Sciences, College of Agriculture, Hawassa University, Ethiopia

Abstract: This study was conducted in Adami-TulluJido-Kombolcha and Arsi Negelle districts in south-central Ethiopia. The inferences of this study are, to analyze the effects of grazing pressure and altitude on rangeland condition, herbaceous biomass and species composition in the areas. Assessing rangeland condition: like grass species composition, basal cover, litter cover, the number of seedlings, the age distribution of dominant grasses, soil erosion and compaction were considered and the main factors for rangeland condition assessment. The data were analyzed using the GLM procedure in SPSS 16.0 version, which was used for mean comparisons differences for enclosures areas and open-grazed areas. To test the effect of grazing pressure and altitude on rangeland condition, biomass production, species composition of herbaceous plants and the site was used as a random variable while grazing pressure and altitude were fixed variables. The total scores of herbaceous species, biomass production of grasses, forbs, and legumes in the enclosures areas were significantly ($P<0.05$) higher than in the open-grazed areas across three sites of altitude gradient variations 1578-1928mals, as top altitude,1560-1910masl, as medium altitude and 1550-1900 masl, as lower altitude. A total of 28 herbaceous species were identified. Of the identified herbaceous species, 20 were grasses, 2 were legumes while 6 species were forbs. Among the recorded grass species, some were highly desirable while others were in the category of intermediate and less desirable. Effects of grazing pressure are a cause the disturbance of plant life with an important determinant of plant community structure and influence plant species performance and plant ecology. Altitude determines the distribution of climatic factors and land suitability due to influence the plant has grown and the rate of the growth, natural vegetation types. Our findings indicate that the rangeland condition in the open-grazed areas was more degraded than the enclosures areas. We suggest that proper grazing management, restoration, and continuous monitoring programs are required for sustainability of rangelands in the study areas. Livestock has gone optimum nutrients from an early stage of maturity forages could be provided for future direction.

Keywords: Grazing pressure, Altitude, Range condition, species composition, and biomass production

1. INTRODUCTION

Rangelands are an uncultivated land that provides major sources of native forage for grazing and browsing animals (Holechek *et al*., 2001). In Africa, rangelands represent 65% of the total land area of the region supporting 59% of all ruminant livestock (Friedel *et al.*, 2000).In Ethiopia, most rangelands are found below 1500 m above sea level and characterized by arid and semi-arid ecosystems (Angassa and Oba, 2008). The effects of attitude variation within the distribution of vegetation species diversity differ along altitudinal at different layers at different scales of herbaceous plants model (Rathod, 2014). Currently, the condition of rangelands and inhabitants' livelihoods are deteriorating due to population growth, bush encroachment, expansion of cultivation, settlement, conflicts and recurrent drought (Tafesse 2000; Beruk 2003; Alemayehu 2004; Schmidt and Pearson, 2016). Effects of grazing pressure management practices with regular monitoring supported by research outputs safeguard the resilience of plant species composition and range condition for sustainable rangeland development (Alemayehu 2005; Angassa *et al.*, 2006; Smith *et al.*, 2016). The grazing capacity of most rangelands in Ethiopia are reduced and highly degraded due to increased grazing pressure, the proliferation of bush encroachments and expansion of crop cultivation in the rangelands, increased settlement, conflicts and frequent drought (Tafesse, 2000; Beruk, 2003; Alemayehu, 2004). Several studies on traditional rangeland management practices (Oba, 1998; Solomon 2000; Angassa and Fekadu, 2003; Mapinduzi et al., 2003; Limb *et al.*, 2011) have shown that pastoralists have detailed knowledge and strategies of how to manage and conserve rangeland resources. Pastoralists' indigenous ecological knowledge is helpful in classify in rangelands in terms of suitability for grazing to facilitate the proper use and management of rangeland resources (Oba and Kotile, 2001). According to Oba (1998), the managerial skills and compressive environmental knowledge of pastoralists is crucial for adaptation and coping strategies in response to climate variability. Similarly, others (Angassa, 1999; Solomon, 2000; Alemayehu, 2004; Gemedo, 2004) have also shown that traditional rangeland management practices are largely supported by indigenous range condition assessment with regard to the status of natural resources, peace, and stability that are crucial for coping strategies. Although rangeland condition assessments were widely documented (Angassa, 1999; Oba 2001; Abule, 2003; Ahmed, 2003; Gemedo, 2004), rangeland condition studies in relation to the interactive effects of grazing pressure and altitude are scarce. So far, little research has been conducted in terms of the interactive effect of grazing pressure and altitude on rangeland condition, herbaceous biomass and species composition in Adami-TulluJido-Kombolcha and Arsi-Negelle districts. The objectives of the study were the effects of grazing pressure, enclosure, and altitude on rangeland condition, herbaceous biomass and species composition in the study areas.

2. MATERIALS AND METHODS

2.1. Description of the study area

The study was carried out in Adami-TulluJido-Kombolcha and Arsi-Negelle districts in the Oromia Regional State of Ethiopia. Adami-TulluJido-Kombolcha is located between 38037'12''-38040'4''E and 7045'36''-7049'48''N and Arsi-Negelle is located 38038'24''-38042'36''E and 7026'24''-7034'12''N. The average annual rainfall ranges from 700 mm to 900 mm while temperature varies from 23°C-26°C (Adami-TulluJido-Kombolcha (OESPO), 2003)). In Arsi-Negelle district, the annual rainfall and temperature are within the range of 900 mm to 1100 mm and 28°C-30°C, respectively (Arsi- Negelle Agricultural office). In both districts sandy and clay soils are dominant within elevation range of 1500 m-2300 m above sea level (masl) in Adami-Tulu Jido-Kombolcha district (OESPO), 2003)).

2.2. Site selection

The actual field study, observations were made throughout the study kebeles for a general overview of the nature and distribution of enclosures and open-grazed areas for proper site selection. The study kebeles were stratified into three gradients altitude variations (350masl) in the rangeland condition assessment since altitude is considered as one of the most important that determines the distribution of vegetation types and species diversity (Rathod, 2014). The altitude categories of vegetation samples were stratified into three altitude zones: bottom (1550-1900 masl), medium (1560-1910 masl) and top-land (1578-1928 masl).

2.3. Sampling procedure

Systematic stratified random sampling technique was used for sampling (ILCA, 1990). A total of 108 samples across the study sites, i.e., 36 samples per site (12 samples per altitude) were randomly collected using 1 m x 1 m quadrant. At each sample site, herbaceous biomass was assessed by harvesting samples at a ground level in 1 m x 1 m quadrat along the transect at an interval of 30m. Samples were weighed using digital balance, stored in the properly labeled paper bag and fastened at the top. Then, samples were kept under shade until sampling for the day was finalized and consequently sun-dried until the research work was completed. Dry matter of herbaceous biomass was determined at 65^0c for 48 h at Hawassa University, Animal Nutrition Laboratory. Sampling was collected between June and July 2014 when most of the herbaceous plants were fully grown to their flowering stage. Herbaceous species were identified by their local right in the field with the help of an experienced person and their scientific names were compared from the flora of Ethiopia (Tewoldeberhan, 1991). The classification of herbaceous plants into highly desirable, desirable, less desirable and undesirable was done with the help of a locally experienced person.

