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ASSESSMENT OF RANGELAND BROWSE WOODY SPECIES BIODIVERSITY AND PRODUCTIVITY IN *SHINILE* AREA, *SOMALI* REGIONAL STATE, *ETHIOPIA*

In Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE IN AGRICULTURE

(RANGELAND ECOLOGY AND MANAGEMENT)

By

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Assessment of Rangeland Browse Woody Species Biodiversity and Productivity in *Shinile* Area, *Somali* Regional State, *Ethiopia*

ABSTRACT

A study with the objectives of assessing on Rangeland Browse Woody Species Biodiversity and productivity was conducted in the grazing and browsing areas of the pastoral and agro-pastoral rangeland production systems in *Shinile* District of Somali Regional State. Plots were laid under two rangeland production systems (Pastoral Production System and Agro-pastoral Production System) with three grazing types (Riverside, Enclosure and Communal). The Statistical Analysis Software was used to analyze the vegetation and soil data. In the study district, a total of 23 species were identified. Woody species evenness was significantly higher in the Pastoral Production System than Agro-pastoral Production System. Woody species diversity and evenness were significantly increased from the communal, enclosure and then riverside grazing areas of the rangeland. Potassium and sodium content of the soil were significantly higher in the Agro-pastoral Production System as compared to the Pastoral Production System. From the result, this study implies that a process of degradation maybe undergoing in the Pastoral Production System more than in the Agro-pastoral Production System, most likely due to poor grazing management practices and recurrent drought in the area. Therefore, this demands due attention on integrated management for the conservation of the soil, productivity of the rangeland and appropriate plan of biodiversity conservation such as establishing, designing and implementations of watershed management for physical and biological conservation should be planned to minimize loss of biodiversity, which also require the support of appropriate rangeland vegetation monitoring and evaluation systems based on the participation of the pastoral and agro-pastoral communities.

Keywords: Basal cover, biomass production, Plant species abundance, species composition, species diversity and soil characteristics.

1. INTRODUCTION

Different arid and semi-arid rangeland vegetation types, such as grasslands, open savannas (bush grassland) and closed savannas (bushland) are found in eastern Ethiopia, especially in the Somali Regional State (SoRPARI, 2005). These rangelands are rich in botanical resources, but at present they are subjected to human and natural influences (Gemedo-Dalle *etal.*, 2006). The state of biodiversity in the Somali region is threatened by encroaching weeds and woody plants (EARO, 2003). According to the decrease in the production of the grass layer, difficulty in herding, wildlife attacks were the major problem associated with abundance of trees and shrubs in the rangelands (Abate *etal.*, 2012).

Feed problem is one of the major factors that hinders the development and expansion of livestock production in Ethiopia (Ahmed *etal.*, 2010; Solomon *etal.*, 2010). Natural grazing land is predominant feed sources for livestock in lowland and crop residues represent a large proportion of feed resource in mixed crop livestock system of Ethiopia (Malede and Takele, 2014). The state and condition of range vegetation and its dynamics over time, has witnessed to be an opportunity for better livestock production and better livelihood condition and/or challenge for survival to the existing pastoral production system in place (Muhidin, 2009).

Research studies undertaken in Somali National Regional State (SNRS) indicated that the current status of the rangelands is highly affected by the recurrent droughts, shortage of rainfall, overgrazing, population pressure, overstocking and soil erosion. Sites, which are found in agro-pastoral farming systems, have demonstrated higher level of rangeland degradation (Belayenesh, 2006). The rangeland condition has declined with increased grazing pressure (Lishan, 2007).

The Shinile zone is one of the zones in the SNRS, which is located in the northernmost part and the Government of Ethiopia classified this zone as susceptible to drought and suffering from chronic food deficit. The pastoral mode of life covers the largest area in the zone where pastoralists make up about 75-85% of the population.

