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Feed Resources Gozamen District, East Gojjam Zone, Amhara Region

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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, the floristic composition, and biomass yields of herbaceous species to generate baseline information which can be used for future management of grazing land resources and to identify feed constraints 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, 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 was 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 [1]. The largest livestock were found in Oromiya, Amhara and South Nations and Nationalities of People regions [2]. However, the production of livestock is low [3] 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 [4].

Feed problem is one of the major factors that hinders the development and expansion of livestock production in Ethiopia [5,6]. 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 [7]. 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 [8,9]. Fallow lands, grazing of roadsides and crop margins are also used for animal feed resources in some part of Ethiopia [6].

The Ethiopian highland regions account the largest share of livestock population (63.2%) and the lowland account the lowest (36.7%) [10]. 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 [11]. The seasonal fluctuation of availability of natural pasture is a common phenomenon which resulted in a serious

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feed shortage which affects production and productivity of animals [12]. 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 [12,13]. 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 [5,14].

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 [15], 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. 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:-

- To assess the major livestock feed resources in the district.

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 North western highlands of Ethiopia at a geographical location of 10°1′ 46″ and 10° 35′ 12″ N latitudes and 37° 23′ 45″ and 37° 55′ 52″ E longitudes and at a distance of 305 and 251 km from Addis Ababa and Bahir Dar, respectively (Figure 1). 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 [15].

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 [15]. 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 25°C and 11°C, respectively [15]. 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 [16].

Agriculture is the mainstay of farmers in the district which is characterized by mixed crop livestock production systems. According to [15], the most important crops grown in the district are cereals like wheat, teff, maize, barley and oats. 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

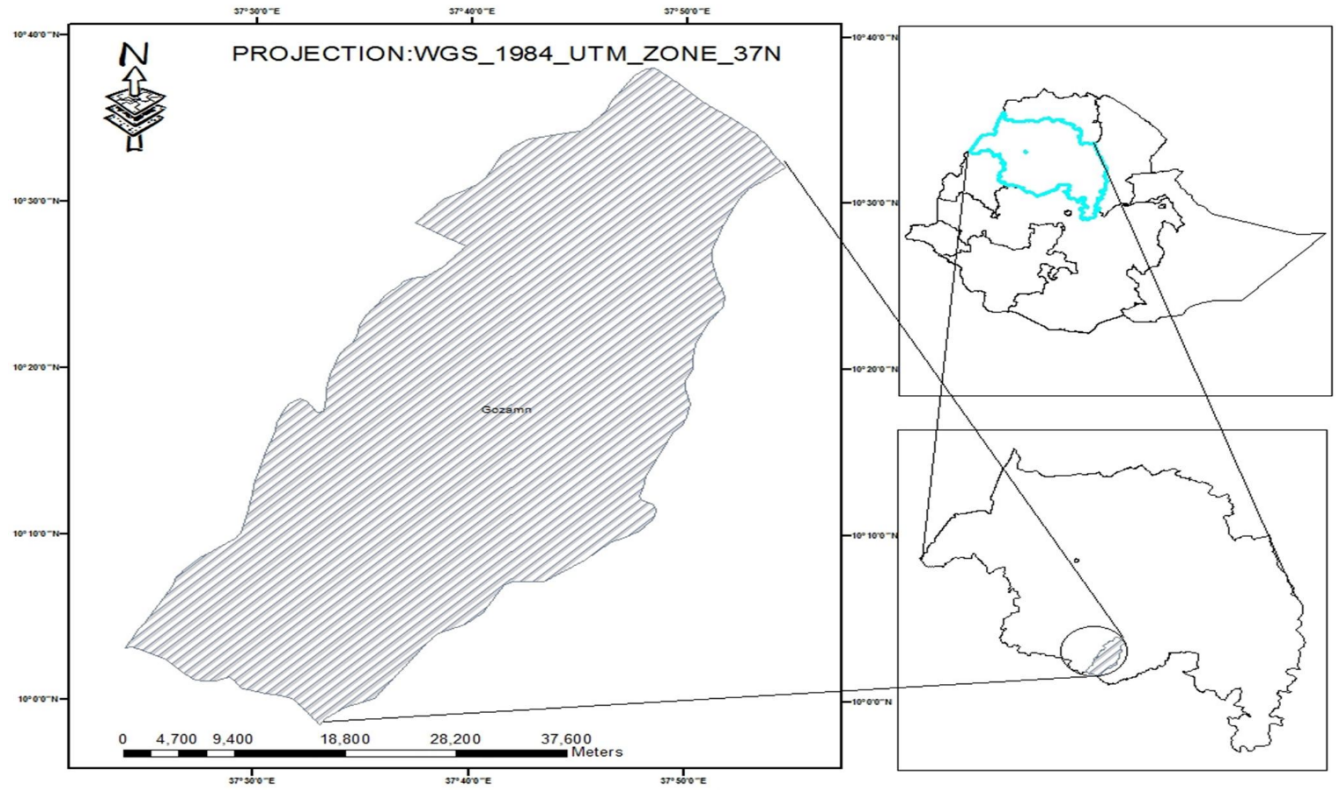

Figure 1: Geographical location of *Gozamen Woreda*.