Table 1: The experimental design used for herbaceous sample collection in Adami-Tullu Jido-Kombolcha and Arsi-Negelle districts.

	Location of rangeland Site (Kebele)				
Grazing type	Abernosa	Hadha-Bossa	Gubeta-Arjo	Sub-total	Quadrats
Enclosed areas	1	1	1	3	54
Open-grazed areas	1	1	1	3	54
Total	2	2	2	6	108

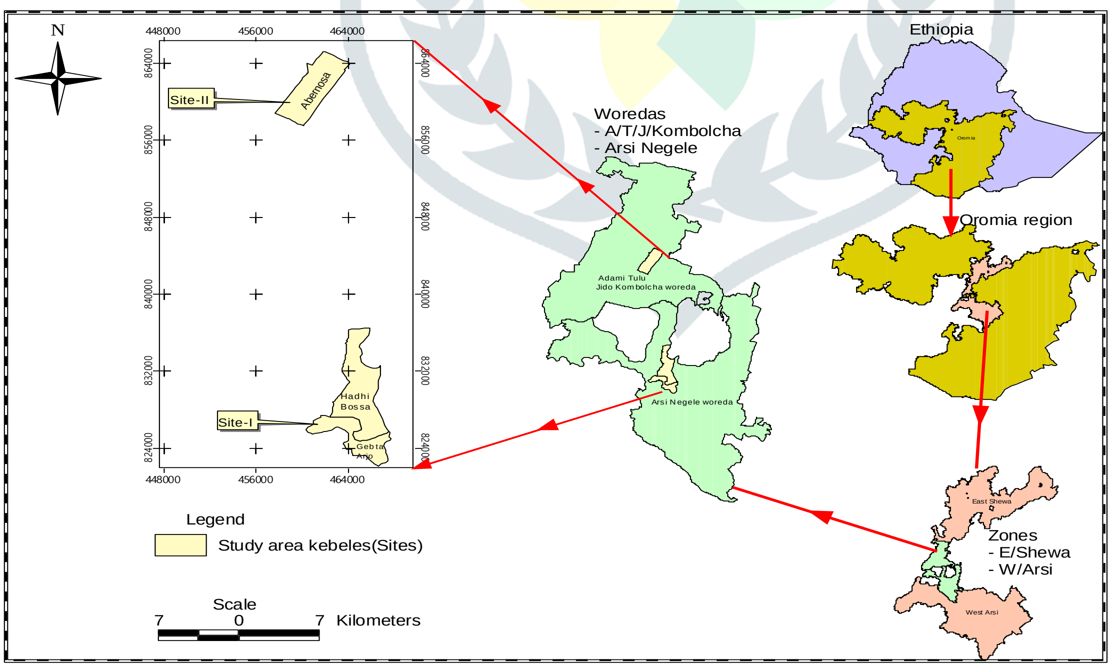

Figure 1: Map of the Study sites in Adami-Tullu Jido-Kombolcha and Arsi-Negelle districts, Ethiopia

3. Rangeland condition indicators

The factors considered and the criteria for scoring rangeland conditions were based on Tainton (1981) and Baars (1997) were presented in table 2. The maximum possible score was 50 points. The ratings were interpreted as excellent (41 to 50 points), good (31 to 40), fair (21 to 30), poor (11 to 20) or very poor (3 to 10).

3.1. Grass species composition

At each sample site, grass species composition was studied in the month of June based on visual observation. For grass composition, a score of one to ten points was considered according to the methods shown in Table 2. Then, the grass species was divided into desirable species likely to decline with heavy grazing pressure (decreasers), intermediate species likely to increase with heavy grazing pressure (increasers), and undesirable species likely to invade with heavy grazing pressure (invaders), according to the succession theory (Tainton, 1981). Classification of grasses into decreasers, increasers, and invaders was done by conducting a detailed interview with experienced persons in the study areas about the palatability and distribution of each identified grass species in relation to the intensity of grazing.

3.2. Basal and litter cover

Basal cover and litter cover were assessed on a scale of 0-10 points (Table 2). A representative sample area of 1 m^2 was selected for detailed assessments of basal and litter covers. In both cases, the 1 m2 was divided into eight. All plants in the selected 1 m2 were removed and their basal/litter cover transferred to the eight in order to facilitate visual estimations. The rating of basal cover for tufted species was considered excellent if the eighth was completely filled (12.5 percent) with the transferred grass basal cover (Baars *et al.*, 1997 and Dahlberg, 2000). The basal cover was considered very poor at < 3 percent cover. The rating for litter covers within the same 1 m^2 was considered excellent when it exceeded 40 percent and poor at < 10 percent litter cover (Table 2).

3.3. Number of seedlings and age distribution

The number of seedling per unit area is an indicator of the intensity of grazing pressure (Baars *et al.*, 1997; Friedel, 1991). For the assessment of the number of seedlings, the score was counted using three areas, each equal to the size of an A4 sheet of paper (30 cm x 21 cm) sample at random. For the number of seedlings, 0-5 points were considered. For the category "no seedlings'', a score of 0 points was given and the maximum score of 5 points was given when encountered more than 4 seedlings per the above-mentioned area. For the age distribution, 1-5 points were considered. When in all age categories, young, medium-aged and old plants of the dominant species were present, a maximum score of 5 points was given. When there were only old, medium aged or young plants, the scores 3, 2 or 1 point was given, respectively. If all age categories, young, medium and old plants of the dominant species were present, a maximum score of 5 points was given. If there were only young plants then, a minimum score of one (1) point was given.

3.4. Soil erosion and soil compaction

The extent of soil erosion was based on the number of pedestals (higher part of soils held together by plant roots, with eroded soil around the tuft), and in severe cases, the presence of pavements (terraces of flat soil, normally without basal cover, with a line of tufts between pavements) if there is no sign of soil erosion (no soil movement), a maximum score of 5 was given and a minimum score of 0 was given in situations where gully formation was observed due to soil erosion. The occurrence of slight sand mulch, slope-sided pedestals, steep-sided pedestals, and pavements coincided with scores of 4, 3, 2 and 1, respectively. Soil compaction was based on the amount of capping (crust formation). If there was no compaction, a maximum score of 5 was given and the score decreased with increasing capping of the soil. Scores of 4, 3, 2 and 1 were given for soils with isolated capping, > 50 % capping, > 75 % capping and almost 100 % capping, respectively (Baars1997; Angassa, 2014).