In Shinile Wereda, shortening of rainy seasons and associated replacement of valuable grazing species is worsening the already aggravated feed and water shortage in the area

(Amaha, 2006; Lishan, 2007). Understanding the responses of vegetation to different grazing intensities is crucial to facilitate the management of these arid and semi-arid savannas for both biological conservation and sustainable use (Hoshino *etal.*, 2009). It is very important to have basic information on biomass production dynamics and rangeland biodiversity, as these may facilitate the efficient and effective use of rangeland resources as livestock and wildlife feed. However, this research work is assessed to examine the effects of grazing land management and pastoral production systems on biomass production dynamics, rangeland biodiversity, identify the problems and propose effective range management practices. Therefore, this study was conducted with the general objective of assessing on the rangeland browse woody species biodiversity and productivity in the *Shinile* area and the specific objectives are as follows:

- To investigate the species composition, plant abundance and species diversity of the herbaceous vegetation of the rangeland.
- To investigate rangeland biomass production, soil characteristics, basal and bare ground cover of the study area

2. METHODOLOGY

2.1. Study Area

2.1.1. Location and Area Coverage

Shinile zone is one of the nine zones of the SNRS. It is located 460 km south-east of Addis Ababa and 179 km northwest of JigJiga (capital city of SNRS) at 9^{o}-10^{o}N Latitude and 41^{o}-42^{o}E Longitude. Its altitude ranges from 950 to 1350m a.s.l. and the zone has a total area of 30, 689 km^2. Shinile zone falls under the Hot to warm arid agro-ecological zone with 60 % arid, and 40% semi-arid agro ecologies. The average temperature ranges from 28 to 38 ºC. The rainfall pattern of the area is bimodal similar to JigJiga zone, and the annual rainfall ranges from 300-600 mm (SZARDO, 2013; Helen *etal.*, 2015). There are two rainy seasons.