(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 [15].

Data collection methods

Livestock feed resources assessment in the district: The district was stratified into three altitudes namely high (>2400), mid (1800-2400) and low (1200-1800 meter above sea level) using stratified sampling method. From each altitude two rural-kebeles were selected randomly. Thus, a total of six rural-kebeles were selected from the district. From each rural-kebele 20 households those who possessed different animals were purposively selected. A total of 120 households were selected from the district. Preliminary surveys were conducted to gather information about the availability of the different feed resources in each PA. Before actual data collection, information was gathered in single visit interviews using semi-structured questionnaires. Based on the feedback of the semi-structured questionnaires, well-structured questionnaires were prepared and households were interviewed individually. Data collected using questionnaires strengthened by information obtained from key-informants through cross-questioning, making field visit and checking at the time of survey. Secondary data (total size of fallow land, shrub and bush land, forest land, grazing land, aftermath, size of cropping land, grain yield of different crop species and number of livestock in the district) were collected from the Gozamen district and East *Gojam* Administrative Zone Agricultural Office to estimate feed balance.

Quantification of dry matter from different feed resources: Dry matter (DM) yield of different feed resources were estimated to calculate the balance between annual feed available and requirements of livestock in the study area. Dry Matter yield from natural pasture land, aftermaths, bush and shrub land, fallow land, forest lands were estimated by multiplying the grazing land by 2, 0.5, 1.2, 0.7 and 1.8 tones ha^{-1}, respectively to estimate the annual DM yield [17]. The quantity of DM from crop residues were estimated from crop grain yields using the conversion factors as follows: 1.5 for teff, wheat, barley and oat, 1.2 for chickpeas, horse bean and oil seeds crops such as niger seed and linseed, 2 and 2.5 for stover yield of maize and sorghum, respectively and 0.3 for Irish and sweet potato and 8000 is for both enset and banana [17].

Data analyses

Data collected from feed assessment survey were analysed by procedure of SAS. 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: $\mathbf{Y_i=\mu+A_i}$ where, Yi=the value of survey data, μ=overall mean, A_i=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 + Ai + Gj + Bk + AGij where,** Yijk=the value of natural pasture condition assessment, μ=overall mean, Ai=effect of altitude, Gj=effect of grazing type, Bk=effect of block, AGij=interaction effect of altitude and grazing types.

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

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

Results and Discussion

This chapter includes demographic characteristics of households, land holding, livestock herd size, availability of feed resources, technique of improving nutritive values, annual feed balance, 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).

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 [18] the low levels of education of the households have an influence on adoption of improved poultry management practices. 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) [19]. However, as the study area, the primary and secondary schooling was low in all attitudes (Table 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 Yenesew et al. [20] in *Burie* district of west Gojam zone, 1.8 ha in Amhara region and 1.4 ha in Ethiopia [2]. 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, respectively [21]. This shows shortage of grazing land size was the main reason for shortage of feed in the study area.

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.

Yields of crop: The major crops grown in the district were *teff*, wheat, oat, maize, sorghum, barely, horse bean, chick peas, nigerseed and linseed. The overall average grain yields per households were 32.67 quintals or 3.27 tones (Table 4). In terms of percentage of yield, *teff*, wheat, oat, maize and barely were the major crops in the district in descending order. This was different from the report of Zewdie et al. [22] maize, wheat, barley; haricot bean and *teff* were the major crop yields in *Ziway*. Moreover, as indicated by Abu et al. [23] the most important cereal crops in terms of yield in Ethiopia were *teff*, wheat, maize, sorghum and barely in descending order. This difference may be due to soil types, cropping intensity and climatic conditions.

The mean yield of *teff* and oat varied significantly (P<0.05) among altitudes of the study areas due to the lower land size in mid altitude than in high and low altitudes. The average yield of wheat was significantly lower (P<0.05) in mid-altitude than in high and low altitudes. The estimated yield of maize and sorghum were significantly higher (P<0.05) in low altitude than in the other two altitude categories. The total average yields of crops in mid altitude were significantly lower (P<0.05) than in high and low altitudes. The variations of yields observed among the altitudes were due to the result of variation of size of cropping land and altitudes.

