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Evaluation of Grazing Land Condition in Gozamen District, East Gojjam Zone, Amhara Regional State, Ethiopia

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Abstract

The study was conducted in Gozamen district of East Gojam Zone of the Amhara region to assess the major feed resources, the grazing land condition, and the floristic composition and biomass yields of herbaceous species to generate baseline information which can be used for future management of grazing land resources in the area. The survey data was collected by interviewing a total of 120 households by random selection of two rural-kebeles from three altitudes [high, mid and low].To assess grazing land condition, the district was stratified into three altitudes [high, mid and low altitudes]. From each altitude, communal and enclosed grazing areas were selected randomly. From each altitude 8 composites and 12 composites from enclosed and 12 composites from communal grazing for herbaceous vegetation and 4 transects from each altitude of communal grazing were selected. Thus, a total of 72 quadrats were used for herbaceous and 12 transects for woody species. For the natural pasture condition assessment, analyses of variance [ANOVA] were carried out by the General Linear Model [GLM] procedure of SAS. Mean separation was tested using the least significant difference. The main feed resources to the livestock in all altitudes were natural pasture, crop residues and stubble grazing. During dry season, crop residues was the first livestock feed source followed by natural pasture in all altitudes. However, during wet season, natural pasture was the first livestock feed source followed by crop resides in all altitudes. In terms of dry matter [DM] crop residues contributed the highest proportion [66.7%] of the total feed sources. The DM obtained from crop residues significantly varied [$P<0.05$] among the altitudes. The total annual estimated available feed supply to maintain the livestock in the area satisfied only 79.4%. The conservation of feed resources in the form of hay in high, mid and low altitudes was 38.5, 80, and 22.5%, respectively. But, none of the respondents used silage in the study area due to lack of knowledge how to make it. In the district, a total of 21 herbaceous species were identified [Table 4], from these 57, 24 and 19% were grasses, legumes and other species, respectively. Based on dry matter of biomass, Medicago polymorpha in high and mid altitudes and Eleusine floccifolia in low altitude were the dominant species. Altitude and grazing have effects on grazing land conditions and biomass production. The average dry matter yield of grasses, legumes and total biomass had a significant difference among altitudes in enclosed and communal grazing areas. The average dry matter yield of grasses, legumes, and total biomass were higher in enclosed area than communal grazing areas in all altitudes. There were a significant [$P<0.01$] interaction of altitude and grazing on biomass and species composition. There were positive correlation of species composition, grass species composition and basal cover with biomass. Crop residues and natural pastures are the major feed resources in dry and wet seasons, respectively. The total annual dry matter does not meet the total livestock requirement per annum in district. Further research and development work is recommended to alleviate feed shortage through different options such as development of improved forages and alternative means of crop residue utilization and conservation of feed in the form hay and crop residues.

Keywords: Altitudinal range; Botanical composition; Crop residues; Dry matter; Feed balance;

Grazing land types; Natural pasture;

Introduction

Ethiopia is the largest livestock producer in Africa, with 70.79 million heads of cattle, 28.48 million sheep, 25.91 million goats, 24.56 million donkeys, 11.39 million horses, 8.08 million mules, 8.39 million camels, and 42.51 million poultry [15]. The largest livestock were found in Oromiya, Amhara and South Nations and Nationalities of People regions [16]. However, the production of livestock is low due to technical constraints to livestock development like absence of approved livestock policy, lack of rural infrastructure and services, inadequate specialists and skilled staff, feed constraints, prevalent animal diseases, grazing land shortage, lack of credit, poor management, low genetic quality of most indigenous breed, recurrent drought, and lack of technical skill on feeding [2, 31].

Feed problem is one of the major factors that hinders the development and expansion of livestock production in Ethiopia [3, 37]. Natural grazing land is the predominant feed sources for livestock in lowland and crop residues represent a large proportion of feed resource in mixed crop livestock system of Ethiopia [28]. However, the availability and quality of these feed sources cannot satisfy effective livestock production even for maintenance because of low digestibility and low intake of

livestock for the whole year round, as a result body weight gains obtained during the wet season may be lost totally or partially in the dry season [5, 29]. Fallow lands, grazing of roadsides and crop margins are also used for animal feed resources in some part of Ethiopia [37].

The Ethiopian highland regions account the largest share of livestock population [63.2%] and the lowland account the lowest [36.7%] [39]. In the country, about 61.5, 27.7, 6.4, 0.8, 0.08 and 3.5% [energy value] contributed natural pasture, crop residues, hay, by products, improved fodder and others, respectively [26]. The seasonal fluctuation of availability of natural pasture is a common phenomenon which resulted in a serious feed shortage which affects production and productivity of animals [35, 30]. the most critical periods are from February to May, when all feed resources are virtually depleted and conservation of crop residues is inadequate in highland of Ethiopia [13, 30]. In highland areas, land is increasingly cultivated for crop production to satisfy the increasing demands of human food. This is the evident in the mixed crop-livestock farming systems of the highland areas crop residues were the main livestock resource [3].

Gozamen district is one of the 18 districts of Eastern Gojam Administrative Zone of Amhara National Regional State. Livestock production in the district is an integral part of the land use system. According to the reports of animal feed resources in study areas are mainly based on grazed native pastures and crop residues, which are low in production and quality, resulting in poor animal performance[24]. Livestock feed supply from these natural pasture is characterized by seasonal fluctuation because of the distinct seasonal variation in relation to the annual rainfall pattern. Therefore, the district is known for its critical feed shortage especially in the dry season.