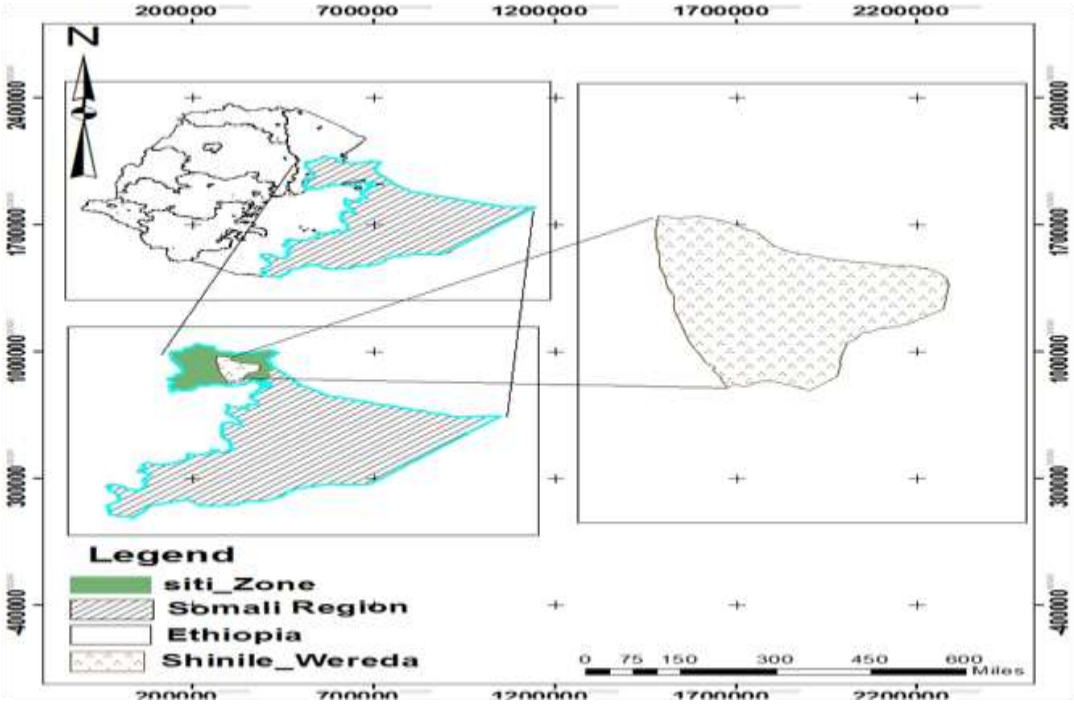


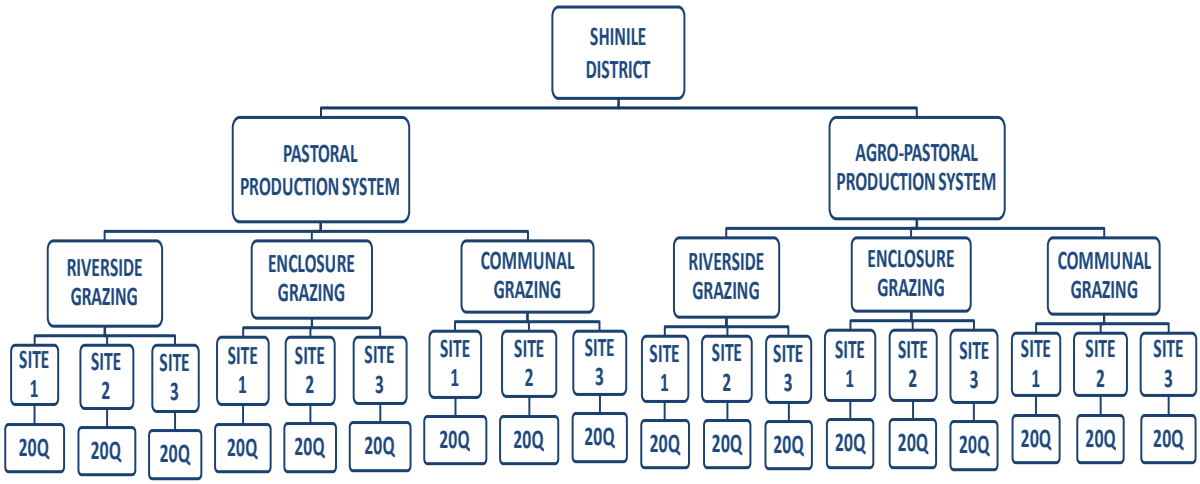
Figure 1 The location of *Shinile* district in *Shinile* Zone

2.2. Sampling Procedure

2.2.1. Selection of Sampling Sites

The study was conducted in the grazing and browsing areas of the pastoral and agro-pastoral rangeland production systems in Shinile area. For each rangeland production system, three different grazing types (i.e., communal, riversides/stream banks and enclosure grazing areas) were selected in the study district (2 rangeland production systems x 3 grazing types x 3

distance intervals (Figure 2)). For each grazing type, three study area sites with 1km interval distances.



Q = Quadrat

Figure 2 The selection of the study areas in *Shinile* district

2.2.2. Sampling of Woody Vegetation

The browse woody vegetation sampling were conducted from the beginning of September up to the end of October 2014 at the time when most of the plants are at over 50% flowering, which makes the identification of plants easy. The woody species composition, plant abundance, species richness and their trunk diameter were recorded in a randomly sample area of 50m x 50m at each distance intervals. A total of 90 quadrat samples of woody vegetation were covered to estimate the woody plant density and the number of individuals of each tree or shrub. In order to assess the rangeland production by grazing type for species composition, biomass production and species diversity. The species diversity, as Shannon diversity and species evenness was calculated. Accordingly, the most appropriate parameter to determine species diversity was Shannon- Wiener diversity index (Magurran, 2004).

$H= -\Sigma(P_i)\ (\ln P_i)$

Evenness, $E= -\Sigma(P_i)\ (\ln P_i)\ /\ln S$,

Species richness was represented by the number of species in each quadrant.

Browse woody vegetation were recorded and identified based on their morphological, structural and floristic characteristics. Identification of the woody species was carried out

using field guide books, key informants from the pastoralists and agro-pastoralists. The leaf biomass of selected browse species was estimated using the model of Petmak (1983).

Log W = 2.24 log DT-1.50

For the leaf biomass of shrub:

Log W = 2.26 log DS-2.45

Browse woody species composition similarity among grazing types was estimated by the model of Jaccard coefficient of similarity using the relative abundance of species in each sampling sites under each rangeland production systems and different grazing types.

$S_j = a/ a + b + c,$

2.2.3. Soil Sampling and Analysis

Five soil samples per sample plots with total soil samples of 90 quadrats were collected from each grazing type in the different rangeland areas of the Wereda in a zigzag pattern laid out plot of $1m^2$ using auger from a depth of 0 to 30cm. The soil samples at each distance interval of the grazing land were pooled to form one composite soil sample and the composite soil samples were divided into three equal parts and yield at total of 18 soil samples.