	Altitude			
Level of education	**High**	**Mid**	**Low**	**Overall 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

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

Livestock herd size

Cattle, sheep, goats, donkeys, horses, and mules were reared by the local community of all altitudes. The total population of livestock species of sampled households in the study area was presented in Table 5. Out of the total livestock, cattle contributed the largest herd size than other animals in all altitudes. This was in line with the findings of Mergia et al. [24], Birhan et al. [25], Taddese and Solomon et al. [26], and Samson and Frehiwot et al. [27]. This may be due to cattle are important sources of draught power.

The number of cattle reared per household in low altitude was significantly lower (P<0.05) than that of high and mid altitudes (Table 5) which, disagreed with Ayana et al. [28] the cattle size was smallest in the mid-lands. The possible reasons for variation may be due to size of communal grazing, purpose of sheep and economic level of farmers among altitude categories. The number of goats reared per household in low altitude was significantly higher (P<0.01) than that of high and mid altitudes. High number of goats in low altitude may be due to development of browse vegetation which is a source of feed for goats. The average number of sheep reared per household in high altitude was significantly higher (P<0.01) than that of in high and low altitudes. Variation in size of herd per respondent among altitude categories may be due to with the availability of water and grazing lands, prevalence of diseases and parasites as well as the management of the livestock owner have also been reported earlier [13].

Availability of feed resources

The main feed resources to livestock in all altitudes were natural pasture, crop residues, and crop stubbles, which agreed with earlier

	Altitude				
Type of land use	**High**	**Mid**	**Low**	**Over all mean**	**%**
Homestead	0.34 ± 0.01^{a}	0.25 ± 0.01^{b}	0.32 ± 0.02^{a}	0.30 ± 0.010	15.50
Cultivated land	1.57 ± 0.05^{a}	1.42 ± 0.07^{b}	1.65 ± 0.04^{a}	1.55 ± 0.030	79.02
Private grazing	0.06 ± 0.01^{a}	0.06 ± 0.01^{a}	0.03 ± 0.01^{a}	0.05 ± 0.008	2.48
Woody land	0.08 ± 0.01^{a}	0.06 ± 0.01^{a}	0.01 ± 0.01^{b}	0.05 ± 0.007	2.50
Improved forage	0.003 ± 0.003^{a}	0.005 ± 0.003^{a}	0.00 ± 0.00^{a}	0.003 ± 0.002	0.05
Fallow Land	0.009 ± 0.01^{a}	0.003 ± 0.003^{a}	0.006 ± 0.01^{a}	0.006 ± 0.003	0.33
Total	2.046 ± 0.06^{a}	1.795 ± 0.08^{b}	2.006 ± 0.05^{a}	1.95 ± 0.04	100.0

Table 3: Sample households' land use system in the study area (Mean ± SE in ha).

	Altitude				
Crop type	**High**	**Mid**	**Low**	**Overall mean**	**%**
Teff	6.50 ± 0.26^{c}	10.73 ± 0.68^{a}	8.39 ± 0.43^{b}	8.54 ± 0.32	25.20
Wheat	10.38 ± 0.53^{a}	4.95 ± 0.77^{b}	9.63 ± 0.95^{a}	8.32 ± 0.49	24.02
Oat	13.03 ± 0.69^{a}	7.20 ± 0.87^{b}	0.00 ± 0.00^{c}	6.74 ± 0.52	19.72
Maize	4.00 ± 0.89^{b}	4.63 ± 1.02^{b}	7.83 ± 0.82^{a}	5.48 ± 0.41	16.03
Barely	1.44 ± 0.53^{a}	1.55 ± 0.42^{a}	0.00 ± 0.00^{b}	1.50 ± 0.48	5.15
Sorghum	0.00 ± 0.00^{b}	0.00 ± 0.0^{b}	5.28 ± 0.87^{a}	1.76 ± 0.22	5.02
Horse bean	0.49 ± 0.27^{a}	0.55 ± 0.2^{a}	1.00 ± 0.36^{a}	0.68 ± 0.28	1.99
Niger seed	0.00 ± 0.00^{b}	0.38 ± 0.16^{a}	0.09 ± 0.09^{b}	0.17 ± 0.08	0.45
Lin seed	0.04 ± 0.04^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.01 ± 0.01	0.37
Total	35.85 ± 1.23^{a}	29.98 ± 1.58^{b}	32.20 ± 1.15^{a}	32.68 ± 0.79	100.0

Table 4: Yield of crops (Mean ± SE in quintals) at different altitudes in the study areas.

reports Yeshambel et al. [21] and Mergia et al. [24]. According to the responses of respondents, in the study area, the availability of feed resources varied in seasons with respect to quantity. The principal dry season feed resources available to livestock in all altitudes include crop-residue, natural pasture, stubble grazing, and hay in their descending order of magnitude. Whereas, during the wet season, the principal feed resources in all altitudes include natural pasture, crop-residue, hay, and stubbles in their descending order of intensity of use by producers. However, types of feed resources were not different among altitudes (Table 6). This, due to mixed crop livestock production system is more practiced by all altitudes.