Knowledge about the current grazing land resources is absolutely necessary to maintain the optimum productivity and sustainable use of the grazing land resources for the future. There is insufficient information regarding the feed resources in the study area. It is important to gather data on the grazing land conditions, and the constraining circumstances in the area. Therefore, this thesis research was designed with the general objective of assessing available feed and grazing land resources to generate base-line information and it encompasses the following specific objectives as to assess the grazing land condition based on herbaceous and woody species. and to investigate the floristic composition and biomass yields of herbaceous species.

Materials and Methods

Descriptions of the Study Area

Gozamen is one of the 18 districts in East Gojjam zone of Amhara National Regional State. It is found in the Northwestern highlands of Ethiopia at a geographical location of 100 10 460 and 100 350 120 N latitudes and 370 230450 and 370 550 520 E longitudes and at a distance of 305 and 251 km from Addis Ababa and Bahir Dar, respectively. Debre Markos is the capital of the district and it contains 25 rural-kebeles. The district was surrounded by Aneded and Debay Tilatgin in the east, Machakel and Debre Elias in West, Sinan district in North, Baso Liben district and Abay River in the South [24].

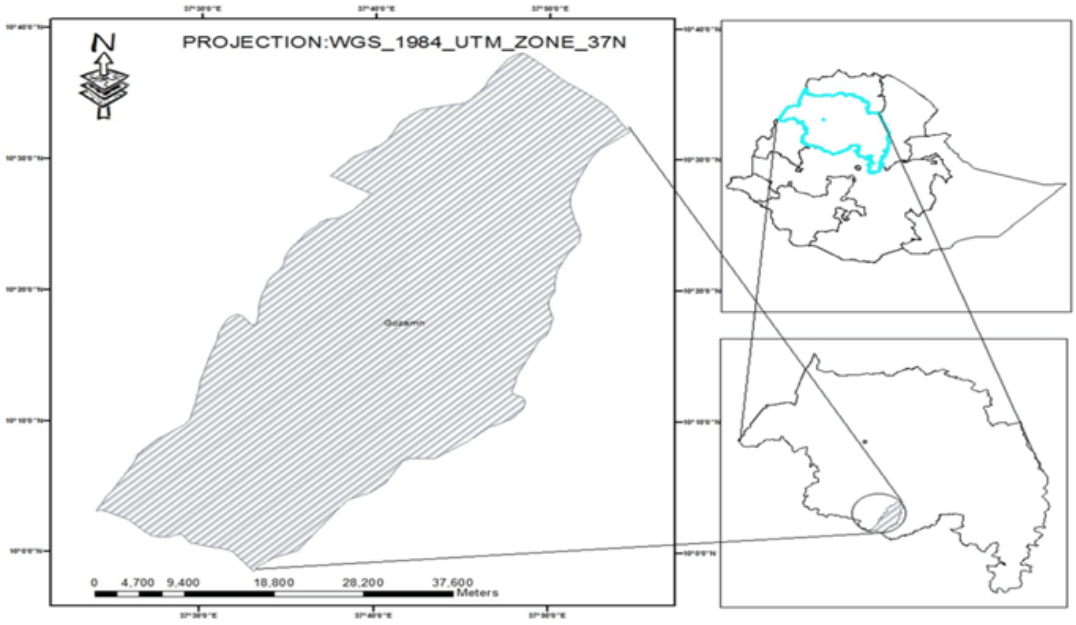

Figure 1: Geographical location of *Gozamen Woreda*

The district has an altitudinal difference of 1200-3510 meter above sea level. Based on these altitudinal differences, the district has three agro-climatic zones namely, Dega, Woina-dega and Kola meter above sea level [24]. The average annual rainfall of the district was 1628 mm with the rainy season extended up to 6 months. However, the heavy rainfall is concentrated in the Meher season of June to September. The maximum and minimum average temperatures are 25oC and 11oC, respectively [24]. The most dominant soil types are *Nitosols, Vertisols* and *Cambisols while, Pheazomes, Acrisols* and *Leptosols* are associate soil types in different parts of the district [12].

Agriculture is the mainstay of farmers in the district which is characterized by mixed crop livestock production systems. According to the most important crops grown in the district are cereals like wheat, teff, maize, barley and oats [24]. Pulse crops such as horse beans and chickpeas are produced. Oil seed crops [linseed and Niger seed], Vegetables [onion, garlic, potato, tomato, pepper and carrot] and fruits [banana, mango, papaya, orange and lemon] are also produced in the district. The district has a livestock population of 155287 cattle, 97263 sheep, 8577 goats, 25473 equines, 56,920 poultry and 10,019 beehives [24]. the population of livestock indicated that the Barden of the livestock on the range land and it can compared the stocking rate and determining the carrying capacity.

Data Collection Methods

Grazing Land Condition Assessment

Sampling procedures

The sampled data were collected by stratifying the district into three altitudes [high, mid, and low]. Within these altitudes, the grazing lands were further stratified into two sampling areas [2 communal and 2 enclosed grazing areas], using stratified random sampling technique. Enclosures are small areas of land protected by the different local farmers for use during feed shortage season, by allowing the animals to graze, and they are mainly found around crop lands. They are established by the farmers to have reserve forage for oxen and lactating animals. The communal grazing areas are those grazing sites, exposed for mismanagements; it is out of the control of the communities and freely allowing livestock to graze the land throughout the year.