Table 2: Methods for range condition assessment and scoring in arid to semi-arid rangelands

GC	BC	LC	NS	AD	SC	SE	Score
91-100 percent decreaser	>12 per cent no bare spot	>40 per cent					10
81-90 percent decreasers	>12 per cent slightly bare spots						9
71-80 percent decreasers	>9 percent evenly distributed	11-40 per cent and evenly distributed					8
61-70 percent decreasers	>9 percent occasional bare spots						7
51-60 percent decreasers	>6percent evenly distributed	11-40 per cent and unevenly distributed					6
41-50 percent decreasers	>6 percent bare spots		>4 seedlings	All age categories	No sign of erosion	No sign of compaction	5
10-40percent decreasers and ≥30 percent increasers	>3percent mainly perennials	3-10 percent mainly of grasses	4 seedling	Two size category present	Slight sand mulch	Isolated capping	4
10-40 percent decreasers and <30 per	>3percent mainly of		3	Present only	Slope side pedestals (>50 per cent	>50 per cent capping	3
cent increasers	Annuals		Seedlings	Old	capping)		
<10 per cent decreasers and ≥50percent increasers	1-3 percent basal cover	3-10 percent weeds or tree leaves	2 Seedling	Only Medium	Steep-sided pedestals(>75 per cent capping)	>75 per cent capping	2
<10percent decreasers and<50percent increasers	<1 percent basal cover		1 Seedling	Only young	Pedestals (almost 100 capping)	Almost 100 per cent capping	1
Bare ground	0 percent	<3 per cent cover	No seedling		Gullies		0

GC=grass composition; BC= basal cover; LC= litter cover; NS= number of seedlings; AD= age distribution; and SC= soil condition. Source: (Baars et al., 1997)

4. DATA ANALYSIS

Grass composition, basal cover, litter cover, the age distribution of dominant grasses, numbers of seedlings and soil condition, as well as herbaceous biomass were considered as numerical response variables. Herbaceous species composition was analyzed using descriptive statistics. The t-test was employed to compare mean differences between the enclosure and open-grazed areas. The mixed model analysis was used to test the effects of grazing pressure and altitude on range condition and herbaceous biomass production of species with a site is random variable while grazing pressure and altitude were fixed.

5. RESULTS AND DISCUSSION

5.1. RESULTS

5.1.1. Effect of grazing pressure on herbaceous biomass and species composition

Herbaceous species composition across as influenced by the interactive effects of altitude and grazing pressure is presented in Appendix Table 1. A total of 28 herbaceous species were recorded both in the enclosures and open-grazed areas across the three altitude gradient variation ranges. Out of the total herbaceous species, grass species comprised 72 %, while forbs and herbaceous legumes together accounted for 28% of the herbaceous plant community composition. The classification of herbaceous species into highly desirable, desirable, less desirable and undesirable is presented in Appendix Table 1. The main grass species found included:*Aristidaadoensis*,*Aristida*,*adscensionis*,*Cenchrusciliaris*,*Chlorisgayana*,*Chlorispycnothrix*,*Cynodondactylon*,*Bothriocholainsculpta*,*Sidaovate*,*Panicummaximum*,*Heteropogoncontortus*,*Eragrostispapposa*,*Sporoboluspyramidalis*,*Themedatriandra*,*Tetrapogonteneullus*,*Dactylocteniumaegypticum*,*Indigoferaspinosa*,*Tephrosia pumila*,*Bides pilosa*,*Amaranthusdubis*, *Chrysopogon plumulosus*,*Tribulosterrestris*, *Achyrantesaspera*, *Cenchrus setigures* and *Ocimum basilicum*. The results showed that the proportion of herbaceous legumes and forbs was very low in the study sites. Overall, we recorded similar herbaceous species composition across the study sites regardless of management (enclosure versus open-grazed areas) and altitude gradient variation.

5.1.2. Herbaceous species composition in the bottomland altitude (1550m-1900m)

A total of 16, 2 and 4 species of grasses, legumes and other herbaceous plants were identified in the bottomland altitude, respectively (Appendix Table 1). Of the total herbaceous species identified in the bottomland altitude, 51.6% were grasses of different species, 6.4% legumes species and 12.9% forbs species. Of the grass species, 43.7% were highly desirable, 50% desirable and 31.2% less desirable species.

5.1.3. Herbaceous species composition in the medium altitude (1560m -1910 m)

A total of 14, 2, and 6 species of grasses, legumes and forbs were identified in the medium altitude of the study sites, respectively (Appendix Table 1). Of the total herbaceous species identified in the medium altitude, 45.1% were grasses of different species, which included highly desirable, desirable and less desirable species. The grasses *Bothriochola insculpta*, *Brachiaria humidcola*, *Bothriocholan igropedata*, *Indigofer spinosa*, *Tephrosiapumila*, *Eragrostispapposa* and *Sporobolus pyramidalis* were common and/or dominant in the open-grazed areas, where as species like *Heteropogon contortus* and *Chloris pycnothrix* were common and/or dominant species in the enclosure areas (Appendix Table 1). There was a relatively high amount of highly desirable (decreasers) grass species in the enclosure followed by open-grazing areas.

5.1.4. Herbaceous species composition in the top altitude (1578 m -1928 m)

A total of 15 species of grasses, 1 legume and 6 species of other herbaceous plants were identified (Appendix Table 1). The grass species in the top land altitude consisted of 48.38% of the total herbaceous species composition and of these categories 53.3% were highly desirable, 60% desirable and 33.3% less desirable species. The most common and dominant plant species both in the enclosure and open-grazed areas of the top land altitude included: *Cynodon dactylon,Entropogon,Panicummaximum,Heteropogoncontortus,Chrysopogon,plumulosus,Tetrapogonteneullus, Sidaovate, Cenchrus ciliarus, Chlorisroxburghiana, Indigoferspinosa, Amaranthusdubis,bidespilosa, Themedatriandra, Ocimumbasilicum, Achyrantesaspera and Tribulosterrestris* (Appendix Table 1)

Appendix Table 1: Distribution of common grass, legumes and forbs species in the enclosures versus open grazed areas by three altitude ranges in the study areas.

Site	Species	Species value	Altitude					
			Bottomland		Medium		Top land	
			Enclosure	Open-grazed	Enclosure	Open-grazed	Enclosure	Open-grazed
Abernosa	*Aristida adoensis*	LD	P	-	-	P	-	-
	Aristida adscensionis	LD	P	C	P	-	P	P
	Cenchrus ciliaris	HD	C	C	P	-	P	P
	Cenchrus setigures	D	-	P	D	-	P	-
	Chlorisgayana	HD	D	D	C	C	P	P
	Chlorispycnothrix	D	C	-	-	P	-	-
	Chroris roxburghiana	D	C	-	P	-	-	C
	Cynodondactylon	D	-	P	-	P	C	-
	Dact.aegypticum	HD	P	P	-	P	-	P
	Bothriochola insculpta	D	P	D	-	C	P	-
	Entropogon	LD	-	P	P	-	C	-
	Eragrostispapposa	D	P	-	-	D	P	-
	Heteropogoncontortus	D	P	-	D	C	-	-
	Microchloa kunthii	LD	-	-	C	-	P	P
	B.nigropedata	HD	P	-	D	-	-	P
	Panicum maximum	HD	-	P	P	P	C	P
	Chrysopogon	HD	P	-	P	P	C	D
	Brachiaria humidcola	HD	-	P	C	D	P	-
	Themedatriandra	LD	P	P	-	-	D	-
	Sporoboluspyramidalis	LD	P	-	C	-	P	P
	Tetrapogon teneullus	HD	P	-	-	P	-	-
	Legumes							
	Indigofera spinosa	D	C	C	D	-	C	C
	Tephrosiapumila	HD	-	C	C	D	-	P
	Forbs or Other							
	Bides pilosa	UD	P	P	C	C	C	P
	Soda ovate	D	C	C	D	C	D	C
	Amaranthus dubis	UD	C	C	C	C	C	C
	Tribulosterrestris	D	C	C	D	D	D	P
	Achyrantes Aspera	D	D	D	C	C	C	C
	Ocimumbasilicum	HD	P	P	C	C	C	P