The ranking was done by counting the percentage of numbers of respondents who ranked the type of feeds (natural pasture, crop residue, crop stubbles and hay) first, second, third and fourth, and comparing how many numbers of respondents rank the types of feed first, second, third and fourth. Some respondents did not rank all types of feeds because of the absence of feed type (e.g. hay).

Private grazing lands: The number of respondents used private grazing land as animal feed sources were small (30%). This was less than 94% in *Guagusa* district Yeshambel et al. [21]. This difference may be due to size of land and the awareness of the farmers to feed their livestock. Of the total respondents having private grazing land, 35, 35 and 20% contributed in high, mid and low altitudes respectively. The size of private grazing land per household was very small (0.05 ha) (Table 3). This was comparable to 0.04 ha which reported by Yenesew et al. [20].

The grazing system of private grazing land in the study area varied among the season of the year (wet and dry) and altitudes. Paddocking, herded, unherded, tethered and cut-carry grazing systems were practiced during wet seasons (Table 7). Paddocking system was the highest in mid altitude than in the high and low altitudes during wet season. This may be due to the mid altitude is nearest to *Debre Markos* town to get enough information about the grazing system. Unherded (identified productive and non-productive animals), tethered and cut-carry grazing system were very low or not more adapted in all altitudes. However, in dry season, almost all of the respondents grazed livestock by herding (all livestock species grazed on the common land) (Table 7).

Crop residues: The major crop residues available for livestock feeding in the area were cereals (*teff*, oat, maize, wheat and barley), pulses (horse bean and chickpea) and oil seeds (linseed and nigerseed). The annual total dry matter (DM) feed produced from crop-residues in the study area was 5.2 tones (t) per household. This figure was lower than 8.74 t DM at *Adami Tullu Jiddo Kombolcha* District which was reported by Dawit et al. [29]. *Teff* and wheat straws and maize stover contributed the largest DM related to other crop residues in the study area.

The overall average yield of crop residues varies among the altitudes. The overall average yield of crop residues owned per household in mid altitude was significantly lower ($P<0.05$) than the overall average yield of crop residues owned in high and low altitudes. The reason of lower yield of crop residues in mid altitude was due to lower cultivated land size in mid land than in high and low altitudes (Table 3). The average dry matter yield of *teff* straws of mid altitude was significantly higher ($P<0.01$) than dry matter yield of *teff* straws of high and low altitudes which matched with the earlier report of Ahmed et al. [5]. The average yield of wheat straw owned per household in

	Altitude				
Livestock species	**High**	**Mid**	**Low**	**Overall mean**	**%**
Cattle	8.87 ± 0.64^a	9.93 ± 0.74^a	7.13 ± 0.56^b	8.64 ± 0.38	56.5
Sheep	5.60 ± 0.68^a	2.89 ± 0.67^b	2.25 ± 0.40^b	3.59 ± 0.37	23.2
Goats	0.00 ± 0.00^b	0.47 ± 0.29^b	1.55 ± 0.48^a	0.68 ± 0.19	4.4
Donkeys	1.18 ± 0.12^a	0.78 ± 0.12^a	1.00 ± 0.10^a	0.98 ± 0.07	6.4
Horses	0.58 ± 0.14^a	0.38 ± 0.12^a	0.03 ± 0.02^b	0.33 ± 0.07	2.1
Mules	0.05 ± 0.05^a	0.00 ± 0.00^a	0.00 ± 0.00^a	0.02 ± 0.02	0.1

Table 5: Respondent's livestock herd size (Mean ± SE) in the study areas.

	Altitude															
Feed resources	**High**				**Mid**				**Low**				**Over all**			
Rank dry	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
NP	10	57.5	42.5	-	7.5	60	33	23	-	75	23	5.0	6	64	33	9.2
CR	90	10.0	-	-	85	13	2.5	-	100	-	-	-	92	7.5	0.8	-
SG	-	32.5	55.0	-	-	25	40	5.0	-	25	73	-	-	24	56	1.7
Hay	-	-	-	28	8	2.5	18	45	-	-	5	7.5	2.5	0.8	7.5	27
Rank(wet)	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
NP	100	-	-	-	100	-	-	-	100	-	-	-	100	-	-	-
CR	-	97.5	2.5	-	-	48	28	18	-	100	-	-	-	78	16	5.8
SG	-	-	17.5	7.5	-	-	8	15	-	-	13	12	-	-	15	12
Hay	-	-	30.0	-	-	38	45	-	-	-	20	2.5	-	16	23	0.8