In each of the grazing site, two sampling block of 100x100m^2 was demarcated in a separate way to make it homogenous [to allow sampled area to have an equal chance to be sampled] and representative's vegetation samples. This was further stratified into three sampling plots having equal size [5x5m^2 each] for herbaceous species. Then, within 5x5 m, 0.5 m x 0.5 m quadrants were used for herbaceous species. But, 10x10 m^2 transects were selected randomly from communal grazing lands for woody vegetation assessment.

For ease of data analyses a combination of three quadrats [composite] were used for herbaceous vegetation in each grazing site. A total of 24 composite sampling units [3 quadrats per composite] for herbaceous vegetation sampling units were used. In the assessment of herbaceous vegetation, 12 composite sampling units were used for communal grazing land and 12 composites for enclosed areas, 8 composites for each altitude. About 4 composites samples units were used for each grazing land and altitude. A total of 72 quadrats were used for herbaceous vegetation and 12 transects [4 from each altitude] were selected for woody vegetation. Sample collections conducted from September 19 to October 21 when all pasture plants are expected to be fully-grown, and to over 50% flowering stage [42].

Species identification and composition analysis

A plant was identified with the aid of manuals, by comparing with previously identified plants or specimens. The species to be identified were collected with its relevant plant parts and properly mounted in a press, coded and identified compared with national herbarium of Addis Ababa University. On the other hand, the species composition was assessed from a 0.5 x 0.5 m^2 quadrats. The samples were separated into grasses, legumes and other species to determine the percentage composition of each species on dry matter weight basis [25].

Basal cover

Basal cover, is the area occupied at the intersections of the plant-soil interface of the living plant parts, were estimated in quadrats of 0.5 m x 0.5m areas. For the surface of basal cover of species, the 0.5m^2 was divided into halves. Then, one half of it divided into eighths. All plants in the selected 0.5m2 area were removed and transferred to the eighth for the purpose of visual estimation [11].

Biomass assessment

From each grazing site, the herbaceous species composition and yields were assessed by taking samples from quadrats. The herbaceous species within the quadrats were harvested from ground level and total fresh weights were measured immediately after harvesting. The samples were separated into different species and their fresh weights were determined and they separately put in a paper bag. Samples in a paper bag were put in an oven adjusted at a temperature of 105^{0}C for 16 hours at laboratory to determine the dry matter percentage [20].

Woody vegetation layer

In the woody vegetation assessment, the species composition, density and heights of vegetation were considered. The height of each species in transect was measured using tape meter. The density of woody species were enumerated from each transects [10mx10 m] areas.

Data Analyses

Data collected from feed assessment survey were analyzed by procedure of SAS[statically analysis system]. Descriptive statistics such as mean, frequency, percentage and standard error of mean were used to present the results of survey data.

Before the data were subjected to analyses, the survey data were stratified to three altitudes [high, mid and low]. The statistical model used for survey data were: $Y_i = \mu + A_i$ where, Y_i = the value of survey data, μ = overall mean, Ai = effect of altitude For the natural pasture condition assessment, analyses of variance [ANOVA] were carried out by the General Linear Model [GLM] procedure of SAS. The experiments were arranged in a factorial experiment and the model includes the three altitudes [high, mid, and low] and grazing types [communal and enclosed grazing]. Mean separation was tested using the least significant difference [LSD]. The following statistical model was used for grazing land condition analysis.

Yijk = μ + A_i + Gj + Bk + AGij where, Yijk = the value of natural pasture condition assessment, μ = overall mean, A_i = effect of altitude, Gj = effect of grazing type, Bk = effect of block, AGij = interaction effect of altitude and grazing types.

Results and Disscusion

This chapter includes demographic characteristics of households, land holding, livestock herd size, botanical composition of herbaceous and woody species, the effect of altitude and grazing on biomass and grazing land conditions.

Demographic Characteristics of Households

Demographic characteristics of interviewed farmers included age; family size and educational level of the respondents.

Household Characteristics of the Respondents

The age of the respondents varied between 29 and 68 years with an overall average age of 47.3 years. The studied households had an average total family size of 5.9 [high = 6.1; mid = 5.7 and low = 5.8 altitudes]. The average ages, total family size and sex of family size of the respondents among altitudes were no significant [P>0.05] differences [Table 1].

Table 1: Age and family size of the respondents in the study areas (Mean ± SE(standard error))

Altitude	N	Age	Males	Females	Total family size
High	40	47.28±1.1[a]	3.05±0.1[a]	3.08±0.2[a]	6.13±0.26[a]
Mid	40	47.53±1.5[a]	2.98±0.2[a]	2.70±0.2[a]	5.68±0.28[a]
Low	40	47.18±1.2[a]	2.90±0.1[a]	2.90±0.1[a]	5.80±0.17[a]
Overall	120	47.33±0.2	2.98±0.1	2.89±0.1	5.87±0.14

Educational Level of Respondents

Out of the total respondents, 24.2 and 5.8% had attended primary and secondary school, respectively, while about 8.3 and 4.2% respondents were attended basic and religious education, and the rest of 56.7% of the respondents were illiterates who could not read and write. This indicates the highest numbers of respondents were illiterates in all altitudes. As indicated by the low levels of education of the households have an influence on adoption of improved poultry management practices [19]. Other author stated that education is the main issue in agricultural development [especially primary and secondary schooling had higher impact on agricultural development compared to any other level of education] [14]. However, as the study area, the primary and secondary schooling was low in all attitudes. [Table 2]

