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Study on Livestock Feed Resources, Biomass Production, Feeding System and Constraints of Livestock Production in Relation to Feeds in Weliso District, South West Shoa Zone, Ethiopia

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Abstract

The study was undertaken to contribute information on livestock feed resources, biomass production, feeding system and constraints of livestock production in relation to feeds in Weliso district, south west Shoa zone; which is, agro-ecologically classified into highland (60%) and midland (40%). Based on the availability of various livestock feed resources and high number of livestock populations, six kebeles (three kebeles from each agro-ecology) were purposively selected. A total of 175 representative sample farmers (94 from highland and 81 from midland) were randomly selected for an interview. Data were collected by formal interview method using semi-structured questionnaire; and all the collected data were analyzed by statistical package for social science (SPSS) software version 20.0. Crop-residues (34.49%), shrubs and fodder trees (12.02%), stubble grazing (6.26%) and non-conventional feeds (4.46%) were the principal dry season livestock feed resources reported in the study area in their descending order of magnitude. Whereas in wet season, the principal livestock feed resources were natural pastures (32.75%) which include communal grazing land (11.48%), private grazing land (10.12%), fallow grazing land (8.64%) and road side (2.51%) and improved forages (0.58%). 0.44t/ha, 0.284 t/ha, 0.08t/ha were the average biomass produced from private grazing land, whereas 0.57t/ha, 0.06t/ha, 0.04t/ha were the average biomass produced from communal grazing land from grasses, legumes and herbaceous, respectively in highland. Whereas in mid altitude area, 0.44t/ha, 0.08t/ha, 0.07t/ha from private grazing land and 0.48t/ha, 0.02t/ha and 0.05t/ha from communal grazing lands were the average biomass produced from grasses, legumes and herbaceous, respectively.

About 2.8 ± 0.03 and 0.94 ± 0.02 tons in highland and 0.50 ± 0.05 and 1.60 ± 0.07 tons in midland were the mean annual dry matter produced per household from private grazing land and communal grazing land, respectively. The total dry matter produced from private and communal grazing land was significantly different at ($p < 0.05$) between the two agro ecologies of the study area. The average annual dry matter production obtained from fallow land was 0.92 ± 0.01 and 0.70 ± 0.05 tons per household in highland and midland, respectively. While, 0.54 ± 0.01 and 0.31 ± 0.02 tons per household was the annual dry matter production obtained from roadside grazing land in high and mid land, respectively. The biomass dry matter yields of fodder trees and shrubs were 6.35 - 25.69kg/ tree and 1.18 - 2.36kg/shrub in highland; and 8.04 - 36.06kg/tree and 1.78 - 3.98kg/shrub in midland. As the current result indicated, the use of improved forages as livestock feed resources was not well adopted by farmers in both agro ecologies, and 1.48% in highland and 0.67% in midland was the proportion of improved forages available in the study area. In the study area, about 67%, 13%, 16% and 4% of respondents fed their animals in free grazing, tethering, split feeding, and cut and carrying system, respectively. Inefficient utilization of livestock feed resources, shortage of grazing land, land degradation, low biomass yield, weak adoption of improved forage production, shortage of family labor and poor extension service in the area were among the constraints hampering livestock production in relation to feeds. Conclusively, improper utilization of available livestock feed resources in the study area could be one of the contributing factor affects livestock productivity. Therefore, improving the way of feeding, improving digestibility of fibrous feeds, like crop residues through refining harvesting time and storage as well as feed treatment should be employed.

Keywords: Biomass; Constraint; Feed resources; Feeding system; Livestock; Weliso

Introduction

Ethiopia is home for diverse livestock populations, numbering 60.39 million cattle, 32.74 million goats, 31.30 million sheep, 2.01 million horses, 8.85 million donkeys, 0.46 million mules, and 1.42 million camels and about 60.04 million poultry [1]; parallel to its diverse ecology, production systems and ethnic communities. However, the current levels of contributions of the livestock sector in Ethiopia, at either the macro or micro level is below potential. The levels of foreign exchange earnings from livestock and livestock products are also much lower than would be expected, given the size of the livestock population [2]. This may be due to various constraints, among issues related to feed are the most remarkable ones [3]. For instance, the limited feed supply and poor qualities of the available feeds [4,5]; the progressive decline of average grazing land in response to rising human populations, encroachment of cropping land, and expansion of degraded lands [6] and poor grazing management [7] are among the feed related constraints hampering livestock production and productivity.