NP: Natural Pasture; CR: Crop Residue; SG: Stubble Grazing

Table 6: Major feed resources calculated fr om ranking results of respondents during wet and dry seasons of Gozamen district.

mid altitude was significantly lower (P<0.01) than the average yield of wheat straw owned in high and low altitudes. But, the average yield of sorghum and maize stovers owned per household in low altitude was significantly higher (P<0.01) than the average yield of sorghum and maize stovers owned in high and mid altitudes. The variation of yield of crop residues among altitudes may be associated with the size of crop lands, yields of crops and altitudinal difference. As obtained from the group discussions and development agent, crop residues were the mainly used for source of livestock feed. They also used for construction of house, income source and as a fuel in the study area.

Stubble grazing lands: Crop stubble, (*teff*, oat, wheat, barley and maize), was one of the important feed resources in the study area from November to February. All respondents in all altitudes grazed animals on aftermath of cereal crops from 2 to 4 months. This was comparable to Solomon et al. [26] and Malede and Takele et al. [7] on which livestock in mixed crop-livestock farming systems graze two to three months on stubbles. The length of feeding on crop stubble in mid altitude was longest than in the high and low altitudes. The possible reason for this may be the ratio of livestock population to the size of crop stubbles may be lower in mid altitude than in other altitudinal zones (Tables 8 and 9).

Improved forage and pasture: The number of respondents used improved forage as animal feed sources in study area was very low 21 (17.5%). This was lower than 75% of respondents reported by Freweini et al. [30]. The main reasons for this difference may be due to the size of land and adoption of the farmers to cultivate improved forage. As obtained from responses of respondents and field observations only one respondent grown vetch in mid altitude by intercropped with maize, while almost all respondents established *Susbania sasban* in the live fence, field borders and backyards in all altitudes.

The overall percentages of respondents' sown improved forage were low in all altitudes. This was similar with the earlier report of (ESAP, 2009). About 82.5% of respondents in the study area did not cultivate improved forages which used as animal feed source. The main reasons for this were shortage of land, lack of awareness and lack of forage seed supply. The reasons for not cultivating improved forage varied among altitudes. In high and mid-altitudes, shortage of the land was the main reason which agreed with report of Zewdie et al. [22], while in low altitude, lack of awareness was the major reason (Table 10). This may be because of low altitude is far from the *Debre Markos* town to get agricultural information and extension services. Moreover, most of the respondents (57%) in the study area were illiterates, which may influence the adoption of the forage technologies.

Supplementary feeds: Natural pasture and crop residues do not fulfill the nutritional requirements of animals particularly in the dry season due to poor management and poor quality Malede and Takele, et al. [7]. Thus, provision of supplementary feeds to increase the productivity of livestock is essential. However, in the study area, most of the farmers did not provide supplementary feeds for their livestock due to high cost, not available in the area and lack of knowledge about importance of supplementary feeds. The main reason not supplied additional feed in high and mid altitudes was high cost; while in low altitude not available in the area was the main reason (Table 11). Although the use of supplementary feeds for livestock was not well adopted, about 35, 50, 25% of respondents in high, mid and low altitudes respectively provided feeds of their own farm sources (e.g. oat) and local brewery by products (*Atella* and *brint)*. In all altitudes, local brewery products were the main supplementary feed (Table 11).

Agro-industrial by-products: According to the report of GWARDO, the use of agro-industrial by-products as their livestock

		Altitudes			
Seasons	**Grazing types**	**High N=14 (35%)**	**Mid N=14 (35%)**	**Low N=8 (20%)**	**Over all N=36 (30%)**
Wet	Paddock	21.43	85.71	12.5	44.44
	Herded	57.14	7.14	50.0	36.11
	Unherded	7.14	7.14	12.5	8.33
	Tethered	7.14	-	25.0	8.33
	Zero- grazing	7.14	-	-	2.78
Dry	Unherded	-	14.3	-	5.56
	Herded	100.0	85.71	100.0	94.4

Table 7: Types of grazing systems of private grazing land in dry and wet seasons (%).