HD=highly desirable, D=Desirable, LD=Less desirable, UD=Undesirable; P=present, C=Common, D=Dominant

Appendix Table 1. Cont'd

Site	Species	Species value	Altitude					
			Bottomland		Medium		Top land	
			Enclosure	Open-grazed	Enclosure	Open-grazed	Enclosure	Open-grazed
Hadha-Bossa	*Aristida adoensis*	LD	P	-	-	P	-	-
	Aristida adscensionis	LD	-	C	P	-	P	P
	Cenchrus ciliaris	HD	C	-	P	-	P	C
	Cenchrus Setigerus	D	-	P	D	-	P	-
	Calories gayana	HD	D	D	C	-	P	P
	Chlorispycnothrix	D	C	P	-	P	-	P
	Chloris roxburghiana	D	C	-	P	-	-	C
	Cynodondactylon	D	-	P	-	P	C	-
	Dact.aegypticum	HD	P	P	-	P	-	P
	Bothriochola insculpta,	D	P	D	-	C	P	-
	Entropogon	LD	-	P	P	-	C	-
	Eragrostispapposa	D	P	-	P	D	P	-
	Heteropogoncontortus	D	P	P	D	C	-	-
	Microchloa kunthii	LD	P	-	C	-	P	P
	B. nigropedata	HD	P	P	D	P	-	P
	Panicum maximum	HD	-	P	P	-	C	-
	Themedatriandra	LD	P	-	P	P	D	P
	Sporoboluspyramidalis	LD	P	-	C	P	P	-
	Legumes							
	Indigofera spinosa	D	C	C	D	-	C	C
	Tephrosiapumila	HD	-	C	C	D	-	P
	Forbs or Others							
	Sida ovate	D	C	C	D	D	C	C
	Bides pilosa	UD	P	P	C	C	P	P
	Amaranthus dubis	UD	C	C	C	C	C	C
	Tribulosterrestris	D	C	C	D	D	P	P
	Achyrantes Aspera	D	D	D	C	C	C	C
	Ocimumbasilicum	HD	P	P	C	C	P	P

HD=highly desirable, D=Desirable, LD=Less desirable, UD=Undesirable; P=present, C=Common, D=Dominant

Appendix Table 1. Cont'd

Site	Species	Species value	Altitude					
			Bottomland		Medium		Top land	
			Enclosure	Open-grazed	Enclosure	Open-grazed	Enclosure	Open-grazed
Gubeta-Arjo	*Aristida adoensis*	LD	P	-	-	P	-	-
	Bothriochola insculpta,	D	P	D	-	C	P	-
	Aristida adscensionis	LD	-	C	P	-	P	P
	Cenchrus Ciliarus	HD	C	-	P	-	P	C
	Cenchrus setigerus	D		P	D	-	P	-
	Chloris gayana	HD	D	D	C	-	P	P
	Calories pycnothrix	D	C	-	P	P	-	-
	Chlorispycnothrix	D	C	-	-	P	-	-
	Calories roxburghiana	D	C	-	P	P	-	C
	Cynodondactylon	D	-	P	-	P	C	-
	Dact.aegypticum	HD	P	P	-	P	-	P
	Eragrostispapposa	D	P	-	-	D	P	-
	Heteropogoncontortus	D	P	-	D	C	-	-
	Microchloa kunthii	LD	-	-	C	-	P	P
	Panicum maximum	HD	-	P	P	-	C	-
	Themed triandra	LD	P	-	-	P	D	P
	Sporoboluspyramidalis	LD	P	-	C	P	P	-
	Tetrapogon tenellus	HD	P	P	-	P	-	-
	Legumes							
	Indigofera spinosa	D	C	C	D	-	C	C
	Tephrosiapumila	HD	-	C	C	D	-	P
	Forbs or Others							
	Sida ovate	D	C	P	D	-	C	D
	Bides pilosa	UD	P	D	C	P	P	P
	Amaranthus dubis	UD	C	P	C	-	C	-
	Tribulosterrestris	D	C	C	D	C	P	P
	Achyrantes Aspera	D	D	D	C	P	C	-
	Ocimumbasilicum	HD	P	-	C	-	P	D

HD= highly desirable, D= Desirable, LD= Less desirable, UD= Undesirable; P= present C= Common, D= Dominant

5.2. The effect of enclosures on rangeland condition

The effects of the grazing pressure on rangeland condition parameters are presented in Table 3. Grass species composition did not show any significant (P>0.05) different between enclosures areas and open-grazed areas in Abernosa site while it was significantly (P<0.05) different at Hadha-Bossa and Gubeta-Arjo sites. The score values for basal cover, letter cover and age distribution of dominant grasses were significantly (P<0.05) higher in enclosures than in the open-grazed areas across the three study sites. The number of seedlings for herbaceous plants did not show significant (P>0.05) difference between the enclosure and open-grazed areas across the three study sites. Age distribution of dominant grasses did not show any significantly (P>0.05) difference between the enclosure and open-grazed areas at Hadha-Bossa site while Gubeta- Arjo and Abernosa sites were significantly (P<0.05) varied. Soil erosion and soil compaction were significantly (P<0.05) higher in the open-grazed areas than in the enclosure areas across the three study sites. The overall range condition score was in the range of 18.09 (in poor condition) to 34.13 (in good condition) and the difference was significantly (P<0.05) varied.

Table 3**:** Range condition score (LSM+SE) effects of enclosures versus open grazed areas found in three different Sites

Parameters	**Abernosa**		**Hadha-Bossa**		**Gubeta-Arjo**	
	Enclosed	Open-grazed	Enclosed	Open-grazed	Enclosed	Open-grazed
Grass composition	6.90±0.33^{a}	6.16±0.33^{a}	6.65±0.33^{a}	5.71±0.33^{b}	7.74±0.33^{a}	5.58±0.33^{b}
Basal cover	7.12±0.21^{a}	2.25±0.21^{b}	7.16±0.21^{a}	2.53±0.21^{b}	7.75±0.21^{a}	1.95±0.21^{b}
Letter cover	6.83±0.30^{a}	4.16±0.30^{b}	6.75±0.52^{a}	3.28±0.35^{b}	7.28±0.28^{a}	3.57±0.20^{b}
Number of seedling	0.00+0.00^{a}	0.00+0.00^{a}	0.00+0.00^{a}	0.00+0.00^{a}	0.00+0.00^{a}	0.00+0.00^{a}
Age distribution	4.45±0.17^{a}	2.94+0.17^{b}	3.34+0.17^{a}	3.35+0.17^{a}	4.20±0.17^{a}	2.49±0.17^{b}
Soil erosion	3.29±0.13^{a}	1.89±0.13^{b}	3.66±0.13^{a}	1.85±0.13^{b}	3.55±0.13^{a}	2.40±0.13^{b}
Soil compaction	3.08±0.13^{a}	1.75±0.13^{b}	3.54±-0.13^{a}	1.70±0.13^{b}	3.61±0.13^{a}	2.10±0.13^{b}
Total range score	31.67±1.27^{a}	19.15±1.27^{b}	31.1+1.27^{a}	21.95±1.27^{b}	34.13±1.27^{a}	18.09+1.27^{b}

Means with different letter in a row are significantly different (P<0.05), The Range Score was interpreted as excellent (41-50 points), good (31-40 points), fair (21-30 points), poor (11-20 points), or very poor (3-10 points).

