Full Length Research Article

Livestock Feed Resources and Feeding Practices in Bonke and Geresse Districts, Gamo Zone, Southern Ethiopia

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ABSTRACT

The study was conducted at Bonke-Geresse District of Gamo Zone, Southern Ethiopia with the objectives of assessing the availability of feed resources in terms of quantity and quality and feeding practices of livestock. The district was stratified into three distinct agro-ecologies. A total of 138 farmers were randomly selected based on the probability of proportional sampling by means of a structured questionnaire. Direct field observation was also used in the collection of data.The major feed types used by farmers were identified and categorized into five classes: natural pasture grazing, green feeds, hay, concentrate (commercial mix and agro-industrial by-products) and non-conventional feed resources. The total Data were analyzed using statistical Package for Social Sciences version 20. Chemical analysis on crop residues indicated that they have low crude protein (2.66 to 6.7) and are composed of high lignin content ranging from 8.42 to 16.83. The major constraints related to livestock feed were shortage of feed, shortage of grazing land, poor market access, lack of sample awareness on forage cultivation and poor feeding system. Overall feed balance in terms of DM yield per year to a total TLU value of 7,068.8 was found to be 12,947.51 tons of DM per annum with negative feed balance of 5,878.71tons. Based on the findings of the present study, low productive and reproductive performances of livestock at Bonke are clearly associated with meager availability of feed resources. Therefore, introduction and adaptation of alternative feed production technologies such as development of improved forages, feed processing and conservation technologies, skill improving training and efficient feed utilization strategies would be taken as important steps to overcome the prevailing feed supply problem.

Keywords: Agro-ecology, chemical composition, crop residues, feed utilization, natural pasture

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1. INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa (CSA, 2013). This livestock sector has been contributing a considerable portion to the economy of the country, and still promising to rally round the economic development of the country. Livestock also plays an important role in providing export commodities, such as live animals, hides and skins to earn foreign exchanges to the country. Furthermore, livestock provides farmyard manure that is commonly applied to improve soil fertility and also used as a source of energy (CSA 2012/13).

The livestock-feeding system of the country is ineffective and mainly based on overgrazed natural pasture, crop aftermath and poor quality crop residues. The use of improved forages and agro-industrial by products is minimal in rural areas (Benin *et al*., 2004; Alemayehu, 2005). According to Assefa *et al*. (2014), the fast-growing human population created high demand for crop land aimed at increasing the production of human food. Feed shortages and nutrient deficiencies have become more acute in the dry season in both the highlands and lowlands of the study area. Accordingly, this study was conducted to assess the availability of feed resources in terms of quantity and quality and to identify the existing feeding systems of livestock in the study area.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was carried out at Bonke-Geresse District of Gamo zone, Southern Ethiopia. The district is located at 54 km west of the Arba Minch. Bonke-Geresse is one of the districts in Gamo zone and bordered with Derashe and Alle districts in the south, with Weito River in the south, with Deramalo in the northwest, with Dita inthe north and with Arba Minch Zuria district in the east .

2.2 Sample Size and Sampling Techniques

A multistage sampling technique was employed to select the study *kebele*s and households. In the first stage, the study area was stratified into three based on the agro ecological differences. In the second stage, a systematic random sampling technique was used to select study *kebeles* from each agro ecology. From each agro ecology, 2 *kebele*s were selected based on the local and cross breeds livestock farming potential, information on feed shortage frequency, farmers' motive and preference to improve feeding system. In the third stage, the simple random sampling technique was also applied to select households from each selected *kebele*. The sample size from each *kebele* was determined based on the proportion to the total household population in each selected agro-ecology. Thus, a total of 57, 46 and 35 households from highland, midland, and lowland were selected, respectively. The total sample size for household interview was determined using probability proportional to size sampling technique (Cochran, 1977).