The samples were kept in plastic bags, labeled, sealed and transported to the soil laboratory of Haramaya University in Ethiopia for physical and chemical analysis. The pH and texture of the soil were determined in a 1:2.5 soil water ratio suspensions using the Bouyoucos hydrometer method (Bouyoucos, 1962), while electrical conductivity (EC) was determined using the sodium saturation ratio (Van Reeuwijk, 1992). The percentage organic carbon (OC) was determined according to the Walkley and Black (1934) method, and total N using the Kjeldahl procedure (Bermner and Mulvaney, 1982). Available phosphorus (P), exchangeable potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) were analyzed according to Olsen *etal.* (1954). Cation exchangeable capacity (CEC) was analyzed using the method of NRC (1996).

2.3. Statistical Analysis

Data collected from woody species composition similarity among pastoral production systems was estimated by the model Jaccard coefficient of similarity according to Krebs (1998). Biomass of selected browse woody species was estimated using the model of Petmak

(1983). The diversity indices for woody species, plant abundance of each species and species evenness data were estimated using PAST software (Koleff *etal*., 2003). To test differences in woody species diversity, plant abundance, soil characteristics and biomass production, a General Linear Model (GLM) was applied using SAS software (1999). Moreover, Jaccard coefficient of similarity (Magurran, 2004) was used to test the differences on species compositions similarities along altitudinal range and distance from settlement. Tukey multiple comparison was used to test significant differences among the means.

Soil analyses were done in the soil laboratory of Haramaya University in Ethiopia for organic carbon (OC), organic matter (OM), total nitrogen percentage (TN %), available potassium (K), available phosphorus (P), pH and percentage of soil textures (clay, silt and sand).

The following model was used to assess on total dry matter biomass production, biodiversity, soil characteristics and basal and bare ground cover of the rangeland during the study.

$$Y_{ijk} = \mu + PS_i + GT_j + (PS*GT)_{ij} + B_k + E_{ijk}$$

3. RESULTS AND DISCUSSION

3.1. Woody Species Composition

3.1.1. Woody Species Composition

3.1.1.1. Woody species composition in different rangeland production systems

In the study area 23 woody species have been identified. Woody species identified in this study correspond partially with those reported in the earlier study (Lishan, 2007). In the Shinile district, over-cutting of the woody plants is the most challenge due to lack of protection, while the overall deforestation is diminishing the sustainability of browse feeds and becoming a threat to goat and camel production. The woody plants serve as browse feed for camel and goat production, source of energy, income generation and traditional values by the pastoralists (Amaha, 2006). The pastoral areas of the study district comprised 19 woody species. *Grewia tenax* and *Prosopis juliflora* were identified as common woody species in all grazing types; and their relative abundance increased with grazing types, from communal, to enclosure and then riverside. The agro-pastoral areas of the study district comprised 18 woody species *Acacia tortilis, B. aegyptiaca, C. glandulosa, G. tenax, P. Juliflora* and *Z. mauritania* were identified as common woody species in all grazing types; and their relative abundance increased with grazing types, from communal, to enclosure and then riverside (**Table 1**).

3.1.1.2. Woody species composition in different grazing types

The riverside grazing areas comprised 15 woody species. *Acacia nubica*, *A. tortilis*, *C. glandulosa*, *G. tenax* and *P. Juliflora* were identified the most dominant woody species in the riverside grazing of the pastoral production system. However, *Acacia tortilis, A. apsilostachya, C. glandulosa, G. tenax* and *P. Juliflora* were identified the most dominant woody species in the riverside grazing areas of the agro-pastoral production system (**Table 1**).

Enclosure grazing areas comprised 11 woody species. *Acacia tortilis, A. apsilostachya, B. aegyptiaca, G. stenax* and *P. Juliflora* were identified the most dominant woody species in the enclosure grazing of the pastoral production system. However, *Acacia nubica, A. tortilis, C. glandulosa, G. tenax* and *P. Juliflora* were identified the most dominant woody species in the enclosure grazing areas of the agro-pastoral production system (**Table 1**).

Communal grazing areas comprised 20 woody species. *Acacia bussei, A. Senegal, B. glabra, G. bicolar* and *P. Juliflora* were identified the most dominant woody species in the communal grazing of pastoral production system, whereas *Acacia tortilis, A. apsilostachya, C. glandulosa, G. tenax* and *P. Juliflora* were identified the most dominant woody species in the communal grazing areas of the agro-pastoral production system (**Table 1**).