Table 2: Education level of the respondents (%) in the study area

Level of education	Altitude			Overall
	High	Mid	Low	mean
Illiterate	60.0	57.5	52.5	56.7
Basic Education	12.5	-	12.5	8.3
Primary School	25.0	20.0	27.5	24.2
Secondary school	-	15.0	2.5	5.8
Preparatory	-	2.5	-	0.8
Religious Education	2.5	5.0	5.0	4.2

Land Holding and Land Use Pattern

Land is one of the most important resources required for any agricultural farming activities. The results indicate the largest proportion of farm size was allocated for cultivation in all altitudes, while the rest was allocated for private grazing, homestead, fallow land, improved forage land and woody lands [Table 3]. In all altitudes, the land allocated for private grazing areas and improved forage lands were very low. The overall average farmland size owned per respondent in the study area was 1.95 ha. This figure was greater than 1.3 ha reported by in *Burie* district of West Gojam zone, 1.8 ha in Amhara region and 1.4 ha in Ethiopia [48, 16]. The overall mean private grazing land per household [0.05 ha] was less than 0.23 and 0.27 ha in *Banja* and *Guagusa* districts, rspectively [49]. This shows shortage of grazing land size was the main reason for shortage of feed in the study area.

Table 3: Percent of woody plant species composition (%) in communal grazing land

Scientific Name	Local name	Family name	Altitude			
			High	Mid	Low	Overall
Acacialahail	*Cheba*	-	60.6	27.3	25.8	42.2
Carissa edulis	*Agam*	*Apocynaceae*	3.1	33.6	4.3	12.7
Acacia abyssinia	*Grar*	*Fabaceae*	5.6	0.9	17.2	8.0
Maytenus spp	*Atet*	*Celastraceae*	16.3	14.6	7.5	13.8
Phooenix reclinata	*Zennbaba*	*Arecaceae*	4.4	0.9	-	2.2
Rosa abyssinica	*Kega*	-	-	10.0	3.6	3.3
Croten macrotachys	*Bisana*	*Euphorbiaceae*	10.0	10.0	16.1	11.6
Solanum spp	*Embuay*	*Solanaceae*	-	1.8	2.2	1.1
Ficus sycomous	*Shola*	*Moraceae*	-	-	1.1	0.3
Ficus alicitolia	*Warka*	*Moraceae*	-	-	13.2	3.0
Cordial abyssinia	*Wanza*	*Boraginaceae*	-	-	11.8	3.0

The overall average total landholding varies among the altitudes. The average farmland size owned per household in high and low altitudes was significantly higher [P<0.01] than the average farm size owned in mid altitude. The higher landholding of high and low altitudes may be due to expansion of farm land without restriction by clearing of forest and low population density of the area could have allowed individual farmer's larger landholding. The average cropped land and homestead land of high and low altitudes were significantly higher [P<0.01] than the average cropped land and homestead land of mid altitude.

Condition of the Grazing Land

Grazing land is any vegetated land that is grazed or has the potential to be grazed by animals [domestic and wild]. This term is all-inclusive and covers all kinds and types of land that can be grazed [7]. As obtained from the reports of respondents' group discussions, the sizes of the grazing land in all altitudes were decreasing from time to time. Moreover, according to the report of *Gozamen Woreda* Agricultural Office, the size of natural pasture land in the district was 18.1% of the total land, which is less than 21.2%, reported by [40]. The main reason for reduction of the grazing lands was expansion of arable land for crop production; this is in line with the study of in *Burie* district [48].

Botanical Composition of Herbaceous Species

In the district, a total of 21 herbaceous species were recorded. Of these, 12 [57.1%] were different grasses species, 5 [23.8%] legumes species and 4 [19.05%] other herbaceous species [Appendix Table 17]. In the district, of the total herbaceous species recorded; on dry matter basis 63.3, 32.0 and 4.7% were grasses, legumes and others species, respectively. However, a total of 14 and 9 herbaceous species were identified in high altitude of enclosed and communal grazing area, respectively, and a total of 13 and 11 herbaceous species were identified in mid altitude of enclosed and communal grazing land d respectively. A total of 9 and 7 herbaceous species were identified in low altitude of enclosed and communal grazing lands, respectively.

Based on biomass composition, *Medicago polymorpha* was the dominant species in both enclosed and communal grazing area of high and mid altitudes of the herbaceous community [Appendix Table 17]. This was in line with the study of in Northwestern Ethiopian highlands [45]. A body of literature suggested that the most dominant species contributed the highest amount of biomass in the fertilized community [18]. The dominance of *Medicago polymorpha* in high and mid altitudes may be due to high precipitation and low temperature in high and mid altitudes than in low altitude, and due to soil type and fast establishment characters of legume species in the study areas.

Botanical Composition of Woody Species

A total of 22 woody species were identified in the study district, of these species of which 5 species [*Eucalyptus spp., Justitia schemperina, Vernonia spp., Pedocarpus gracilor* and *Juniperus procera*] were found in private lands and the remaining in the communal grazing lands.