In Ethiopia, livestock feeds are mainly obtained from natural pasture, crop residue, marginal pasturelands, and food and vegetable refusal; and to some degree from agro- industrial by products, improved pasture and forage species [8]. Natural pasture is characterized by seasonal fluctuation in total dry matter (TDM) production and nutritional quality because of the distinct seasonal variation in plant growth, in relation to the annual rainfall pattern. Crop residues are a fibrous and high in lignin content, which limit the feeding value [9,10] and low content of essential nutrients (proteins, energy, minerals and vitamins) and low digestibility and intake. They hardly fulfill even the maintenance requirements of animals for essential nutrients [11]. The quality and quantity of feed supply for livestock in the highlands and mid altitude areas is subject to great seasonal variation. An excessive supply of feed during the rainy season is usually followed by a deficit in grazing in the following dry season [12]. According to ELDMPs [13], even during normal years there is always a deficit of 35% in feed supply and this Figure 1 rises to 70% during drought years.

According to [14], assessment of the type, quantity and quality of available feed resources in relation to livestock requirement has not been yet well addressed in most livestock production areas of the country. To obtain improvement in animal production and productivity, an assessment should be done on the types and sources of livestock feed resources, total DM feed production of the area and livestock feed requirement [15]. Understanding about type of available livestock feed resources, biomass, feeding system and constraints in relation to feeds are

Figure 1: Map of the study area.

important for improving productivity of livestock and providing appropriate knowledge to smallholder farmers; which helps them to enhance feed supply and design the feeding alternatives during worse season of the year to mitigate the livestock feed shortage.

For optimum livestock productivity, the available feed resources should match with the number of animals in a given area. To this effect, comprehensive survey of the types of major livestock feed resources, alternative uses and identifying constraints of livestock production in relation to available feeds is, therefore, the crucial study that has not yet been investigated and largely unknown in the study area. Thus, this study was endeavored to fulfill this gaps.

Materials and Methods

Description of the study area

The study was carried out in Weliso district, south west Shoa zone of Oromia regional state. The district is located at a distance of 114km to south west of Addis Ababa, the capital city of the country. Astronomically, it is located at latitude and longitude of 08°25' 56"N and 034°33'41"E. It has a total (41,581.5 hectares) area of land and bounded by Dendi and Dawo districts in the north; Saden Soddo and Becho districts in the south east and east; Wonchi district in the northwest and Goro district in the west. It comprises 22 rural kebeles administrations and two towns, Weliso and Dilala [16]. Agro-ecologically, the district is classified into highland (60%) and midland (40%); and receives the average annual rainfall of 1350mm which is in summer season from June to August. It receives the maximum and minimum temperature of 27 °C and 18.7 °C, respectively. The area is located at altitude ranges from 1500m to 2500 meter above sea level [16].

Sampling Procedure and sample size

The district was stratified into two agro-ecological zones, high altitude >2500 m.a.s.l, and mid altitude 1500–2500

m.a.s.l [17].Then based on the availability of various livestock feeds resources and high populations of livestock potential, six kebeles from both agro-ecologies were purposively selected. By using random sampling technique, household respondents who were engaged in livestock production were selected and interviewed. The representative sample size was determined by using the formula given by [18] with 95% of confidence interval as follows:

$$no=(z^2 p(1-q))/d^2(1)$$

Where, n is the sample size,
 Z is standard normal deviation (1.96 for 95 confidence level)
 P is 0.15 (population variability i.e. 15%)
 q is 1-P i.e. (0.85)
 d is degree of accuracy desired (0.05)

According to [18] use the following correction factors if the population is less than 10,000 for finite populations.

$$n_1=no/(1+ no/N) = 196/(1+ 196/1671) =175$$

Finally, by using the households listed from the selected kebeles, 175 representatives sample farmers were taken. And the number of respondents per single Kebele was selected by:

$$W= (A/B) \times No$$

Where,
 W = sample of respondents determined per single Kebele

A= Total number of household living in a single selected Kebele

Table 1: The proportion of households selected from agro ecologies for interviews [16].