5.2.1. Effect of grazing pressure on rangeland condition in the bottomland altitude

The effect of grazing pressure on rangeland condition parameters in the bottomland altitude is shown in Table 4. The number of seedlings in Abernosa, Hadha-Bossa and Gubeta-Arjo sites in the bottomland altitude did not show any significant (P>0.05) difference between the enclosure and open-grazed areas (Table 4). The range condition scores for grass composition, basal cover, litter cover and age distribution of dominant grass species were significantly (P<0.05) different between enclosure areas and open-grazed sites in the bottomlands. Grass composition in the categories of bottomland altitude did not show any significant (P>0.05) difference between enclosures and open-grazed areas at Hadha-Bossa site while Abernosa and

Gubeta-Arjo sites were significantly ($P<0.05$) differed. Soil erosion and soil compaction in bottomland altitude were significantly ($P<0.05$) higher in the open-grazed areas than in enclosures. The total score for the range condition status in the bottomland altitude ranged from 17.5 (in poor condition) to 33.6 (in good condition) and the difference was significant ($P<0.05$).

5.2.2. Effect of grazing pressure on rangeland condition in the medium altitude

The effect of grazing pressure on range condition score in the medium altitude is presented in Table 4. The score for grass composition did not show any significant ($P>0.05$) difference between enclosures areas and open-grazed areas in the medium altitude of the study sites at Hadha-Bossa while this was significant ($P<0.05$) at Abernosa and Gubeta-Arjo sites. The range condition scores for basal cover, litter cover and age distribution of dominant grass species were significantly ($P<0.05$) differed between enclosures and open-grazed areas of the medium altitude. In the medium altitude, the extent of range condition score values was in the range of 17.4 (in poor condition) to 33.1 (in good condition) and the difference was significant ($P<0.05$). The score values for soil erosion and soil compaction were significantly ($P<0.05$) higher in enclosure areas than in the open-grazed areas of the medium altitude.

5.2.3. Effect of grazing pressure on rangeland condition in the top land altitude

The effect of grazing pressure on range condition in the top land altitude for the different range condition rating factors is presented in Table 4. The score for grass composition showed a significant ($P<0.05$) difference between enclosures and open-grazed areas in the top land altitude across the three studied sites (Table 4). Soil erosion did not show any significant ($P>0.05$) difference between enclosure areas and open-grazed areas at the Abernosa site while significantly ($P<0.05$) difference at Gubeta-Arjo and Hadha-Bossa sites. The score for basal cover, litter cover and age distribution of dominant grass species was significantly ($P<0.05$) higher in the enclosure areas than in the open-grazed areas in the top land altitude. The litter cover, basal cover and age distribution of grasses was significantly ($P<0.05$) higher in the enclosure areas than open-grazed areas. The magnitudes of range condition mark standards in the range of 18.1 (in poor condition) to 34.6 (in good condition) and the difference was significant ($P<0.05$). The score for soil erosion and soil compaction was significantly ($P<0.05$) higher in the open-grazed areas than in the enclosures in the top altitude site.

Table 4.Range condition score on effect of grazing pressure (LSM+SE) and enclosure versus open-grazed areas in three different altitude Sites

Site	Parameter	Altitude					
		Top land (1578 m-1928 m)		Medium (1560 m-1910 m)		Bottom(1550 m-1900 m)	
		Enclosed	Open-grazed	Enclosed	Open-grazed	Enclosed	Open-grazed
Abernosa	Grass composition	7.86 ± 0.56^{a}	5.29 ± 0.56^{b}	6.86 ± 0.56^{a}	5.86 ± 0.56^{b}	7.00 ± 0.56^{a}	6.33 ± 0.56^{b}
	Basal cover	6.57 ± 0.35^{a}	2.14 ± 0.35^{b}	7.14 ± 0.35^{a}	2.29 ± 0.35^{b}	7.67 ± 0.35^{a}	2.33 ± 0.38^{b}
	Litter cover	6.83 ± 0.30^{a}	4.16 ± 0.30^{b}	7.00 ± 0.30^{a}	3.57 ± 0.36^{b}	7.14 ± 0.34^{a}	4.00 ± 0.18^{b}
	Number of seedling	$0.00+0.00^{a}$	$0.00+0.00^{a}$	$0.00+0.00^{a}$	$0.00+0.00^{a}$	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
	Age distribution	4.43 ± 0.29^{a}	2.85 ± 0.29^{b}	4.23 ± 0.29^{a}	3.14 ± 0.29^{b}	$4.50+0.29^{a}$	2.83 ± 0.29^{b}
	Soil erosion	$3.67+0.23^{a}$	$2.00+0.23^{a}$	$3.29+0.23^{a}$	$2.00+0.23^{b}$	$3.00+0.24^{a}$	$1.67+0.23^{b}$
	Soil compaction	3.14 ± 0.23^{a}	1.74 ± 0.23^{b}	3.29 ± 0.23^{a}	1.86 ± 0.23^{b}	2.86 ± 0.24^{a}	1.67 ± 0.24^{b}
	Total range score	31.4 ± 1.96	18.18 ± 1.96	32.01 ± 1.96	19.72 ± 2.02	32.17 ± 2.02	18.83 ± 1.65
Hadha-Bossa	Grass composition	6.57 ± 0.56^{a}	5.00 ± 0.61^{b}	6.71 ± 0.56^{a}	6.14 ± 0.56^{a}	6.67 ± 0.56^{a}	6.00 ± 0.56^{a}
	Basal cover	6.71 ± 0.35^{a}	2.86 ± 0.35^{b}	7.29 ± 0.35^{a}	2.43 ± 0.35^{b}	7.50 ± 0.38^{a}	2.33 ± 0.38^{b}
	Litter cover	6.75 ± 0.52^{a}	3.28 ± 0.35^{b}	6.83 ± 0.30^{a}	2.33 ± 0.21^{b}	7.33 ± 0.49^{a}	3.00 ± 0.30^{b}
	Number of seedling	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
	Age distribution	4.43 ± 0.29^{a}	3.57 ± 0.29^{b}	4.57 ± 0.29^{a}	3.15 ± 0.29^{b}	4.17 ± 0.31^{a}	3.33 ± 0.31^{b}
	Soil erosion	3.42 ± 0.23^{a}	1.86 ± 0.23^{b}	3.57 ± 0.23^{a}	1.86 ± 23^{b}	4.00 ± 0.23^{a}	1.83 ± 0.24^{b}
	Soil compaction	$3.97\pm0.23^{a+}$	1.57 ± 0.23^{b}	3.37 ± 0.23^{a}	1.86 ± 0.23^{b}	3.50 ± 0.24^{a}	1.67 ± 0.24^{b}
	Total range score	31.45 ± 2.4	18.14 ± 2.06	32.54 ± 1.96	17.77 ± 2.27	33.2 ± 2.77	18.2 ± 1.29
Gubeta-Arjo	Grass composition	8.86 ± 0.61^{a}	5.57 ± 0.61^{b}	7.86 ± 0.56^{a}	6.00 ± 0.56^{b}	7.50 ± 0.56^{a}	5.17 ± 0.56^{b}
	Basal cover	8.29 ± 0.35^{a}	2.00 ± 0.35^{b}	7.14 ± 0.35^{a}	1.86 ± 0.35^{b}	7.83 ± 0.38^{a}	2.00 ± 0.38^{b}
	Litter cover	7.28 ± 0.28^{a}	3.57 ± 0.20^{b}	7.00 ± 0.36^{a}	$2.83+0.30^{b}$	6.85 ± 0.40^{a}	3.00 ± 0.21^{b}
	Number of seedling	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
	Age distribution	4.74 ± 0.29^{a}	3.29 ± 0.29^{b}	4.29 ± 0.29^{a}	2.71 ± 0.29^{b}	4.17 ± 0.31^{a}	2.83 ± 0.31^{b}
	Soil erosion	3.97 ± 0.23^{a}	2.71 ± 0.23^{b}	3.27 ± 0.23^{a}	2.00 ± 0.23^{b}	3.50 ± 0.24^{a}	2.50 ± 0.24^{b}
	Soil compaction	3.71 ± 0.23^{a}	2.29 ± 0.23^{b}	3.29 ± 0.23^{a}	2.00 ± 0.24^{b}	3.83 ± 0.24^{a}	2.00 ± 0.23^{b}
	Total range score	34.66 ± 1.99	19.43 ± 1.19	33.15 ± 2.02	17.4 ± 1.97	33.68 ± 2.13	17.5 ± 1.93