The dominance of woody species was varied among altitudes of the study district. The largest proportion of woody vegetation was contributed by *Acacialahail* [60.6 and 25.8% in high and low altitudes, respectively], while in mid altitudes, *Carissa edulis* and *Acacialahail* contributed about 33.6 and 27.3%, respectively [Table 19]. In high altitude, *Carissa edulis, Acacia Abyssinia, Maytenus spp, Phooenix reclinata* and *Croten macrotachys* are the common species, but *Rosa abyssinica, Maytenus spp* and *Croten macrotachys* common species in mid altitude. In low altitude, *Carissa edulis, Acacia Abyssinia, Maytenus spp, Croten macrotachys, Rosa abyssinica, Ficus alicitolia* and *Cordial Abyssinia* common species. Many of the woody species identified in the study districts are important for livestock production.

The species identified in communal grazing land include *Euphorbia species, Albizia gummifera, Croten macrota-chys, Ficus alicitolia, Cordial Abyssinia, Milletia ferrruginea, Phooenix reclinata, Syzygium guineese, Rumex nervosus, Solanum spp., Dodonea viscose, Ficus sycomous, Rosa abyssinica, Acacialahail,*

Acacia atbalia, Acacia Abyssinia, Maytenus spp., and *Carissa edulis, keret* and *chibeha.*

Height class distribution and density of the woody species

In high and mid altitudes, the plants in 1-2 m height stratum were the dominant vegetation, which could be considered as they are at the browsing height of the animals. Hence, these reachable heights of different woody browse species situation in the district can make the area more favorable for browsing animals, while in low altitude, the plants in the >4 m height stratum were dominant. The mean height of woody species in low altitude was higher than in high and mid altitudes, which may be due to human factors [in high and mid lands, most farmers deforest the woody species for firewood as charcoal], grazing of livestock, and species composition [i.e. some species affect the growth of others species].

In the study area, as altitude increases, the mean density of woody species increases [Table 20]. this was in line with the findings of [1, 43]. This may be related with better soil fertility and high moisture in high altitude. The overall mean density of shrubs in the district was greater than the mean density [2622 ha^{-1}] of shrubs in semi-arid dry lands of Borana and the density of woody plants species [7950 ha^{-1}] in the natural forest [22, 44]. This difference might be due to livestock grazing pressure, soil type, human pressure and altitudes. [Table 4]

Table 4: The percentage of height class distribution and density of shrubs in the district

Height (m)	Altitude			
	High	Mid	Low	Overall
0.0 - 1.0	13.64	29.38	6.45	18.73
1.0 - 2.0	38.18	60.0	12.5	41.32
2.0 - 3.0	29.09	10.63	23.66	19.56
3.0 - 4.0	17.27	-	7.53	7.16
> 4.0	1.82	-	49.46	13.22
Total height Woody plant density ha-1	2.06 ± 0.09^{b}	1.38 ± 0.04^{c}	4.40 ± 0.28^{a}	2.39 ± 0.102^{b}
	15450 ± 902.6^{a}	12000 ± 902.6^{b}	7350 ± 902.6^{c}	11600 ± 271.6

The Effect of Altitude on Grazing Land Conditions at Different Grazing Types

The basal cover, species composition and grass species composition found in the enclosed areas were significantly lower [P<0.01] in low altitude than in high and mid altitudes [Table 21]. this was in line with the studies of [1, 41]. The possible reason for the lower basal cover, species composition and grass species composition in low altitude could be associated with lower precipitation and high temperature than in the other two altitudes. However, the basal cover, species composition and grass species composition found in enclosed grazing areas were no significant difference [P> 0.05] between high and mid altitudes. This may be due to the management of enclosed area by the farmers.

In communal grazing areas, basal cover and grass species composition were significantly lower [P<0.01] in low altitude category than those found in high and mid altitude ranges. The possible reason for the lower basal cover and grass species composition in the low altitude could be associated with low precipitation and high temperature in the lower altitude than in the higher altitude. The species composition was no significant difference [P>0.05] for the enclosure sites found in high and mid altitude categories, and this could be associated with level of grazing pressure. This indicated that species composition alone is not a good indicator of the condition of grazing land and this observation concurred with the finding of [1].

In the communal grazing area, woody plant density was significantly lower [P<0.01] in low altitude than in high and mid altitudes, and this was in line with the study of [1]. The possible reason for the lower plant density in the lower altitude could be associated with low precipitation in the lower altitude than in the higher altitude. The mean woody vegetation density per hectare was higher [P<0.05] in communal grazing areas of high altitude categories than those found in the mid and low altitude zones. This might be lower atmospheric temperature and high precipitation in high altitude than in mid and low altitudes. The higher woody vegetation density the better the grazing lands for grazing animals like cattle and sheep [1]. In the study areas, the woody vegetation density for enclosure areas was not recorded because of the absence of private woody vegetation used for animal feed sources.

The overall average value of the basal cover for the communal grazing areas was greater than 3.66 in Hamer district [1]. The reasons for the higher basal cover in study area may be associated with the soil type, climate condition, and altitude [550-1550 m.a.s.l in Hamer district]. [Table 5]

The Effect of Grazing on Grazing Land Condition at Different Altitudes

In the study area, the species composition, grass species composition and basal cover were affected by types of grazing management. The enclosed areas had a significantly higher

Table 5: The effect of altitude on grazing land conditions (mean±SE) at different grazing type