Most of the dominant/common tree species in the study area were thorny woody species and comparatively their relative abundance were higher than of the other woody species. These are the species that were found dominating the discarded rangelands in the area. They can, therefore, be considered as the best indicators of intensively degraded rangelands of the area. As also indicated in the study of Belaynesh (2006), the very high abundance of small bushes and shrubs suggest that the rangeland might have been exposed to increased anthropogenic disturbances. From this result, it can be underlined that, due to the overuse of these grazing areas for grazing/browsing, the tree and shrub species that were better preferred by animals have declined in number, size and quality over time (Lishan, 2007). During the study period, over-cutting of the woody plants in the rangelands of the Shinile district was observed, which pose a threat to goat and camel production due to a decline in browse material. Clearing of trees for expansion of crop agriculture, firewood, charcoal making, and house construction was dominant. The same result was reported in *Shinile* rangelands by Amaha (2006).

Table 1. List of woody species with their relative abundance (N 0.25ha^{-1}) under two rangeland production systems (pastoral and agro-pastoral), three grazing types (communal, enclosure and riverside) in *Shinile* area, *Somali* Regional State, *Ethiopia*

	Rangeland Production System					
	Pastoral			**Agro-Pastoral**		
Woody Species	**R**	**E**	**C**	**R**	**E**	**C**
Acacia bussei	0	0	50.86	6.67	0	0
Acacia mellifera	0	0	5.41	23.38	0	0
Acacia nilotica	0	0	12.53	13.33	3.23	0
Acacia nubica	106.57	29.67	0	0	92.39	27.09
Acacia Senegal	0	0	449.41	0	6.64	30.61
Acacia tortilis	148.60	131.57	0	125.46	170.03	116.55
Acalypha apsilostachya	11.11	84.05	0	125.01	0	79.16
Aloe somaliensis	97.01	0	0	24.44	0	54.91
Balanites aegyptiaca	63.27	82.06	0	87.99	28.69	58.23
Balanites glabra	0	0	50.60	0	0	0
Berberis holstii	1.28	0	0	6.67	0	0
Cadaba forinosa	0	0	0	0	9.09	0
Cadaba glandulosa	141.06	32.11	0	104.82	34.08	123.81
Celtis africana	0	0	0	18.52	0	2.44
Cissus rotundifolia	0	0	0	0	0	2.04
Dobera glabra	0	0	43.53	0	0	0
Gomphocarpus fruticosus	0	0	0	3.70	0	0
Grewia bicolar	0	0	120.64	0	0	0
Grewia tenax	132.96	169.08	10.81	184.91	91.33	82.71
Grewia trichocarpa	0	0	21.56	0	0	0
Prosopis Juliflora	798.13	969.84	725.96	752.44	1058.90	920.53
Ziziphus mauritania	0	1.61	0	22.65	5.61	1.92
Ziziphus spina-christi	0	0	8.70	0	0	0

3.1.2. Woody Species Diversity and Plant Abundance

3.1.2.1. Woody species diversity and plant abundance in different production systems

Woody species evenness (**Table 2**; $F_{1, 84} = 4.35$, P=0.0401), was significantly higher in the pastoral than agro-pastoral production system. This result indicates that in the agro-pastoral production system woody vegetation were equally distributed. This could be related to the distribution of shrubs in the riverside and enclosure grazing areas **(Table 2**).

3.1.2.2. Woody species diversity and plant abundance in different grazing types

Woody species diversity (**Table 2**; $F_{1, 84} =11.03$, P<0.0001), and evenness (**Table 2**; $F_{1, 84} = 8.59$, P=0.0001) were significantly increased from the communal, enclosure and then riverside grazing areas of the rangeland production system (**Table 2**). This could be related to

the presence of high plant damage by human activities like, cutting woody plants for fire wood and house constructions and expansion of cultivation as well as high grazing pressure and mobility of livestock grazing lands which damage the new re-growing of shoots and roots. This was demonstrated in the Massai rangelands of Kenya by Jeffrey (2007).

3.1.3. Browse Species Biomass Production

3.1.3.1. Browse species biomass production in different production systems

Leaf biomass of browse plants showed no significant difference between rangeland production systems and within the different grazing types of the study area (**Table 2**).