Name of selected kebeles	Total number of Households	Proportion of households	Number of sample households
	1671	1	175
High altitude	901	0.53	94
D/Jebo	420	0.25	44
K/simala	280	0.16	29
M/Babali	201	0.12	21
Mid altitude	770	0.46	81
O/Kojii	260	0.15	27
B/Koricha	320	0.19	34
X/Anchabi	190	0.11	20

B = Total sum of house hold living at all selected sample kebeles

$$No= \text{Total required sample size [19]}$$

Accordingly, 94 households from highland and 81 from midland agro-ecological zones were randomly selected for an interview Table 1.

Methods of Data Collection

The required data according to the objective of the study were collected by using primary and secondary data sources. Pre-tested semi-structured questionnaire and field observation were used to collect the primary data. To strengthen the survey data, focus group discussion was held with individuals who have knowledge and experience on livestock production. In addition, key informant interviews were made with Districts’ Livestock and Fishery Resource Development Office experts and Development Agents (DAs). Then, secondary data were collected from zonal and districts agricultural offices, published journal articles, reports and other relevant documents.

Statistical Analysis

The collected data was organized and analyzed with the help of Statistical Package for the Social Sciences [20] and reported by descriptive statistics (frequency, mean and percentage).

Results and Discussion

Land Holding and Land Use Pattern

Table 2: Average land holding and use patterns per household in study area (ha)

P-value = 0.05, N = number of respondents, SE = Standard Error

Types of land use	High altitude	Mid altitude area	Over all	p-value
	N=94	N=81	N=175	
	Mean ± SE	Mean ± SE	Mean ± SE	
Crop land	1.52±0.07 ^b	1.65 ± 0.10 ^a	1.58±0.08	<.001
Private grazing land	0.57±0.03 ^a	0.43± 0.06 ^b	0.50± 0.04	<.002
Communal grazing land	0.17± 0.35 ^b	0.78 ± 0.02 ^a	0.23 ± 0.18	<.001
Fallow land	0.43±0.08 ^a	0.28 ±0.05 ^b	0.35 ± 0.06	<.001
Roadside	0.06±0.01 ^a	0.01±0.01 ^b	0.03± 0.01	<.036
Forest land	0.06±0.02 ^b	0.20 ± 0.02 ^a	0.13 ±0.02	<.012
Woody land	0.04±0.14 ^a	0.03 ± 0.01 ^a	0.03± 0.07	<.218
Total	2.85± 0.05 ^b	3.38±0.17 ^a	3.12 ±0.11	<.0001

The total land holding of the respondents was smaller in the highaltitude area (2.85 ± 0.05 ha per household) as compared to (3.38 ± 0.17 ha per household) in mid altitude area (Table 2). The average landholding of the respondents in the study area was 3.31 ± 0.11 ha/hh, which was higher than the average national landholding size (1.4 ha/hh) and Oromia region (1.7 ha/hh) [21]. Households in the mid altitude area had significantly ($p < 0.01$) larger private farm size than in high altitude. This was due to the availability of larger size of land per household in mid altitude area. Allocation of grazing land within a household depends on agro-ecologies and farming system. The private grazing land holding varies between the agro ecologies. This was due to decreased communal grazing land in high altitude area, farmers decided to separate private grazing land from own crop land area to their livestock. The results therefore, indicated that more animals are maintained on a small plot of grazing land and the bulk of the feed comes from crop residues. This has resulted in overgrazing of the small grazing land, poor biomass productivity and limited productivity potential due to poor quality of feed from crop residues. Hence, this may lead to the depletion of feed resources through overgrazing, contributing to the low productivity of livestock [22-24] and to food insecurity.

In general, the households in the study district were allocated about 1.58 ± 0.06 ha for crop production and 0.50 ± 0.04 ha, 0.23 ± 0.18 ha, 0.13 ± 0.02 ha for private grazing, communal grazing and forest land, respectively. [25] reported that the amount of land size allocated for crop production was 1.7 ha and grazing land was 0.4 ha in Jeldu district, west Shewa zone. [26] also reported the average land allocated for different crops per household was 1.55ha and private grazing was 0.04ha in Bure district, Amhara region.

The Interdependency of Crop-Livestock Production

The correlation between different parameters in the study district was presented in Table 3. The total crop land holding ($p < 0.01$, $r = 0.79$) was significant and positively correlated with total land holding, private grazing land holding ($p < 0.01$, $r = 0.30$), fallow land holding ($p < 0.01$, $r = 0.68$) and communal grazing land holding ($p < 0.01$, $r = 0.72$). Whereas roadside feed ($p > 0.05$, $r = 0.12$) was not significant but negatively correlated with total land holding in the study area. The total livestock holding per household ($p < 0.01$, $r = 0.78$) was significantly different and positively correlated with total crop land production ($p < 0.01$, $r = 0.72$), private grazing land ($p < 0.01$, $r = 0.26$), fallow land ($p < 0.01$, $r = 0.62$)

Table 3: Correlation between Different Parameters Considered in the Current Study.