2.3 Feed sample preparation for quality assessment

Samples were collected from grazing sites using 0.5m × 0.5m quadrants placed randomly. The representative samples of five major straws of crop residues and three major stubles tree species which were used as major livestock feed resources and accepted as highly desirable by communities in the study districts were included to laboratory evaluation. Samples were also collected from three different grazing types (private, communal and river/road side) in dry and rainy seasons. Two samples of hay from standing and cut, five samples of fodder trees and one sample of *Ensete ventricosum* were collected. Crop residues (maize, teff, sorghum, field pea, wheat, faba bean and barely) were collected. Thereafter, the same samples taken from the different grazing areas were bulked and thoroughly mixed, and sub-samples were taken for laboratory analysis. The sub-samples taken from bulked samples were dried in an oven at 105Co for 16 hrs. Then dried samples were grounded in a Wiley mill with a 1mm sieve.

2.4. Feed Balance Estimation

The quantity of feed resources was estimated using grain yield (FAO, 1987). A utilization factor of about 90% and 10% for other purposes like fuel and wastage was used. The quality of various crop residues is determined by the protein and energy or digestible dry matter (DDM) content of the particular residue, because these are the nutrients most important to livestock performance.

2.5 Chemical Analysis of Feed Samples

Chemical analysis of feedstuffs was performed at nutrition laboratory of College of Agricultural sciences, Arba Minch University, and in Debre Zeit Agricultural Research Center. Feed samples were analyzed for DM and ash contents according to AOAC (1980). Nitrogen was determined by micro-Kejeldhal method. Then, crude protein (CP) was calculated as N x 6.25 (AOAC, 1980).

Neutral detergent fibers (NDF) were analyzed according to the method developed by Van Soest *et al* (1991) while analysis for acid detergent fiber (ADF) was made following Van Soest and Robertson (1985). Metabolisable Energy (ME) and Digestible Crude Protein (DCP) content of feeds were estimated from IVDOMD and CP contents, respectively, as per the following equations:

ME (MJ/kg DM) = 0.015 × IVDOMD (g/kg) (MAFF, 1984).

DCP (g) = 0.929×CP (g) -3.48 (Church and Pond, 1982).

2.6 In vitro Dry Matter Digestibility

In vitro dry matter digestibility (IVDMD) was determined according to procedures of Tilley and Terry (1963). Representative samples from crop residues, natural pasture and *enset* were dried in an oven at 65 °C for 72 hours. The dried materials were grounded to pass through 1 mm sieve for *in vitro* dry matter digestibility. About 0.5 g of the samples was incubated in 125 ml flasks containing rumen fluid-medium mixture for 48 hours in a water bath maintained at 39°C. This was followed by a 24 hour acid-pepsin digestion phase at 39°C, under anaerobic conditions. The DMD was calculated according to Galyean (2010) as follows: IVDMD (%) = 100 x [(Initial dry sample wt - (Residue -blank)) /initial dry sample wt.].

2.7 Statistical Analysis

Data were analyzed using statistical package for social sciences version 20. One way Analysis of variance was employed for analysis of numerical data collected whereas chi-square test procedure was used to compare binomial data. Means were separated using Tukey HSD test and were considered significant at $P < 0.05$. The data were presented using tables, figures, percentages, means and standard errors.

3. RESULTS AND DISCUSSION

3.1 The demographic characteristics of respondents

The average age of the interviewed HH heads was 36.3 ± 1.23 years, and it ranged from 22 to 72 (Table1). There was no significant difference (P > 0.05) in the average age and family size of the

HHs among the different agro- ecologies. On the other hand, the average size of family members with <5 years old was higher (P<0.05) for mid-altitude and low land agro-ecology.