Table 2. Effect of production system on woody species diversity, species evenness, total plant abundance (N 0.25ha^{-1}), species richness and browse biomass (kg ha^{-1}) at different types of grazing in *Shinile* Area, *Somali* Regional State, *Ethiopia*

Factor Levels and interaction effect	Shannon diversity	Species Evenness	Plant abundance	Species richness	Browse biomass
Pastoral Production System (PPS)					
R	1.08^{a}	0.80^{a}	96.35	4.1	50.18
E	0.88^{b}	0.72^{b}	109.17	3.5	50.16
C	1.10^{a}	0.78^{a}	87.81	4.2	45.5
Agro-pastoral Production system (APPS)					
R	1.15^{a}	0.79^{a}	89	4.3	39.78
E	0.75^{b}	0.60^{b}	105.22	3.7	52.68
C	1.00^{b}	0.74^{a}	93.35	3.9	47.82
Production System (PS)					
F (df = 1, 84)	0.93	4.35	0.1	0.04	0.22
P	0.339	0.040	0.751	0.833	0.639
Lsd	NS	0.06	NS	NS	NS
Grazing Type (GT)					
F (df = 2, 84)	11.03	8.59	3.01	2.41	0.96
P	0.001	0.001	0.055	0.096	0.388
Lsd	0.13	0.07	NS	NS	NS
PS*GT (interaction)					
F (df = 2, 84)	1.40	1.43	0.41	0.55	1.18
P	0.253	0.245	0.665	0.582	0.313
Lsd	NS	NS	NS	NS	NS

Df = degree of freedom, F-ratio = F test value, P = probability value; NS = non significant, PPS = Pastoral Production System; APPS = Agro-pastoral Production System; GT = Grazing type; R = Riverside; E = Enclosure; C = Communal. Means with the same letter in columns within each production system (PS) are not significantly different at $P \leq 0.05$.

3.1.4. Woody Species Similarity

The highest three Jaccard coefficient similarity index (0.67, 0.60, and 0.60) for woody species composition between rangeland production systems of the different grazing areas in the study area were recorded between riverside and communal grazing areas of the pastoral and agro-pastoral rangeland production systems; and riverside and enclosure of the pastoral and agro-pastoral rangeland production systems, respectively.

The lowest species similarity indexes (0.11 and 0.11) were recorded between riverside and communal grazing areas of the pastoral production system; and the communal grazing areas of the pastoral and agro-pastoral production systems, respectively. In all rangeland production systems of the study area, species similarity was high between riverside and communal grazing areas of the pastoral and agro-pastoral production systems, respectively. In average, less species similarity was recorded between riverside and communal grazing areas of the same rangeland; and communal grazing areas of the pastoral and agro-pastoral production systems (**Table 3**).

Table 3. Jaccard coefficient of similarity for woody species under two rangeland production system and three grazing types in the rangelands of *Shinile* area, *Somali* Region, *Ethiopia*

		Rangeland Production System					
		Pastoral			**Agro-pastoral**		
		R	**E**	**C**	**R**	**E**	**C**
Pastoral							
	R	-					
	E	0.60	-				
	C	0.11	0.14	-			
Agro-pastoral							
	R	0.50	0.17	0.29	-		
	E	0.29	0.17	0.29	0.60	-	
	C	0.67	0.60	0.11	0.29	0.29	-

3.2. Soil Parameters in Different Production Systems

Potassium (**Table 4**; $F_{1, 12} = 5.68$, $P = 0.035$), and sodium (**Table 4**; $F_{1, 12} = 5.69$, $P = 0.034$) content of the soil are significantly higher in agro-pastoral production as compared to the pastoral production system. This result is in agreement with those reported by in *Erer* district (Selam, 2008).

Even if, soil chemical properties (excluding potassium and sodium minerals) did not show significant difference over all rangeland production systems and grazing types were generally low and differed non-significantly in all the study sites (**Table 4**). All the findings in the chemical analysis of soil nutrients may indicate that the data are notable for their lack of variability within the given soil type of the Shinile rangelands. This is supported by the finding of Tefera *etal.* (2007) in Borana rangelands, Ethiopia. This finding is partially, related to a study conducted in Awash National Park and Abernosa Cattle Breading Range (Tessema *etal., 2011*). Complex spatial patterns of soil nutrients have been commonly presumed to develop over time as a result of the interactions of climate, parental material, vegetation type and topography (Wang *etal.*, 2001). Overall, the rangelands of east Africa are regarded as having a low fertility. This principally was attributed to the very old age of common parental material (Pratt and Gwynne, 1977).