Type of crop	**Altitude**				
residues	**High (N=40)**	**Mid (N=40)**	**Low (N=40)**	**Overall (N=120)**	**%**
Teff	9.74 ± 0.39^{c}	16.23 ± 1.11^{a}	12.56 ± 0.71^{b}	12.81 ± 0.51	23.83
Wheat	15.56 ± 0.79^{a}	7.43 ± 1.16^{b}	14.29 ± 1.43^{a}	12.47 ± 0.74	22.83
Maize	7.98 ± 1.35^{b}	9.25 ± 1.49^{b}	15.65 ± 1.17^{a}	10.96 ± 0.83	20.04
Oat	19.54 ± 0.77^{a}	10.8 ±1.21^{b}	0.00 ± 0.00^{c}	10.11 ± 0.87	18.51
Sorghum	0.00 ± 0.00^{b}	0.0 ± 0.00^{b}	13.18 ± 2.16^{a}	4.39 ± 0.91	8.05
Barely	2.17 ± 0.56^{a}	2.33 ± 0.59^{a}	0.00 ± 0.00^{b}	2.72 ± 0.32	4.90
Bean	0.58 ± 0.23^{a}	0.66 ± 0.25^{a}	1.20 ± 0.33^{a}	0.80 ± 0.15	1.48
Niger seed	0.00 ± 00^{b}	0.45 ± 0.19^{a}	0.11 ± 0.07^{b}	0.18 ± 0.07	0.34
Linseed	0.045 ± 0.05^{a}	0.00 ± 00^{a}	0.00 ± 00^{a}	0.012 ± 0.02	0.03
Total	55.04 ± 2.03^{a}	45.91± 2.5^{b}	55.62 ± 2.1^{a}	52.20 ± 1.35	100.0

Table 8: Respondents' annual dry matter yield (Mean ±SE in Quintals) of crop residues.

	Altitudes			
	High (N=40)	Mid (N=40)	Low (N=40)	Over all (N=120)
Numbers of respondents (%) allowed animals to graze on crop stubbles Month's animals graze on the aftermath (mean ±SE)	100.0	100.0	100.0	100.0
	2.8 ± 0.1[b]	3.48 ± 0.2[a]	2.7 ± 0.1[b]	3.0 ± 0.1

Table 9: Month's animals graze on the crop aftermaths in the study areas.

		Altitude		
Sowing methods	**High N=8(20%)**	**Mid N=7(17.5%)**	**Low N=6(15%)**	**Over all N=21(17.5%)**
Intercropping with maize	-	14.3	-	4.8
As live fence	100.0	85.7	100.0	95.2
Examples of improved forages *Susbania sasban*	100.0	85.7	100.0	95.2
Common vetch *(Vicia dasycarpa)*	-	14.3	-	4.8
Reasons not used improved pasture	80%	82.5%	85%	82.5%
Shortage of land	65.6	75.8	44.1	61.6
Lack of awareness	59.4	36.4	55.0	50.5
No forage seed supply	12.5	21.2	2.9	13.1
No effort to introduce by organization	-	-	2.9	1.0

Table 10: Sowing methods, examples and reason for not establish and utilize improved forages.

	Altitude			
Sources of supplementary feed	High (N=14)	Mid(N=20)	Low (N=10)	Overall (N=44)
Home grown	100.0	95.0	100.0	95.5
Purchased	-	5.0	-	4.5
Type of supplementary feed Oats	42.85	60.0	-	40.94
Wheat bran	7.14	5.0	-	4.54
local brewery by products (Atella) and salt	57.15	40.0	54.7	59.0
Reasons not supplied additional feed				
High cost	88.5	65.0	13.3	52.6
Not available in the area	11.5	40.0	93.4	51.3
Lack of knowledge about importance	3.85	15.0	-	5.3

Table 11: Percentage of sample households used supplementary feeds, sources, types and reasons not supplied supplementary feeds to livestock in the study areas (%).

feed in the district was not common due to absence of agro-industries around the district. Out of the total respondents, only 4 (3.3%) respondents supplied agro industrial by product (only wheat bran) to their livestock in high and mid altitudes which, comes from local small grain mills. None of the respondents in lowland used industrial by-products as supplement for their livestock.

The main reasons not supplied agro-industrial by-products to their livestock in the district were availability in the area, high cost and lack of understanding about importance (Table 12). This was confirmed to Freweini et al. [30] agro-industrial byproducts are not common in Eastern *Harerghe* Zone due to availability and cost. In all altitudes, the main reasons did not provide agro industrial by products for animals were due to availability in the area. Majority of respondents (32%) in low altitudes did not understand about importance agro-industrial by- products to their livestock than the rest. The possible reason for this may be due to the low altitudes is far from the Debre Markos town, this may affect to get agricultural information.

Feed preservation: The overall percent of respondents conserved feed in the form of hay in the district was low (45.8%) which was smaller than 87.2% and 71.8% reported by Ahmed et al. and Solomon et al. in *Basona Worana* and *Pawe* districts, respectively. The percentages of respondents who made hay varied among altitudes. Majority of respondents made hay in mid altitude and least respondents in low altitude. This was similar to the result of Yeshambel et al. The possible reasons, for more respondents made hay in mid altitude may be due to the nearest of the mid altitude to the Debre Markos University to get agricultural information (hay conservation).