Table1. The demographic characteristics of the respondents

Variables		Agro-ecology (mean ± SEM)				
		Highland (n = 57)	**Mid-altitude (n = 46)**	**Lowland (n = 35)**	**Overall (n = 138)**	***P***
Sex of HHs (%)	M	70%	70%	70%	70%	
	F	30%	30%	30%	30%	
Age of HHs (year)	Range	22 – 50	22 – 58	22 – 72	22 – 72	
	Average	39.2±10	36.2±1.16	33.6±1.49	36.3±0.74	Ns
Family size	Range	2 – 15	4 – 14	3 – 12	2 – 15	
	Average	7.58±0.37	7.55 ± 0.37	7.55 ± 0.39	7.56 ± 0.21	ns
Average Number of family in age/year	< 5	0.88±0.16[b]	1.38 ±0.17[a]	1.65 ±0.18[a]	1.30 ±0.1	*
	5-15	3.25 ±0.26	2.75 ±0.29	2.60 ±0.24	2.87 ±0.16	ns
	16-45	3.08 ±0.22	3.08 ±0.26	3.03 ±0.2	3.06 ±0.13	ns
	> 45	0.35 ±0.08	0.38 ±0.12	0.33 ±0.1	0.35 ±0.06	ns

Variables	Level of education (%)				
	Highland (n = 57)	**Mid-altitude**	**Lowland (n = 35)**	**Overall (n =**	**P**
Illiterate	27.5	17.5	10.0	18.3	**
Basic education	5.0	15.0	5.0	8.3	*
Elementary	27.5	15.0	45.0	29.2	**
Junior secondary	32.5	40.0	32.5	35	**
High school	5.0	12.5	7.5	8.3	*
Higher education	2.5	-	-	0.9	-

HH, household; SEM, standard error of means; [a, b,c] Means in the same row for each parameter with different superscripts are significantly different (P <0.05); *P <0.05; ns, non-significant difference (P>0.05)

The number of illiterates was higher in highland than those in mid-altitude and lowland agro ecologies (*P*<0.01). From the interviewed respondents, around 35 % are graduates of junior secondary school while 29.2 % attended elementary school. Among the interviewed HH heads, 81.7 % were literate while 18.3% were illiterate mid-altitude and lowland agro-ecology.

3.2 Land holding and Use Pattern

The survey result indicated that the average land holding per household in the study area was 1.65 ± 0.11 ha, and it was significantly higher (P<0.05) in lowland and mid-altitude than Highland agro-ecology (Table 3). The land allocated for crop production and animal grazing in the lower altitudes was smaller than higher and mid altitudes and this could be due to the availability of smaller size of land per household in the lower altitude. Bedasa (2012) reported that the amount of land size allocated for crop production was 1.7 ha (70%) and grazing land was 0.4 ha (16.6%) in Jeldu district, west shewa zone. The average private grazing land was 0.21 ± 0.02 ha per household, and this accounted for only 12.73% of the average total land holding. The average private grazing/pasture land holding was significantly (P< 0.05) higher in mid-altitude compared to highland agro-ecology.

Table 3. Average (M ± SEM) land holding and use patterns of the households in the study area.

Land allocation (ha)	**Highland**	**Mid-altitude**	**Lowland**	**Overall**	**P**
Total land	1.17 ± 0.09^{b}	1.83 ± 0.17^{a}	1.96 ± 0.26^{a}	1.65 ± 0.11	*
Homestead/backyard	0.25 ± 0.02^{b}	0.35 ± 0.03^{a}	0.39 ± 0.04^{a}	0.33 ± 0.02	*
Crop production	0.43 ± 0.07^{c}	8.84 ± 0.10^{a}	0.9 ± 0.15^{b}	0.91 ± 0.07	**
Forage production	0.06 ± 0.01	0.05 ± 0.02	0.03 ± 0.01	0.04 ± 0.01	ns
Private grazing land	0.15 ± 0.02^{b}	0.29 ± 0.04^{a}	0.20 ± 0.04^{a}	0.21 ± 0.02	*
Forest cover	0.05 ± 0.02	0.07 ± 0.02	0.04 ± 0.02	0.05 ± 0.01	ns
Vegetable production	$13\times10^{-4} \pm 15\times10^{-4b}$	$2\times10^{-3} \pm 2\times10^{-3b}$	0.11 ± 0.06^{a}	0.04 ± 0.02	*