	Altitude			
Enclosed areas	**High**	**Mid**	**Low**	**Overall**
Basal cover	28.17±2.30[a]	26.17±2.30[a]	15.60±2.30[b]	23.31±2.3
Species composition	6.67±0.41[a]	5.92±0.41[a]	4.00±0.41[b]	5.53±0.23
Grass species composition	4.12± 0.28[a]	3.50 ± 0.28[a]	2.25±0.28[b]	3.31±0.16
Communal grazing				
Basal cover	21.34±2.4[a]	17.67±2.4[a]	9.71±2.4[b]	16.25±2.4
Species composition	4.67±0.29[a]	4.50±0.29[a]	4.00±0.29[a]	4.39±0.12
Grass species composition	3.17±0.26[a]	2.92 ±0.26[a]	2.25±0.26[b]	2.78±0.15
Woody density	15450.0±902[a]	12000.0±902[b]	7350.0±902[c]	7353±902.2

[P<0.01] value of basal cover than that of communal grazing areas in all altitudes. The enclosed areas had a significantly higher [P< 0.01] value of basal cover than that of communal grazing areas in all altitudes. This was in line with the studies of [1, 9, 21 and 27]. The lower basal cover in the communal grazing areas might be due to the high grazing pressure in communal grazing areas than in enclosed areas. As indicated by the grazing pressure affects loss and compactness of the soil which in turn significantly affects the grazing land condition [1].

In mid altitude, the enclousres had a significantly higher [P<0.01] value of species composition, basal cover and grass species composition than that of communal grazing areas [Table 22]. The higher species composition, basal cover and grass species composition in the enclosed grazing areas could be attributed to the better management and less opportunity for the vegetation to access and disturb the enclosed sites, in contrast to grazing pressure exerted on communal grazing area is more vulnerable for livestock grazing and trampling in the communal grazing areas. The result of this study supports the finding of Teshome [2006]. This implies that decline in the grazing land condition in communal grazing areas have a direct negative influence on the livestock production. The similarity in species composition and grass species composition in the enclosures and communal grazing areas located in high and low altitude may be associated with the less grazing pressure in communal grazing areas [Table 6].

Table 6: The effect of grazing on grazing land condition (Mean±SE) at different altitudes

Altitudes	**Type of grazing**		
High	**Enclosed grazing**	**Communal grazing**	**Overall mean**
Basal cover	28.2±1.50[a]	21.3 ±1.50[b]	24.80±1.5
Species composition	5.92±0.41[a]	4.67±0.41[a]	5.29±0.28
Grass species composition	3.50± 0.37[a]	3.17 ± 0.37[a]	3.33± 0.26
Mid			
Basal cover	26.17±3.27[a]	17.67±3.27[b]	21.92±3.27
Species composition	6.50 ± 0.26[a]	4.50± 0.26[b]	5.58±0.18
Grass species composition	4.17± 0.22[a]	2.92 ± 0.22[b]	3.54± 0.15
Low			
Basal cover	15.58±1.42[a]	9.71±1.42[b]	12.65±1.42
Species composition	4.00 ± 0.29[a]	3.83±0.28[a]	3.92±0.21
Grass species composition	2.25± 0.12[a]	2.25± 0.12[a]	2.25± 0.08

Interaction Effects of Altitude and Grazing on Grazing Land Conditions

There was an interaction effect of altitude and grazing on grazing land conditions in the study area. There were a significant [P<0.01] interaction of altitude and grazing on biomass and species composition [Appendix Table 9 and 10]. This was similar to the earlier study of [1]. The possible reason for the interaction between altitude and grazing on biomass and species composition could be due to the variation of grazing pressure between altitudes, and it could be the natural plant community of a site varies with altitude difference, as a result, they respond differently to similar grazing effect and this result agreed with the reports of [1, 6].

Correlation among Variables Studied in Grazing Land Conditions

Correlation analysis of the variables in the study area shows that basal cover, species composition, grass species composition and biomass were found to be positively correlated [P<0.01] with each other [Appendix Table 13]. This indicates that there was an increase in total biomass due to increase in basal cover, species composition and grass species composition and this was agreed with [17]. Species composition and basal cover were positively correlated [P<0.05] with biomass in high and low altitudes. This indicates that there was an increase in biomass due to increase in species composition and basal cover. The species composition was positively correlated [P<0.01] with grass species composition in high and mid altitudes. The species composition and grass species composition were positively correlated [P<0.05] with biomass in mid altitude. The basal cover and species composition were positively correlated [P<0.05] with biomass in low altitude.

Biomass Production

The Effect of Altitude on Dry Matter Biomass at Different Grazing Types

Enclosed grazing land

In enclosed areas, the overall biomass of herbaceous vegetation significantly [P<0.05] increasing with altitude increasing [from low to high altitudes]. This agreed with the findings of [41, 46]. Possible reason for this may be due to lower altitude may have higher atmospheric temperature and low precipitation which affect plant growth. The biomass yield of grass and legume, in enclosed areas of the high altitude categories was significantly lower [P<0.05] than that of the grass and legume biomass in the high and low altitude categories and such difference might be attributed to the variations in altitude. But, the grass and legume biomass were no significant [P>0.05] differences between the high and mid altitudes. The similarity of this measured biomass could be due to influence of management of enclosed areas undertaken by the farmers.In enclosed grazing area, grasses species contributed 52% of the dry matter, while legumes 39.5%. This was different from the result of 86 and 2% of grasses and legumes species represented dry matter composition around Ziway of enclosure area [50]. This difference might be due to soil type and altitudes [1500-1700 masl in Ziway]. [Table 7]

Communal grazing land

The total dry matter biomass, grasses, legumes and others biomass in the enclosed grazing areas located in the low altitude were found to be significantly higher [P<0.05] than in the communal grazing areas of high and mid altitudes [Table 24]. This was in line with study of [1]. Therefore, the total biomass, total biomass of grass and legumes were influenced by altitudes. The better biomass in communal grazing areas located in the high and mid altitude categories could be associated with the better rainfall in the high and mid altitude than in low altitude. But, there was no significant [P>0.05] differences the total biomass of grass and other species between mid and low altitudes. This could be due to the variation of grazing pressure in the mid and low altitude [grazing intensity may be relatively lower in the low altitude than mid altitude].