Means with different letter in a row are significantly different ($P<0.05$)

5.3. DISCUSSION

5.3.1. The effect of enclosure on biomass production

The harvested samples from each quadrant (1 m^2) were separated into sub-samples of grasses, legumes and forbs in the field to determine the biomass production of different herbaceous plants (Table 5). The score values of grass biomass production was significantly (P<0.05) higher in enclosures than in the open-grazed areas across all study sites. The biomass production of legumes did not show any significant (P>0.05) difference between enclosures and open-grazed areas at Abernosa site, while significantly (P<0.05) different in Gubeta-Arjo and Hadha-Bossa sites. At same time, the biomass production of legumes and forbs in the study sites was significantly (P<0.05) higher in enclosures than in the open-grazed areas across the three sites. The overall total grass biomass production, forbs and legumes across the study sites were increase considerably from 32.4 kg/ha to 42.5 kg/ha with the declining status of range condition. Generally, enclosures had significantly (P<0.05) higher biomass production than that of open-grazed areas across the three study sites.

Table 5.Biomass production (kg/ha) of herbaceous species in enclosures versus open-grazed areas in three sites

Parameters	**Abernosa**		**Hadha-Bossa**		**Gubeta-Arjo**	
	Enclosed	Open-grazed	Enclosed	Open-grazed	Enclosed	Open-grazed
Grass	146.90 ± 29.0^a	93.16 ± 29.96^b	218.26 ± 29.96^a	131.10 ± 29.96^b	186.70 ± 29.96^a	107.20 ± 29.96^b
Forbs	62.70 ± 9.07^a	32.05 ± 9.07^b	76.12 ± 9.07^a	34.88 ± 9.07^b	64.14 ± 9.07^a	32.99 ± 9.07^b
Legumes	18.06 ± 3.52^a	13.98 ± 3.52^a	26.02 ± 3.52^a	15.82 ± 3.52^b	24.92 ± 3.52^a	12.05 ± 3.52^b
Total biomass	227.66 ± 32.43	139.19 ± 42.55	320.4 ± 42.55	181.8 ± 42.55	275.76 ± 42.55	152.24 ± 42.55

Means with different letter in a row are significantly different (P<0.05)

5.3.2. Biomass production in bottomland altitude (1550 m-1900m)

Grass biomass production in the bottomland altitude did not show any significant (P>0.05) difference between enclosures and open-grazed areas at Abernosa and Hadha-Bossa (Table 6). However, grass biomass production in the Bottomland altitude was significantly varied between enclosures and open-grazed areas at Gubeta-Arjo site. Biomass production of forbs in the bottomland altitude showed significant (P<0.05) differences between enclosure areas and open-grazed areas at Abernosa and Gubeta-Arjo while Hadha-Bossa site did not show any significant (P>0.05) differences. The biomass production of grasses and forbs in the bottomland altitude did not show any significant (P>0.05) difference between enclosure areas and open-grazed areas at Hadha-Bossa and Abernosa sites. The Biomass production of legumes in the bottomland altitude showed a significant (P<0.05) difference between enclosures and open-grazed areas in all study sites. The total average biomass production of grasses, forbs, and legumes was significantly (P<0.05) higher in enclosures than in the open-grazed areas. The overall range condition score values are considerably varied from 115.4 kg/ha to 32.2 kg/ha as the range condition deteriorate from good within enclosures to poor condition along the open-grazed areas for different altitude sites.

5.3.3. Biomass production in the medium altitude (1560 -1910 masl)

The effect of medium altitude on biomass production of grasses showed significant (p<0.05) difference between enclosures and open-grazed areas in all the three study sites. The biomass production of forbs and legumes in the medium altitude across the three study sites was significantly (P<0.05) different between enclosure areas and open-grazed areas. Grass, forbs and legumes biomass production in the medium altitude was significantly (P< 0.05) higher in enclosure areas than in the open-grazed areas along the three altitude categories across the study sites. The total biomass production of grass, forbs, and legumes in the medium altitude was significantly (P< 0.05) higher in enclosures than in the open-grazed areas across the three study sites. Biomass production varied from 249.8 kg/ha to 54.6 kg/ha as the range condition declines from good within enclosures to poor condition in the open-grazed areas across the three altitude ranges.

5.3.4. Biomass production in the top altitude (1578 -1928 masl)

The Biomass production of grass and forbs in the top altitude showed a significant (P<0.05) different between enclosure areas and open-grazed areas in Abernosa and Gubeta-Arjo sites while biomass production of grass and forbs in the top altitude in Hadha-Bossa site did not show any significant (P>0.05) difference. The biomass production of legumes in the top land altitude was significantly (P<0.05) higher in enclosures than in the open-grazed areas at Badha-Bosa and Gubeta-Arjo sites. The biomass production of grass and forbs scores was significantly (P<0.05) higher in enclosures than in the open-grazed areas along the three sites. The total range condition score value in the top land altitude were considerably varied from 449.2 kg/ha to 102.2 kg/ha as the range condition deteriorates from good condition to poor condition along study sites.