^{a,b,c} Means with different superscripts within a row are significantly different (P< 0.05); ns, non-significant

The study also showed that, although there was difference in terms of management and use, there was a communal grazing land across the 3 agro-ecological zones (Table 4). In the highlands, the communal grazing land (also known as *Bonke-Halila (Kallo))* was used by a group of farming community, according to focus group discussion with this group, *Bonke-Halila (Kallo)* is reserved for wet season (June- September) to let their animal grazes during *Meskel* (*Masqqala*) holiday festivity. Since the society has bylaws/common consensus on the use of grazing land together, nobody sends his/her livestock to the area from June to half of September.

The dominant crops grown in the study area showed slight variation among the different agro ecologies (Table 4). Thus, farmers in the lowland area allocate more land (P<0.05) for the cultivation of teff and maize compared to those in mid-altitude agro-ecology. The dominant crops in the highland area included barley, wheat, vegetables and fruits (apple). Whereas sorghum production was higher in mid-altitude (0.11 ha) compared to lowland. The average land area allocated for barley (0.19) hectare and wheat (0.3 ha) were significantly (P<0.05) larger in highland than two agro-ecologies.

Table 4. Major food crops grown and average area (mean ± SE) coverage (ha) per crop

Parameters (ha)	Highland	Mid-altitude	Lowland	Overall	P
Teff	-----	0.5 ± 0.05[b]	0.6 ± 0.07[a]	0.5 ± 0.06	*
Maize	-----	0.28 ± 0.04 [b]	1.1± 0.12[a]	0.6 ± 0.08	*
Sorghum	-----	0.11 ± 0.02 [a]	0.05 ± 0.01[b]	0.06 ± 0.01	*
Haricot bean	-----	0.02 ± 0.01[b]	0.09 ± 0.02[a]	0.06 ± 0.15	*
Barley	1.12± 0.03[a]	0.11 ± 0.02[b]	0.07 ± 0.02[b]	0.61± 0.01	*
Wheat	0.30 ± 0.03[a]	0.18 ± 0.05[b]	-----	0.24 ± 0.04	*
Faba bean	0.04 ± 0.01[a]	0.01 ± 0.01[b]	-----	0.01 ± 0.05	*
Field Pea	0.06 ± 0.01[a]	0.03 ± 0.05[b]	-----	0.04 ± 0.03	*
Irish potato	0.18 ± 0.02[a]	0.001 ± 0.01[b]	-----	0.05 ± 0.01	*
Enset	0.29±0.01[b]	0.46±0.02[a]	-----	0.37±0.01	*

[a, b] Means with different superscript within a row are significantly different (P< 0.05), *P<0.05; ns non-significant

3.3 Livestock Ownership of the Respondents

The average number of local cattle and chicken per HH was higher (P<0.05) for lowland and mid-land agro-ecology compared to highland (Table 5). On the other hand, the average numbers of crossbred cattle and exotic chicken holding per HH was higher (P<0.05) for highland compared to mid-altitude and lowland agro-ecologies. The average number of sheep per HH was higher (P<0.05) in highland and mid-altitude than in lowland agro-ecology. On the other hand, the average number of goats holding per HH was higher (P<0.05) for low land compared with highland and mid-attitude. Farmers in the lowland own more (P<0.05) traditional bee hives compared to highland areas.