The overall biomass yield of grasses, legumes and others species were 1.02, 0.8 and 0.06 t ha-1 respectively [Table 24]. These values were different from the results of 3.4, 0.06 and 0.3 t ha-1 of grasses, legumes and others were, respectively on natural pastureland around Ziway [50]. The possible reason for variation of this could be associated with climate change, grazing pressure and soil type which affect the plant growth. [Table 8]

Table 7: Dry matter yield (Mean ±SE in t ha^{-1}) of the enclosed grazing at different altitudes

Altitudes	Total grasses	Legumes	Others	Overall biomass
High	2.59±0.31[a]	2.42±0.38[a]	0.97±0.59[a]	6.03±0.85[a]
Mid	2.40±0.53[a]	2.31±0.28[a]	0.08±0.01[b]	4.38±0.46[b]
Low	1.68±0.22[b]	0.34±0.06[b]	0.05±0.02[b]	2.10±0.20[c] **±0.20c**
Overall	2.22±0.53	1.69 ±1.03	0.37±0.54	4.17±1.76
DM composition (%)	52.0	39.5	8.6	100.0

Table 8: Dry matter yields (Mean±SE t ha^{-1}) of the communal grazing at different altitudes

Herbaceous Family	Altitude			Overall mean
	High	Mid	Low	
Grasses	1.41±0.08[a]	0.96±0.08[b]	0.70±0.080[b]	1.02±0.34
Legumes	1.30±0.22[a]	0.78±0.16[b]	0.31±0.130[c]	0.80±0.45
Others	0.11±0.02[a]	0.04±0.03[b]	0.03±0.004[b]	0.06 ±0.04
Total biomass	2.82±0.41[a]	1.78±0.11[b]	1.03±0.080[c]	1.87±0.80

The Effect of Grazing on Biomass at Different Altitudes

In all altitudes, the total dry matter biomass value obtained in the enclosed areas was significantly higher [P<0.05] than those reported in communal grazing areas. This was in line with the findings of [1, 8, 9, 23, 32, 33, 41, 47]. The higher biomass in enclosed area might be due to proper grazing management aids recruitment and persistence of species whereas poor management [communal] hastens the demise of species. High grazing pressure caused loss of high yielding forage species, and grazing land exposure to livestock grazing caused compact of soil which reduces the amount of water and air those are necessary for the reliable growth of plant roots [6, 42]. In high and mid altitudes, the average dry matter yield of grasses and legumes were significantly higher [P<0.01] in enclosed area than communal grazing areas. This was due to the variation of grazing in the enclosed and communal grazing areas. This argued with the continuous grazing pressure resulted in decreased biomass production [1] . The average dry matter yield of grasses in low altitude was significantly higher [P<0.05] in enclosed area than communal grazing areas. The difference of dry matter between enclosed and communal grazing area may be under grazing plants may not compensate sufficiently for the biomass removed by continues grazing of animals. But, there was no significant [P>0.05] differences in other specie biomass between the enclosure and enclosed areas located in all altitude categories. The similarity in the measured other specie biomass could be due to the selectivity of animal to graze these species. [Table 9]

Table 9: Effect of grazing types on biomass (mean ±SE in t ha^{-1}) of the different altitudes

	Types of grazing			Overall mean
Altitude	**Family Biomass**	**Enclosed area**	**Communal grazing**	
High	Grasses	2.60±0.31[a]	1.41±0.27[b]	2.00±0.27
	Legumes	2.42±0.38[a]	1.30±0.22[b]	1.86±0.67
	Others	0.97±0.59[a]	0.11±0.2[a]	0.54±0.60
	Total biomass	6.03±0.85[a]	2.82±0.41[b]	4.43±1.83
	Total grasses	2.40±0.53[a]	0.98±0.12[b]	1.68±0.85
mid	Legumes	2.31±0.28[a]	0.78±0.16[b]	1.55±0.85
	Others	0.08±0.01[a]	0.04±0.03[a]	0.06±0.03
	Total biomass	4.38±0.46[a]	1.78±0.12[b]	3.08±1.42
	Total grasses	1.68±0.22[a]	0.69±0.08[b]	1.20±0.55
low	Legumes	0.34±0.06[a]	0.31±0.13[a]	0.32±0.09
	Others	0.054±02[a]	0.027±004[a]	0.04±0.02
	Total biomass	2.10±0.08[a]	1.03±0.19[b]	1.56±0.58

Summary, Conclusions and Recommendations

Summary

The study was conducted in Gozamen district with the aim of assessing the major livestock feed resources, grazing land condition of herbaceous and woody species, to investigate the floristic composition and biomass yields of herbaceous species. The survey data was collected by interviewing a total of 120 households, by random selection of two rural-kebeles from each altitude [high, mid and low]. To assess grazing land conditions, enclosed and communal grazing lands were selected randomly from each altitude [high, mid and low]. From each altitude, 24 quadrats [12 from enclosed and communal grazing] for herbaceous vegetation and 4 transects from each altitude of communal grazing were selected. Thus, a total of 72 quadrats for herbaceous and 12 transects for woody species were selected to asses woody vegetation.