Table 6.Biomass production (kg/ha) of herbaceous species in enclosures versus open-grazed areas in three site

Site	Parameters	**Altitude**					
		Top(1578m-1928m)		Medium (1560m-1910m)		Bottom(1550m-1900m)	
		Enclosed	Open-grazed	Enclosed	Open-grazed	Enclosed	Open-grazed
Abernosa	Grass	159.90±29.0^{a}	98.16±29.96^{b}	150.80±29.0^{a}	93.16±29.96^{b}	46.88±29.0^{a}	36.88±29.0^{a}
	Forbs	62.70±9.07^{a}	32.05±9.07^{b}	51.75±14.68^{a}	34.57±5.95^{b}	72.92±8.12^{a}	20.85±4.57^{b}
	Legumes	18.06±3.52^{a}	13.98±3.52^{a}	45.27±1.17^{a}	18.88±2.99^{b}	23.57±1.93^{a}	11.58±2.82^{b}
	Total biomass	240.66±32.43	144.19±42.55	247.82±3.19	146.61±1.56	143.37±2.46	69.31±1.02
Hadha-Bossa	Grass	291.56±14.30^{a}	144.97±11.18^{a}	180.70±6.46^{a}	81.50±15.65^{b}	75.24+15.53^{a}	40.01+13.71^{a}
	Forbs	114.42±7.47^{a}	37.82±6.31^{a}	46.02±5.78^{a}	23.74±2.20^{b}	26.71+5.58^{a}	12.82+0.98^{a}
	Legumes	38.53±5.69^{a}	13.51±1.51^{b}	22.60±4.29^{a}	9.04±1.34^{b}	13.52+1.76^{a}	6.71+1.2^{b}
	Total biomass	444.51±27.46	196.3±19	249.32±16.5	114.28±19.19	115.47±22.87	59.54±15.96
Gubeta-Arjo	Grass	309.60±80.87^{a}	63.80±7.32^{b}	181.90±42.30^{a}	32.50±3.34^{b}	93.17±33.34^{a}	18.77±1.93^{b}
	Forbs	102.41±7.68^{a}	25.87±4.91^{b}	49.98±2.62^{a}	16.00±3.73^{b}	28.01±2.97^{a}	9.58±1.92^{b}
	Legumes	37.27±6.87^{a}	12.57±0.94^{b}	17.93±2.55^{a}	6.17±0.62^{b}	12.54±2.02^{a}	3.94±0.81^{b}
	Total biomass	449.28±95.42	102.24±13.17	249.81±44.47	54.67±7.69	133.72±38.33	32.29±4.66

Means with different letter in a row are significantly different (P<0.05)

5.4. Effect of the enclosure on herbaceous biomass and species composition

The outcome of this study indicates that grazing had a significant effect on herbaceous biomass, species composition, plant community structure and rangeland condition, which is also in agreement with the report of (Amsalu, 2000; Fynn and O'Connor, 2000; Suding *et al.,* 2004). The findings of the present study reflect that open-grazed sites had fewer herbaceous biomass and species composition. Similarly, previous studies (Teshome, 2007; Amsalu, 2000) have indicated the impact of increased grazing pressure on herbaceous biomass species composition in the middle rift valley of Ethiopia and south-eastern part of Ethiopia. In contrast, some herbaceous plant species were grazing tolerant under increased pressure and become more dominant and common in the open-grazed areas (Teshome, 2007; Abate and Angassa, 2016). The present finding shows that the higher herbaceous biomass species that was observed in the enclosure areas is almost certainly correlated to fewer disturbances by livestock and wildlife grazing which is also in line with the report by Angassa and Oba (2008). Moreover, the relationship between grazing pressure and herbaceous biomass production and/or species composition suggests more herbaceous biomass under light to moderate reflecting that herbaceous biomass production and species composition could be greatly affected with increased disturbance. The present findings in references to herbaceous biomass production, species composition, and rangeland condition are consistent with previous reports (Amsalu, 2000; Teshome, 2007; Kotze *et al.*, 2013). Herbaceous biomass production and species composition, as well as the frequency of highly palatable species, were highly diminished with increased grazing pressure, which is in agreement with the work of Amsalu, (2000) and Amaha (2006; Li *et al.*,2011).

5.4.1. Herbaceous species composition in the bottomland altitude (1550-1900 masl)

The occurrence of fewer highly desirable grass species both in frequency and density could be good evidence for the downward trend in rangeland condition in the bottomland altitude and this finding is in agreement with previous reports (Ayana, 1999; Amsalu and Gemedo, 2004; Vogelmann et al., 2012). In the open-grazed areas of the bottomland altitude in the study sites, species like Aristida adscensionis, Cenchrus ciliaris, Indigoferspinos, Sidaovate, Amaranthus, Tribulos terrestris and Chlorispycnothrix were among the dominant and/or common grass species. In the enclosure areas of the bottomland altitude, species like Chlorisroxburghiana, Bothriochola insculpta, Indigoferspinos, Cenchrusciliaris, and Entropogon and Sporoboluspyramidalis were some of the dominant and/or common grass species (Appendix Table 1). Enclosures had the relatively higher percentage of highly desirable grass species than the open-grazed areas. This is probably due to the influence of improved management inside enclosures where livestock impact is minimal to induce damage to desirable grass species. The result is in agreement with the reports of others (Abule, 2003; Gemedo, 2004; Amaha, 2006; Launch *et al.,* 2006).

5.4.2. Herbaceous Species Composition in the Medium Altitude (1560-1910 masl)

The results of the present study indicate that in the medium altitude it seems that desirable plant species were replaced by less desirable and unpalatable species as the effect of grazing pressure increases (Crawley, 1986). Moreover, overgrazing by domestic livestock has been considered as a major factor for the decline in desirable and highly palatable species suggesting that grazing influences vegetation structure and composition as a result of which some species increase in abundance while others decrease (Yates *et al*., 2000; Gemedo, 2004).

5.4.3. Herbaceous species composition in the top altitude (1578-1928 masl)

According to Pratt and Gwynne (1977), prolonged heavy grazing certainly contributes to the disappearance of palatable plant species and the subsequent dominance by other less palatable herbaceous plants or bushes. Furthermore, studies (Fynn and O'Connor, 2000; Yates *et al.*, 2000; Gemedo, 2004) have shown that heavy grazing and low rainfall promote the growth of annual grasses. In the present study in the open-grazed areas of the top land altitude, plant species such as *Bothriocholan igropedata*, *Indigoferspinos*, *Tephrosiapumila*, *Ocimumbasilicum*, *Sidaovata*, and *Eragrostispapposa* were among the dominant and/or common grass species recorded. In the enclosure areas of the higher altitude, species like *Cynodondactylon, Panicum maximum, Tetrapogon teneullus, Indigoferspinos, Achyrantes, Amaranthus, Sida ovate, and Bides pilosa*. The were some of the common and/or dominant grass species (Appendix Table 1).