****Correlation is significant at the ($p < 0.01$) level; *correlation is significant at the ($p < 0.05$) level; N=175; PGL=Private grazing land; FL=Fallow land; RS= Roadside feed; CGL=Communal grazing land; TLU =Tropical livestock unit; TDM= Total dry matter from crop residue**

Parameters	Total land holding (ha)	Total crop land (ha)	PGL (ha)	FL (ha)	RS (ha)	CGL (ha)	Live stock size (TLU)	Crop residue (TDM)
Total land holding(ha)	1.000							
Total crop land(ha)	0.887**	1.000						
PGL (ha)	0.309**	0.322**	1.000					
FL (ha)	0.676**	0.445**	0.141	1.000				
RS (ha)	-0.120	-0.251**	-0.038	-0.147	1.000			
CGL (ha)	0.787**	0.536**	0.047	0.573**	-0.032	1.000		
Livestock size (TLU)	0.795**	0.733**	0.272**	0.609**	-0.182*	0.606**	1.000	
Crop residues (TDM)	0.739**	0.893**	0.352**	0.326**	-0.223*	0.358**	0.580**	1.000

and communal grazing land ($p < 0.01$, $r = 0.62$). The result of the present study was similar with the report of [27] who observed herd size correlated with landholding, cultivated land and grazing land in the Sinana Dinsho district of Bale highland, Ethiopia. The roadside feed resources ($p < 0.05$, $r = 0.25$) was statistically significant and negatively correlated with total crop production and total livestock holding, but not with private and communal grazing land in the study area. The total DM production from crop residues ($p < 0.01$, $r = 0.68$) was highly significant and positively correlated with total crop land ($p < 0.01$, $r = 0.86$) and total livestock holding in the study area.

The positive correlation between total crop land and total livestock holding in the study area indicated that livestock contribute to increased cultivated area through provision of drought power and supply of agricultural inputs. The positive correlation between crop residues and livestock holding was as major feed resources for livestock in dry season.

Major Livestock Feed Resources Available in the Study area

The major feed resources available during the wet and dry seasons were presented in Table 4. The availability, type, quality and quantity of feed resources were varied in seasons and agro ecologies. The principal dry season feed resources

Table 4: The proportion of livestock feed resources available in wet and dry seasons of the study area

Feed resources (%)	Agro ecologies				Overall mean (%)		
	High altitude (%)		Mid altitude (%)				
	Wet	Dry	Wet	Dry	Wet	Dry	Total
Natural pasture(grazing)	36.39	4.00	29.11	1.25	32.75	3.25	36.00
*Private grazing	16.22	3.65	4.02	2.25	10.12	2.95	13.07
*Communal grazing	6.84	-	16.12	-	11.48	-	11.48
*Fallow grazing land	9.94	-	7.34	-	8.64	-	8.64
*Roadside feed resources	3.39	0.35	1.63	0.25	2.51	0.30	2.81
Fodder trees & shrubs	4.15	8.25	3.00	15.80	3.58	12.02	15.60
Non-conventional feed	-	2.38	-	6.53	-	4.46	4.46
Improved forage	0.83	0.83	0.33	0.65	0.58	0.74	1.32
Crop residues	2.50	40.67	1.24	40.84	1.87	40.75	42.62
*Crop residues	-	35.14	-	33.84	-	34.49	34.49
*Stubble crops	-	5.53	-	7.0	-	6.26	6.26

available for livestock during the study period in the study area were crop-residues (34.49%), stubble grazing (6.26%), shrubs and fodder trees (12.02%), non-conventional feed (enset, banana leaf and vegetable waste) (4.46%) in their descending order of magnitude. Whereas in wet season, the principal feed resources were natural pastures (32.75%) which includes private grazing land (10.12%), communal grazing land (11.48%), fallow grazing land (8.64%) and road side (2.51%) and improved forages (0.58%). The result was disagreed with [28] who reported that the major feeds in dry season were natural pasture (55.7%), crop residues (20.7%), stubble (14.3%) and hay (9.3%) and in wet season natural pasture is sole feed resources of livestock in Metema district of north Gondar. This might be due to difference in climatic condition and soil fertility.