As observed during survey and reported from the group discussions, hay making was a traditional practice which was harvested and prepared from matured (dried) natural pasture in all altitudes due to shortage of labor and this result losses of leaves by shattering during harvesting and storage [9]. After harvesting, most of the respondents in high and mid altitudes stored hay under open air. This results the highest nutrient loss due to leaching [9]. Baling of hay was uncommon in all altitudes.

The main reasons did not conserve hay in district were shortage of land, lack of knowledge how to make and type of forage species (Table 13). The use of silages as animal feed resources was not practiced in all altitudes due to lack of knowledge on how to do silage (Table 13). This may be due to lack of extension services and most of the respondents in the study area were illiterates, which may influence acceptance and adoption of the silage making.

Seasonality of feed resources

According to the reports of group discussions, feed was sufficiently available from November to February (crop residues and stubbles) and May to October (natural pasture), severely short supply from March to May (Table 14). The sufficient available of feed from November to February was in line with the reports of Yeshambel et al. [21]. The availability of crop residue in study area disagreed with the reports of

Mesay et al. [12] on which crop residues dominant from December to July in highland of Ethiopia. This difference may be due to the use of irrigation to produce crops and the length of rainfall seasons.

Technique of improving nutritive value

Feeding of urea treated feeds increases feed intake, digestibility and body weight gain of animals Teferi et al. [31]. However, in the study area, most of the respondents did not treat feeds to enhance the above importance (Table 15) which was confirmed to the reports of Bedasa et al. [32], Mergia et al. [24]. Out of the total respondents, only 26.7%, (20, 27.5 and 32.5% in high, mid and low altitudes, respectively) treated feeds by physical methods (water soaking and chopping). Feed treatment by water soaking was the higher in mid altitude than in other two altitudes, but chopping was the lower in mid than in other two altitudes. None of the respondents have been applied urea to treat feed in the district. The main reasons did not treat feeds in all altitudes were lack of knowledge and awareness how to do it. This indicates no awareness of farmers about the importance of feeding treated feeds to livestock and lack of animal science experts in the study area.

Reasons not used agro-industrial by-products to livestock	Altitude			
	High (N=38)	Mid(N=38)	Low (N=40)	Overall (N=116)
Not available in the area	66.6	52.9	54.3	54.7
High cost	27.2	32.9	14.1	27.8
Lack of knowledge about importance importance	6.2	14.2	31.6	17.5

Table 12: Reasons not supplied agro-industrial by-products to feed their livestock in the study area (%).

Annual dry matter production and livestock feed requirement

The estimated annual total dry matter yield from different feed sources in the district was 246,045.8 Tonnes including crop-residues, natural pasture, crop stubbles and shrub lands. The contribution of crop residues in terms of dry matter was highest as compared to the other feed sources which were in line with the result of Mesay et al. [12], because the study area is characterized by mixed crop-livestock farming system. Of the total annual dry matter feed produced in the district, crop residues contributed the largest proportion than other feed sources (Table 16). But, this figure was lower than 74.2% and 69.0% those reported by Solomon [33], and Zewdie and Yoseph [34] in *Sinana* sub-district of Bale highland, and *Adami Tullu Jidokombolcha* and *Dugda* Bora districts, respectively. This difference may be due to the size of cropping land and yields of crops.

The total estimated annual available feed supply in terms of dry matter was presented in Table 16. The total livestock population in the district was 135,593 tropical livestock units (TLU) including cattle, sheep, goats, donkeys, horses and mules (Table 17). For the standard

	Altitude				
		High N=14 (35%)	Mid N=32 (80%)	Low N=9 (22.5%)	Over all N=55 (45.8%)
Store of hay	Under open air	64.25	50.0	-	61.8
	Covering by plastic outside home	-	18.75	-	10.9
	In the house	37.72	31.25	100.0	27.3
Reasons not	Shortage of land	76.92	100.0	83.87	83.1
making hay	Lack of knowledge how to do it	-	-	6.45	3.1
	Forage species	23.08	-	9.68	13.8
Reasons not making silage	Lack of knowledge how to do it Lack of knowledge how to do it and	97.5	97.5	100.0	98.3
	Lack of knowledge how to do it and	2.5	2.5	-	1.7
	Lack of tools				

Table 13: Storage methods of hay and reasons for not making hay and silage in the study area.

Feed Resource	Availability of months											
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Natural pasture	X	X							Y	X	X	Y
Crop residues			Y	X	X	Y						
Stubbles			Y	X	X	Y						

Table 14: Seasonal availability of feed recourse in the Gozamen district (X=sufficiently available, Y=not sufficiently available).