The overall average age and family size of the respondents were 47.3 years and 5.87, respectively. The highest percentages of respondents in all altitudes were illiterates. The largest and lowest proportion of land sizes were allocated to crop production and grazing lands, respectively. The cattle species contributed the largest herd sizes than other animals. The average number of livestock species significantly varied among altitudes.

In all altitudes, natural pasture, crop residues and crop stubbles were the major livestock feed resources. According to the response of respondents, natural pasture was the first and second feed sources during wet and dry seasons, respectively in all altitudes, while crop residue was first and second as source of feed during dry and wet season respectively. In terms of dry matter, crop residues contributed the highest dry matter basis of the total feed sources.

The use of improved forage as animal feed sources was not common in all altitudes due to shortage of land and lack of awareness about it. The use of agro-industrial by-products as animal feed sources in the study area was also not common due to high cost and no available in the area. The conservation of feed resources in the form of hay in mid land was higher than the other two altitudes. None of the respondents used silage

for animal feed source in all altitudes due to the reason of lack of knowledge how to make it. The overall respondents fed physically treated feeds to their livestock was low [26.7%] and none of respondents applied chemical feed treatment methods. The total estimated available feed supply to maintain the livestock in the study area was satisfied only 79.5%. A total of 21 herbaceous species were identified in the study area, of which 57, 24 and 19% were grasses, legumes and others, respectively. On biomass composition, Medicago polymorpha was the dominant species in both enclosed and communal area of high and mid altitudes, while Eleusine floccifolia was the dominant species in both enclosed and communal area of low altitude. A total of 22 woody plant species were identified of which 5 were found in private land and the remaining was in communal grazing lands. Altitude has effect on basal cover, total species and grass species composition, biomass of herbaceous vegetation and density of woody vegetation. In both enclosed and communal grazing areas, the basal cover and grass species composition were significantly lower [$p<0.01$] in low altitude than in other two altitudes. Grazing also has effect on basal cover, species composition, grass species composition and biomass at different altitudes. In all altitudes, the basal cover was significantly higher [$P<0.01$] in enclosed than in the communal area. In mid altitude, grass species composition and species composition were significantly higher [$P<0.05$] in enclosed than in communal grazing areas. There were a significant [$P<0.01$] interaction of altitude and grazing types on biomass and species composition. There were positively correlation [$P<0.01$] of species composition, grass species composition, basal cover and biomass with each other. The average dry matter yield of total grasses, legumes and total biomass in enclosed areas were significantly lower [$p<0.05$] in low altitude than in high and mid altitudes. The average dry matter yield of total biomass, grasses and legumes in communal grazing areas were significantly higher [$p<0.05$] in high altitude compared to mid and low altitudes. The average dry matter yield of grasses and total biomass were higher [$P<0.05$] in enclosed area than communal grazing areas in all altitudes. The average dry matter yield of legumes were higher [$P<0.05$] in enclosed area than communal grazing areas in high and mid altitudes.

Conclusion

In Gozamen district, from the total farmland size owned per respondent, cultivated land contributed the largest proportion of farm size, while the grazing land was very low. The main sources of livestock feed in all altitudes were natural pasture, crop residues and stubbles during wet and dry seasons. Crop residues contributed the highest dry matter of the total feed sources. However, chemical treatment of these feeds was not practiced in all altitudes even physical method was low. In the district, natural pasture was available during wet season in all altitudes. But, most of the respondents did not conserve livestock feeds in the form hay to feed livestock during dry season. None of respondents conserved feed in the form of silage in all altitudes due to lack of knowledge how to make it. Moreover, most of respondents [82.5%] did not cultivated improved forages as livestock feed in the study areas. The total annual estimated available feed supply to maintain the livestock in the area satisfied only 79.5%. The average natural pasture land per households in the district was 18.1% of the total land, which is less than 21.2% in 2011. Grazing had effect on basal cover, species composition, grass species composition and biomass at different altitudes. The total biomass was higher in enclosed area than communal grazing areas in all altitudes.

Recommendations

Based on the summary and conclusions, the following recommendations are suggested:

- The bulk amount of crop-residues accounted about 66.7% of the total annual feed supply but they have low nutritive value or quality. Thus, the local farmers should be encouraged and advised by any development organizations involved in livestock development on the physical [chopping and water soaking] and urea treatment methods.

- The use of improved forage as animal feed sources was not common in the study area due to awareness of farmers about improved forages. Thus, provisions of extension services to farmers about the importance sown forage and forage developing strategies should be required.

- The total annual dry matter does not meet the total livestock requirement per annum in district. Farmers should create awareness on how to balance the annual dry matter feed requirement of livestock and locally available feed supply. This may be done by reducing herd size preferably replacing the less productive animals with fewer more productive animals, proper store of crop residues, conserving feed [hay] and cultivating improved forage.

- The average dry matter yield of herbaceous species in enclosed grazing areas was higher than in communal grazing areas in all altitudes. Thus, to increase the productivity of communal grazing land which is found in large coverage in alt itudes efficient grazing land management systems should be considered. Among these adjusting stocking rate, use of rotational grazing, over sowing of leguminous feed species.

- Detailed monitoring research is imperative to further investigate the effect of altitudes and grazing on chemical composition of herbaceous species.

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