Table 5. Livestock species and ownership (mean ± SEM) of the households

Livestock species	Livestock Structure in altitude zones, TLU				
	Highland (n = 57)	**Mid-altitude (n = 46)**	**Lowland (n = 35)**	**Over all**	***P***
Livestock	5.76+0.40	6.82+0.7	6.75+0.50	6.44+0.53	ns
Local cattle	1.21 ± 0.23[b]	6.15 ± 0.55[a]	6.2 ± 0.56[a]	4.52 ± 0.34	*
Cross bred cattle	3.6 ± 0.61[a]	0.06 ± 0.05[b]	0.0 ± 0.0[b]	1.19 ± 0.26	*
Total cattle	5 ± 0.74	6.23 ± 0.58	6.2 ± 0.56	5.81 ± 0.36	ns
Sheep	0.41 ± 0.07[a]	0.33 ± 0.08[a]	0.05 ± 0.02[b]	0.26 ± 0.04	*
Goat	0.01±0.01[b]	0.03 ± 0.01[b]	0.11 ± 0.03[a]	0.05 ± 0.01	*
Equine*	0.35 ± 0.09	0.23 ± 0.07	0.39 ± 0.11	0.32 ± 0.05	ns
Local chicken	0.01 ± 0.03b	0.04 ± 0.04[a]	0.05 ± 0.01[a]	0.03 ± 0.01	*
Exotic chicken	0.02 ± 0.07[a]	$1x10^{-3}$ ± $9x10^{-4}$[b]	$1x10^{-4}$ ± $9x10^{-5}$[b]	$1x10^{-3}$ ± $2x10^{-3}$	*
Bee colony (*traditional hive, no*.)	0.2 ± 0.1[b]	1.43 ± 0.32[ab]	1.23 ± 0.48[a]	0.95 ± 0.2	*
Mean total	5.53 ± 0.84	6.66 ± 0.66	6.59 ± 0.63	6.46 ± 0.41	ns

[a,b] means with different superscript within a row are significantly different (P< 0.05); *equine included horse, mule and donkey, *P<0.05; ns; non-significant

3.4 Crop residues Production and Utilization

The most common crop residues included in livestock feed and their estimated quantity are presented in Table 6. These residues can and do provide a sizeable contribution to the total available feed supply for livestock production in the studied area. The major crops grown by farmers in the high altitude zone of the district are barley and wheat while tef and wheat are the main crops grown in the medium altitude zone.

Maize and sorghum are the dominant crops grown in the low altitude zone. Barley and Tef constituted the largest share of crop residue fed to livestock. The availability of each type of crop residue varied among the altitude zones, this could be due to the climatic requirement of the different crops, and the area allocated to each crop by the farmers.

Table 6. Livestock types and their percentage composition in the district

Livestock species	Population	TLU equivalent*	Population (TLU)	Share (%)
Cattle	155,029	0.7	108,520.3	81.14
Sheep	103,315	0.1	10,331.5	7.72
Goat	92,693	0.1	9,269.3	6.93
Donkey	73	0.5	36.5	0.02
Horse	4290	0.8	3,432	2.56
Mule	1983	0.5	991.5	0.74
Poultry	108492	0.01	1,084.92	0.81
Camel	28	0.1	2.8	0.002
Total			133,668.82	100

Source: Bonke district Agriculture and Rural Development Office

3.5 Feed Balance Estimate

The estimated amount of crop residues and the contribution of other feeds (grazing lands, stubbles and fallow lands) produced were estimated to be 131581 and 98525 tons per annum, respectively (Table 7). The daily DM requirement for maintenance of one TLU is estimated to be 2.5% of the body weight (ILCA, 1991) which is 250 x 2.5% = 6.25 kg DM daily or 2.28 t DM per year and, thus, the annual maintenance requirement was about 304764.9 tDM. Hence, the annual feed supply on a year basis is estimated to satisfy 75.5% of the maintenance requirement of livestock in the study districts meaning that feed deficiency is clear in the study districts. Therefore, in order to increase livestock production and productivity, the problems related to livestock feeds and feeding must be resolved.