The contribution of each of the feed ingredients to the diet of livestock as perceived by farmers and estimated dry matter production of each ingredient were varied between agro ecologies of the study area. Their contribution to the total feed resource base varies from area to area based on cropping intensity [29]. Generally, natural pasture in wet season and crop residues in dry season were the dominant feed resources in the study area.

Natural Pasture Feed Resources

Natural pasture was one of the major livestock feed resources in wet season, which includes grasses, legumes, other herbaceous and fodder shrubs and trees in the study

area. The proportions of private and communal grazing land were 19.87%, 6.84% and 6.27%, 16.12% in high and mid altitudes of the study area, respectively (Table 4). Ahmed et al. (2010) reported that grazing on either private grazing land (PGL) or communal grazing land (CGL) is a common practice following the onset of rain in most parts of the country. The private grazing land was significantly different at ($p < 0.01$) between high and mid altitude of the study area. This might be because of private grazing land was more practiced in high altitude area as a common source of livestock feed in wet season than in mid altitude area.

Table 5: List of the major grasses, legumes and herbaceous species identified as important to livestock feeds in study area

Scientific name	Vernacular Name (Afan Oromo)	% of respondents (n)	Edible parts	Livestock species	Type of fodders
<i>Pennisetum clandestinum</i>	Coqorsa	94.2% (165)	Leaf, twigs	Cattle, sheep, goat, donkey	Grasses
<i>Digitaria abyssinica</i>	Warati	97.1% (170)	Leaf	Cattle, sheep, goat, donkey	Grasses
<i>Pennisetum sphocelatum</i>	Migra	74.2% (130)	Leaf	Cattle, sheep, goat, donkey	Grasses
<i>Berchemia discolor</i>	Jajjaba	43.4(76)	Leaf	Cattle, donkey, horse, mule	Grasses
<i>Snowdine polystarch</i>	Gargaara	68.5% (120)	Leaf	Cattle, sheep, goat, donkey	Grasses
<i>Plantago lanceolata</i> L.	Qorxobbi	46.8% (82)	Leaf	Cattle, sheep, goat, donkey	Grasses
<i>Dignathia hirtella</i> Stapf	Qambo	33.1% (58)	Leaf	Cattle, donkey, horse, mule	Grasses
<i>Panicum hochstetteri</i> Steud.	Marga gogorri	23.4% (41)	Leaf	Cattle, donkey, horse, mule	Grasses
<i>Pennisetum purpureum</i>	Elephant grass	72.5% (127)	Leaf	Cattle, sheep, goat, donkey	Grasses
<i>Medicago burweed</i>	Siddisa	57.1% (100)	Leaf	Cattle, sheep, goat, donkey	Legumes
<i>Trifolium burchellionum</i>	Hasangira	31.4% (55)	Leaf	Cattle, sheep, goat	Other herbs
<i>Grewia bicolor</i> Juss	Haroressa	24.5% (43)	Leaf	Cattle, sheep, goat	Legumes
<i>Vigna vexillata</i> L.A. Rich.	Gurra hantuta	69.7% (122)	Leaf, twigs	Cattle, sheep, goat, donkey	Legumes
<i>Cucumis ficifolius</i> A. Rich	Facaa'a	52.5% (92)	Root	Cattle, goats	Legumes

However, in mid altitude area communal grazing land was as a common source of livestock feed in wet season than in high altitude area.

The most valued grass species identified were *Digitaria Abyssinia*, *Pennisetum clandestinum*, *Pennisetum sphocelatum*, *Snowdine polystarch* and *Pennisetum purpureum* and the legume species identified were *Medicago burweed*, *Vigna vexillata* and *Cucumis ficifolius* in both agro ecologies of study area (Table 5). Thus the above grass species were similar with Indigenous grass species reported by a number of authors in different areas

Table 6: Species Biomass Composition Production from Private, Communal, Fallow Land and Roadside Feed Resources