5.5. The effect of the enclosure on rangeland condition

Grass composition does not illustrate any significant (P>0.05) difference between enclosures and open-grazed areas at Abernosa site. This may be due to the impact of grazing-related disturbance in both sites. This is in agreement with the report of Amsalu (2000). In the current study, the values for range condition score in enclosures were higher than the values recorded in the open-grazed areas. The lower range condition scores for basal cover, letter cover and age distribution of dominant grasses in the open-grazed areas may be due to the impact of continuous grazing and repeated drought. This is in agreement with the work of (Vander Westhuizen *et al.,* 2001) that suggested that in arid and semi-arid rangelands the range condition rating parameters are greatly influenced by the effects of grazing pressure and rainfall variability. Permanent grazing and frequent drought might lead to a reduction in herbaceous species composition and diversity, which may accelerate the decline in rangeland condition (Bezuayehu *et al.*, 2002). According to Angassa (2014), heavy grazing pressure may reduce plant species composition and basal cover. The main factors for the low basal cover in the open-grazed areas could possibly be associated with relatively high grazing pressure accompanied by frequent drought. Furthermore, the lack of organic matter and a high percentage of very fine sand and silt soils are some of the factors contributing to surface sealing (Bezuayehu *et al.*, 2002). The low score for soil condition in some sampling plots could be attributed to continuous grazing for a longer period of time and loss of herbaceous species. Amsalu (2000) reported that overstocking aggravates the hoof effect, which increases the soil bulk density resulting in reduced infiltration.

5.5.1. Effects of Grazing pressure on Rangeland Condition in the Bottomland Altitude (1550-1900 masl)

Grass composition did not show any significant effect on rangeland condition between enclosures and open-grazed areas both in the bottomland and medium altitudes at Hadha-Bossa site. This could be due to the presence of different types of animals with different feeding habits and feed selectivity that might also minimize damage to certain species of forage plants. The results of the present study are in agreement with the work of others (Amsalu and Baars 2002; Gemedo, 2004). The values for the range condition scores within enclosures in the bottomland and medium altitudes at Hadha-Bossa and Gubeta-Arjo sites were higher than the values recorded in the open-grazed areas. This variation, in turn, influences the distribution, growth, and development of range plants in their various localized habitats and varied elevation. This is in accordance with the results of previous studies (Ayana, 1999 and Admasu, 2006). The results of the current study show that reduced scores for basal cover, letter cover and age distribution of dominant grasses in the open-grazed areas might be attributed to the impact of continuous grazing. Similarly, the effects of variation in altitude could be the most important environmental variable that contributes to the significant difference in the spatial distribution of herbaceous species in the rangelands. Similarly, Pratt and Gwynne (1977) indicate that areas with lower elevation ranges typically produce much less vegetation than higher elevation as precipitation generally increases with altitude. Gemedo (2004) has also reported a similar finding in the Borana rangelands of southern Ethiopia. Overall, range condition scores were significantly higher in enclosures than in the open grazed areas in the top altitude at Gubeta- Arjo site. In general, the state of the rangeland within enclosures was in good condition implying that establishing enclosures might be an alternative method for improving the condition of the rangelands. This is in accordance with others work (Ayana,1999; Amsalu, 2000) who reported that improved range condition inside enclosures as compared to open-grazed areas both in Borana rangelands and in the middle Rift valley of Ethiopia. The number of seedlings had no significant difference between bottomlands, medium and a top altitude of the study sites. This may be due to the influence of rainfall variability and changes in temperature. The soil is more eroded and compacted in the open-grazed areas especially in the bottomland altitude than those located in the medium and top altitude categories. Soil erosion and compaction depend on a number of manmade and natural factors including vegetation cover, soil type, intensity and pattern of rainfall, the degree of wind erosion, and the high percentage value of bare ground and grazing management systems of a particular area. (Bezuayehu *et al.*, 2002) reported a similar effect regarding the problems associated with soil erosion and loss.

5.5.2. Effect of Grazing Pressure on Rangeland Condition in the Medium Altitude (1560 -1910 masl)

The present results on grass composition did not confirm any significant effect between grazing pressure (enclosure vs. open-grazed areas) in the medium altitude at Hadha-Bossa site while the results were significant both at Abernosa and Gubeta-Arjo sites. In some cases, lower range condition scores were recorded inside enclosures which could be attributed to many factors like altitude, grazing practices, and burning, bush encroachment. This is in agreement with the work of previous scholars (Balaynesh, 2006; Bekele, 2007). The basal cover was significantly higher in the open-grazed areas found in the top and medium altitudes than those found in the bottomland altitude category. Due to the replacement of most palatable species (e.g. Cenchrus ciliaris) by creeping, spreading and grazing resistant species such as Cynodondactylonwhich cover the soil (Ayana, 1999; Amsalu, 2000). The results of soil erosion and soil compaction in the open-grazed areas are lower than the values recorded inside enclosures in all the three altitude ranges. The soil is more eroded and compacted in the open-grazed areas of bottomland altitude than in the medium and top altitude categories. The decline in the physical characteristics of the soil surface is the most serious manifestation of a decline in grazing land condition because of its long-lasting and progressive impact on plant production attributes (Bezuayehu *et al.*, 2002)

5.5.3. Effect of Grazing pressure on Rangeland Condition in the Top Altitude (1578 -1928 masl)

Grass composition among the study sites across the three altitude ranges indicates a significantly higher in the medium and top altitudes than in the bottomland altitude except at Hadha-Bossa site. The probable explanation could be due to the fact that grazing pressure is lower in the medium and top altitudes than in the bottomland altitude. Studies (Amsalu, 2000), have shown that the impact of heavy grazing causes a shift in grass composition. This is in agreement with the work of Gemedo (2004), suggesting that increased grazing pressure reduces grass species composition in Borana rangelands. Furthermore, basal cover and litter cover were significantly higher in enclosures than in the open-grazed areas in the medium and bottomland altitudes both at Abernosa and Hadha-Bossa sites. The age distribution of dominant grass species was significantly higher in enclosures than in the open-grazed areas in the top and medium altitudes at Hadha-Bossa and Gubeta-Arjo sites. This is in agreement with the work of others (Lishan, 2007; Teshome, 2007). Soil erosion and compaction were significantly higher in the open-grazed areas than enclosures as range condition deteriorates may be due to increased grazing pressure and trampling effects, which may further reduce the productivity of the rangelands and its ability to support a sustainable pastoral livestock production system. Such results are also in agreement with work of Amaha (2006) in Somali Region of Ethiopia

6. CONCLUSION

The range condition in the open-grazed areas was in poor condition due to increased grazing pressure and continuous grazing, while the enclosure areas were in good condition as a result of reduced disturbance and rest from grazing for certain period of time with high biomass production in the enclosure areas but less biomass production in open-grazed areas. The present study confirmed that safeguarding, monitoring rangeland, proper supervision and evaluation of rangeland due to prolong the cattle production as pastoral in open-grazed areas

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