Table 7. Estimated quantity of feed DM obtainable from crop residues across altitude zones

Types of crops	Crop yield (*quitals*)	Conversion factor	Crop residue yield (*tons*)
Barley	12525	1.5	18787.5
Wheat	1867	1.5	2800.05
Tef	20713	1.5	31069.5
Maize	25816	2.0	51632
Sorghum	10917	2.5	27292.5
Total	71,838		131,581.55

The total available feed (tons DM) was estimated to be about 230106 per annum (Figure 1). The feed requirement of each herbivore was estimated to be 133668.8 TLU

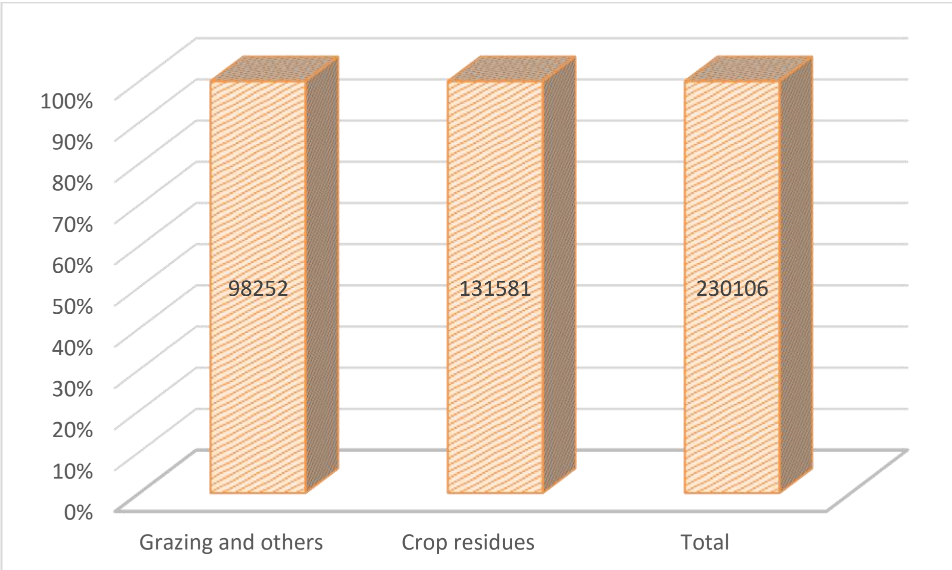

Figure 1. Estimated supply of feed DM obtained from different land types per annum

3.6 Chemical Composition of Main Feed Resources

The chemical composition, *in vitro* dry matter digestibility, metabolizable energy and digestible crude protein contents of the major feed resources is presented in Table 8. Standing hay had a relatively lower (5.8%) CP content than that of hay (6.02%) and the CP content of the standing hay was comparable to the 6.6% reported for the Ethiopian highlands by Leulseged and Jemal (1989). The CP content of hay in the present study was equal to the minimum level (7%) of nitrogen required for optimum functioning of rumen microorganism (Van Soest, 1982). The results of this study in general agree with the general statement made by Preston and Leng (1986) that all cereal straws have low nitrogen content and are composed of cell wall components with little soluble cell contents. The stubbles of barely, field pea, and wheat had a lower CP content than that of their corresponding straws and this is due to the low leaf to stem ratio of the crop stubble, which is similar to the study of Orskov (1988) and Solomon (2004), who found a significant contribution of leaves to CP content of crop residues. The average ash content of samples taken from different grazing types in the different altitude zones were 11.7%. Generally, the ash content of natural pasture decreased as a stage of harvesting of the plant advanced and this finding is in line with the report of Yihalem (2004). According to Singh and Oosting (1992), a feed with the NDF content greater than 65% is categorized as a low-quality feed that could affect intake and productivity of animals. In general, the feedstuffs under study had high fiber content, which is a limitation to intake and animal production.