W/t=weight; t/ha=tons/hectare

Feed resources		High altitude				Mid altitude				Average			
		Grass	Legume	Herbs	Total	Grass	Legum	Herbs	Total	Grass	Legume	Herbs	Total
Private grazing	Fresh wt (t/ha)	1.52	1.17	0.706	3.4	1.746	0.416	0.61	2.77	1.63	0.79	0.656	3.08
	Dry w/t (t/ha)	0.44	0.284	0.08	0.80	0.44	0.08	0.078	0.605	0.44	0.185	0.079	0.705
	Biomass (%)	54.72	35.32	9.95	100	72.72	14.42	13.22	100	58.99	30.26	10.75	100.0
Communal grazing	Fresh wt (t/h)	1.95	0.36	0.36	2.68	1.98	0.125	0.365	2.475	1.97	0.24	0.362	2.577
	Dry w/t (t/ha)	0.57	0.06	0.045	0.67	0.48	0.02	0.05	0.56	0.52	0.04	0.05	0.61
	Biomass (%)	85.07	8.95	6.67	100	86.66	3.56	9.78	100	85.45	6.47	8.08	100.0
Fallow land	Fresh wt (t/h)	2.4	0.812	0.23	3.43	2.81	0.28	0.18	3.28	2.612	0.544	0.202	3.36
	Dry w/t (t/ha)	0.7	0.13	0.027	0.85	0.68	0.04	0.027	0.763	0.69	0.08	0.027	0.81
	Biomass (%)	81.29	15.48	3.23	100	90.54	5.82	3.64	100	85.64	10.94	3.42	100.0
Roadside	Fresh wt (t/h)	1.9	0.345	1.69	1.96	2.18	0.28	0.96	3.42	2.04	0.31	1.32	3.67
	Dry w/t (t/ha)	0.56	0.05	0.21	0.82	0.53	0.045	0.14	0.72	0.54	0.05	0.17	0.77
	Biomass (%)	67.68	6.71	25.61	100	73.80	6.20	20.0	100	70.56	6.47	22.97	100.0
Total	Fresh wt (t/h)	1.94	0.67	0.746	2.867	2.179	0.33	0.527	2.98	2.063	0.471	0.63	3.17
	Dry w/t (t/ha)	0.56	0.131	0.09	0.786	0.532	0.046	0.147	0.66	0.547	0.088	0.15	0.785
	Biomass (%)	68.03	20.83	11.14	100	79.40	8.62	11.98	100	73.16	15.53	11.30	100.0

[28,30,31]. According to the above authors, the availability of grasses like Snowdine polystarch and Plantago lanceolata L. species were common in degraded areas due to heavy grazing.

Species Biomass Composition from Natural Pastures

In the study area, a total of 30 species edible by livestock were identified; of these, 14 were different species of grasses while 16 were different non-grass species. Among the non-grass species, 10 species were legumes whereas 6 species were other herbs. Thus, the study area was dominated by annual grass, legume and other herb species. This was due to continues grazing pressure on limited land and poor management of natural pastures in study area. [32] suggested that overgrazing reduces ground cover, plant height, forage quality and productivity, and perennial grasses which are replaced by annual grass and herb species. The average biomass yield obtained from private, communal, roadside and fallow land in the study area was presented in Table 6. The average biomass production of grasses, legumes and herbaceous were 0.44t/ha, 0.284 t/ha, 0.08t/ha, respectively from private grazing land and 0.57t/ha, 0.06t/ha, 0.04t/ha from communal grazing land in high altitude area. Whereas in mid altitude area, 0.44t/ha, 0.08t/ha, 0.07t/ha from private grazing land and 0.48t/

ha, 0.02t/ha and 0.05t/ha from communal grazing land, respectively. The heavy and continuous grazing pressure might decrease biomass production in mid altitude area as compare to high altitude of the study area.

Alemayehu [33] reported that overgrazing might be the main factor for the decline in the composition and diversity of plant species over a long period of time. In general, the average dry matter yield of biomass composition of grasses, legumes and other herbaceous were 0.547t/ha, 0.088t/ha

Table 7: The mean annual dry matter production from private, communal, fallow land and roadside areas of the study district (tons per household)

N=Number of respondents, SE=standard error

Grazing area	High altitude	Mid altitude	Over all mean	p-value
	N=94	N=81	N=175	
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE	
Private grazing land	2.8 $\pm$ 0.03 ^a	0.50 $\pm$ 0.05 ^b	1.65 $\pm$ 0.04	< .001
Communal grazing land	0.94 $\pm$ 0.02 ^b	1.60 $\pm$ 0.07 ^a	1.27 $\pm$ 0.045	< .001
Fallow land grazing	0.92 $\pm$ 0.01 ^a	0.70 $\pm$ 0.05 ^b	0.81 $\pm$ 0.03	< .002
Roadside	0.54 $\pm$ 0.01 ^a	0.31 $\pm$ 0.02 ^b	0.42 $\pm$ 0.015	< .037
Total	5.2 $\pm$ 0.07 ^a	3.11 $\pm$ 0.17 ^b	4.15 $\pm$ 0.12	< .0001