Table 4. Effect of production systems and grazing types on physical and chemical soil Parameters in *Shinile* area, *Somali* Regional State, *Ethiopia*

Soil Parameters	Pastoral Production System (PPS)			Agro-pastoral Production System (APPS)			Production System (PS)			Grazing Type (GT)			PS*GT		
	R	E	C	R	E	C	F(df=1,18)	P	*Lsd*	F(df=2,18)	P	*Lsd*	F(df=2,18)	P	*Lsd*
	Mean														
pH	7.810	7.983	7.777	7.743	7.793	7.953	0.12	0.740	NS	0.75	0.492	NS	1.89	0.194	NS
EC(mmhos/cm)	0.060	0.028	0.129	0.035	0.039	0.039	2.50	0.140	NS	1.89	0.194	NS	1.82	0.203	NS
OC (%)	1.047	1.155	0.737	0.924	1.271	1.163	0.69	0.424	NS	0.95	0.412	NS	0.89	0.437	NS
OM (%)	1.805	1.992	1.27	1.593	2.191	2.005	0.68	0.425	NS	0.95	0.412	NS	0.89	0.438	NS
AVP.ppm	9.427	13.37	9.39	6.847	7.527	9.717	0.73	0.410	NS	0.18	0.837	NS	0.32	0.734	NS
K(Cmol(+)/Kg.Soil)	2.183^{b}	2.170^{b}	2.343^{a}	2.547^{a}	2.347^{b}	2.523^{a}	5.68	0.035	0.219	1.02	0.389	NS	0.38	0.695	NS
Mg(Cmol(+)/Kg.Soil)	6.623	6.640	6.643	6.703	6.687	6.54	0.04	0.841	NS	1.58	0.245	NS	2.20	0.153	NS
Na(Cmol(+)/Kg.Soil)	2.910^{b}	2.897^{b}	3.123^{a}	3.393^{a}	3.13^{b}	3.367^{a}	5.69	0.034	0.292	1.01	0.394	NS	0.37	0.698	NS
Ca(Cmol(+)/Kg.Sol)	27.98	27.74	24.89	27.12	28.77	23.45	0.03	0.865	NS	1.06	0.377	NS	0.09	0.911	NS
Total N (%)	0.090	0.0997	0.064	0.0797	0.109	0.100	0.67	0.429	NS	0.94	0.416	NS	0.89	0.436	NS
CEC (meq/100g.soil)	39.70	39.44	37.00	39.76	40.93	35.87	0.00	0.957	NS	0.90	0.432	NS	0.09	0.913	NS
Sand (%)	53.31	54.92	59.64	46.64	52.97	61.31	0.45	0.514	NS	3.17	0.079	NS	0.49	0.623	NS
Silt (%)	20.67	22.05	18.33	27.00	20.67	19.33	1.09	0.317	NS	2.31	0.141	NS	1.45	0.274	NS
Clay (%)	26.03	23.03	22.03	26.36	26.36	19.36	0.02	0.885	NS	2.11	0.164	NS	0.59	0.571	NS

Ca = calcium; CEC = cation exchange capacity; EC = electrical conductance; Mg = magnesium; K = potassium; Na = sodium; N = nitrogen; OC = organic carbon; P = phosphorus; Df = degree of freedom, F-ratio = F test value, P = probability value; NS = non significant, PPS = Pastoral Production System; APPS = Agro-pastoral Production System; GT = Grazing Type; R = Riverside; E = Enclosure; C = Communal. Means with the same letter in rows within each production system (PS) are not significantly different at $P \leq 0.05$.

4. CONCLUSIONS

We concluded that, woody species evenness had significantly higher in the pastoral, which indicated that in the agro-pastoral production system woody vegetation were equally distributed. This could be related to the distribution of shrubs in the riverside and enclosure grazing areas. Diversity and evenness were significantly increased from the communal, enclosure and then riverside grazing areas of the rangeland production system. This could be related to the presence of high plant damage by human activities like, cutting woody plants for fire wood and house constrictions and expansion cultivation as well as high grazing pressure and mobility of livestock grazing lands which damage the new re-growing of shoots and roots. Leaf biomass of browse plants showed no significant difference between rangeland production systems and within the different grazing types study area. Potassium and sodium content of the soil are significantly higher in agro-pastoral production as compared to the pastoral production system. Research related to rehabilitation and possible restoration strategies through soil seed bank and above ground dynamics under rangeland production systems and grazing should be considered.

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