The percentage level of ADF on leaf and leaf midribs of enset (*E. ventricosum*) was as low as 38.34% in highland, 39.18% in mid altitude and which is lower than the higher limit category (40%) of ADF for high-quality roughages (Kellems, 1998) and the leaf and leaf midribs of enset can possibly be grouped under high quality roughages used in livestock particularly in cattle feeding The energy value contained in leaf and leaf midribs of enset (*E. ventricosum*) from highland and mid altitude agro-ecological zones, respectively were 0.873 MJ/kg DM, and 0.907 MJ/kg DM. The observed variations on the value of energy content of leaf and leaf midribs of *enset* among agro ecologies could probably be associated with differences in the agro ecology and the type of *enset* landraces (clones) grown in each agro-ecology.

Table 8. Nutritional values of feed type present in three AEZs of the study area

	Chemical composition of feedstuffs (%)						Nutritive value of feedstuffs		
Feed types	**DM**	**AS**	**CP**	**NDF**	**ADF**	**ADL**	**IVDMD**	**ME (MJ /kg DM)**	**DCP(g/kg)**
Straw:									
Tef	93	8.13	5.2	86.6	69.3	9.32	57.9	0.87	1.32
Barely	93	8.68	4.24	88.2	74.6	9.57	60.2	0.9	0.46
Field pea	94	6.55	5.73	66.3	51.1	16.8	53.9	0.8	1.84
Wheat	93	10.1	4.04	87.9	78.7	8.42	60.1	0.9	0.27
Faba bean	94	7.61	5.74	64.5	51.5	15.4	52	0.78	2.78
Stubbles:									
Barely	93.	5.21	2.66	78.7	77.9	9.52	57.1	0.87	-1.01
Field pea	92.	4.51	3.98	68	50.8	15.8	35.7	0.55	0.22
Wheat	93.	5.32	3.58	89.5	81.5	8.36	63.5	0.94	-0.15
Hay:									
Cut hay	93.	11.7	4.02	81.1	46.7	6.90	50.06	0.75	3.04
Standing hay	93.	9.31	5.60	88	53.7	8.5	48.30	0.73	1.63
Natural pasture:									
PGL	92.	13.2	9.04	75.3	39.6	7.45	54.1	0.82	4.92
CGL	91.	11.2	11.6	73.9	40.8	7.39	57.6	0.87	7.32
RGL	92.	12.3	11.2	77.8	46.2	7.6	46.9	0.70	6.93
E. ventricosum:									
Highland	92.	7.12	11.7	64.9	38.3	6.37	58.2	0.87	7.47
Midland	92.	7.31	9.34	61.1	39.2	6.31	60.45	0.91	5.19

DM = dry matter; NDF = neutral detergent fiber; CP = crude protein; ADF = acid detergent fiber; NDF = Neutral detergent fiber, IVDMD = *in vitro* dry matter digestibility, ME= Metabolizable energy, DCP = Digestible crude protein, NP = natural pasture, PGL= Private Grazing Land, CGL= communal Grazing Land, RGL= River/ Road side Grazing Land.

4. CONCLUSIONS

Native pastures, crop residues, grazing of crop stubbles and fallow lands were the majors feed resources in the area. The growth of human population and small land holdings have resulted in perilous feed shortage and overstocking. The feed deficit observed in the study area could be one of the contributing factors affecting livestock productivity. In the area, insufficient supply and poor quality of feeds constitute the major technical constraint to livestock production. It is necessary to do a big effort to overcome feed shortage through proper conservation and utilization of hay and crop residues. Therefore, introduction of potential forage production, improvement of the feed resource through different techniques and supplementing the livestock with other feed resources should be practiced to optimize livestock production. Regardless of feed resources availability, the results of the study of utilization practices indicated that the livestock ownership per household was higher in mid altitude zone than in the low altitude zone. The estimated balance between supply of feed resources and feed requirements differ between regions, pointing to the need to identify the underlying causes for this differences and adaptation of livestock to feed insufficiency throughout the year.

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Conflict of Interests

The authors stated that there was no conflict of interest.

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