Technique of improving nutritive value	Altitude			
	High N=8 (20%)	Mid N=8 (20%)	Low N=8 (20%)	Over all N=8 (20%)
Water soaking	12.5	90.9	23.1	43.75
Chopping	87.5	9.1	92.3	65.63
Reasons not treated straws with urea				
Lack of knowledge and awareness	95.0	95.0	100.0	96.7
Shortage of money to purchase urea	5.0	5.0	-	3.3

Table 15: Techniques of improving nutritive values and reasons not treat feeds with urea in the study area.

Feed sources	Area (ha)	C.F	DM (t DM)	%
Crop residues	36390.0	-	164193.79	66.73
Crop stubbles	36390.0	0.5	18195.0	7.40
Grazing land	19866.75	2	39733.5	16.15
Shrub land	21436.25	1.2	25723.5	10.46
Total	115,550.1	-	246,045.8	100.0

Table 16: Annual dry matter obtained from different land use in the districts (in Tonnes).

Livestock species	Livestock number	C.F	TLU	DM (t) head year^{-1}	Annual DM requirement (tone)	%
Cattle	155287	0.7	108700.9	2.28	247838.1	80
Sheep	97263	0.1	9726.3	2.28	22176.0	7.2
Goats	8577	0.1	857.7	2.28	1955.6	0.6
Donkeys	16433	0.5	8216.5	2.28	18733.6	6.1
Horses	8818	0.9	7936.2	2.28	18094.5	5.9
Mules	222	0.7	155.4	2.28	354.3	0.1
Total	286,600.0		135,593		309,152.0	100.0

Table 17: Annual dry matter requirement of livestock in the Gozamen district.

tropical livestock units (TLU) of 250 kg dual-purpose tropical cattle, a dry matter (DM) requirement of 2.5% of body weight is equivalent to 6.25 kg DM per day or 2.28 Tonnes DM per year for maintenance [35]. Based on the estimated values obtained from different livestock species, 309,152 Tonnes DM feed were required to maintain all livestock species annually. Thus, the total estimated available feed supply to maintain the livestock in the district satisfied only 79.4%. This finding was similar to the findings of Senbeto et al. [36], Zewdie et al. [37], Mergia et al. [24] and Tadesse and Solomon [26], in which the feed balance in the DM supply of the feed was not sufficient to livestock. As reported from group discussions, during severe feed shortage season, the farmers taken measures like destocking, purchasing feed, traveling long distance for searching feed (only in low land).

Sources of water and frequency of watering livestock

The sources of water in district were river, hand dug well and pond which were similar to the earlier report of Demissie et al. [38] in *Enebse Sarmidir* district. All of the interviewed livestock households in all altitudes used rivers as sources of water for livestock (Table 18).

Watering of animals per day varied among the altitudes. The majority of respondents in high (97.5%), in mid (60.0%) and in low altitudes (77.5%) watered cattle twice, three times and three times per day, respectively during the dry season. This result agreed with the result of Beyene et al. most of the respondents in the mid and low land watered their cattle three times per day. Most of the respondents (97.5%) in high, (57.5%) in mid and (45.0%) in low altitudes watered sheep and goats twice, once and three times in a day, respectively during the dry season. These outcomes did not agreed with the result of Demissie et al. [38] on which the majority of the farmers (80%) in highland, (53.3%) in lowland and (76%) in midland provided water for their goats once every two days interval and once a day during the dry season. The majority of respondents in high and low altitudes watered equines twice per day. In wet seasons, all of the respondents watered their animals as they want. Generally, most of the respondents in all altitudes watered different animal species twice in a day during the dry season.

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

	Altitude											
	High (N=40)			Mid (N=40)			Low (N=40)			Overall (N=120)		
Frequency	1	2	>3	1	2	>3	1	2	>3	1	2	>3
Cattle	-	97.5	2.5	5.0	35.0	60	2.5	17.5	77.5	2.5	50.	46.7
Shoats	2.5	97.5	-	57.5	37.5	-	7.5	37.5	45.0	22.5	58	15.0
Equine	17.5	82.5	-	47.5	47.5	-	7.5	45.5	40.0	24.2	58	13.3
Source of water River	100.0			100.0			100.0			100.0		
Hand dug well	70.0			87.5			82.5			80.0		
Pond	-			7.5			-			2.5		

Table 18: Sources of water and frequency of watering for livestock in the area (%).

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 on 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 was higher ($P<0.05$) in enclosed area than communal grazing areas in high and mid altitudes.

Conclusions

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 local communities should be created awareness about the conservation of feed resources in the form hay and silage from natural pasture and the majority of respondents conserved hay under open air in high and mid altitudes. Such a practice could lead to the loss in hay quality as a result of exposure to adverse weather. Thus, provision of strong extension services and training farmers on storage and harvested stage of hay are required.

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 altitudes 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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