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and 0.15t/ha with the overall 0.785tons/ha in study area, respectively. The present result was lower than [34] who reported with the average dry matter yields of grasses, legumes and others herbs from natural pasture were 1.891t/ha, 0.399t/ha and 0.205t/ha in shifting cultivation and 1.251t/ha, 0.218t/ha and 0.216t/ha in permanent farming system ,respectively at Asosa zone of western Ethiopia. This variation might be related to low livestock pressure, soil fertility and rainfall in that area.

Quantity of Dry matter Production from Natural Pasture

The average annual dry matter production obtained from total private grazing land, communal grazing land, fallow land and roadside of the study area were presented in Table 7. About 2.8 ± 0.03 tons and 0.94 ± 0.02 ton in high and 0.50 ± 0.05 ton and 1.60 ± 0.07 tons in mid altitude area were the mean annual dry matter production per household from private grazing land and communal grazing land, respectively. The total dry matter production from private and communal grazing land was significantly different at ($p < 0.05$) between the two agro ecologies of the study area. This might be allocation of land differences for livestock feed resources. This result was greater than [35] who

Table 8: The Mean $\pm$ Se of Dry Matters Production from Crop Residues and Stubble Crops per Household (Tons).

P-value, (0.05); N=Number of house holder; SE = Standard error

Variable	Highland		Midland		Over all		p-value
	N=94		N=81		N=175		
	Mean $\pm$ SE	%	Mean $\pm$ SE	%	Mean $\pm$ SE	%	
Maize	0.91 $\pm$ 0.03	20.70	1.11 $\pm$ 0.07	30.83	1.01 $\pm$ 0.05	25.06	<.001
Sorghum	0.81 $\pm$ 0.04	17.84	0.64 $\pm$ 0.04	19.56	0.72 $\pm$ 0.04	19.21	<.001
Barley	1.45 $\pm$ 0.03	31.93	0.81 $\pm$ 0.04	24.5	1.13 $\pm$ 0.40	28.21	<.001
Teff	-	-	0.55 $\pm$ 0.02	11.27	0.27 $\pm$ 0.01	5.63	<.001
Wheat	0.9 $\pm$ 0.02	19.82	-	-	0.45 $\pm$ 0.01	9.91	<.004
Haricot bean	0.12 $\pm$ 0.01	2.64	0.18 $\pm$ 0.03	5	0.15 $\pm$ 0.02	3.82	<.001
Bean & pea	0.09 $\pm$ 0.01	1.98	-	-	0.04 $\pm$ 0.005	0.89	<.002
Sweet potato	0.06 $\pm$ 0.03	1.32	0.13 $\pm$ 0.02	3.61	0.09 $\pm$ 0.025	2.46	<.004
Vegetable	0.05 $\pm$ 0.01	1.10	0.03 $\pm$ 0.00	0.83	0.04 $\pm$ 0.005	0.96	<.049
Sesame	-	-	0.16 $\pm$ 0.04	4.40	0.08 $\pm$ 0.02	2.2	<.276
Soybean	0.15 $\pm$ 0.01	2.67	-	-	0.07 $\pm$ 0.005	1.65	<.086
Over all	4.54 $\pm$ 0.01	100.00	3.60 $\pm$ 0.19	100.00	4.03 $\pm$ 0.1	100.00	<.0001
Stubble crops	0.64 $\pm$ 0.03	-	0.72 $\pm$ 0.05	-	0.68 $\pm$ 0.04	-	<.001

reported that average dry matter production per household 0.93 $\pm$ 0.10ton, 1.58 $\pm$ 0.19 tons from private grazing land and 0.02 $\pm$ 0.01 ton, 0.10 $\pm$ 0.04ton from communal grazing land

in the two farming systems, respectively at Alaba district, southern Ethiopia. This might be due to plots of land owned by the household in study area.

Feed Resources from Fallow land

Fallow land was one of the livestock feed resources in the study area. Grasses (*Digitaria abyssinica*, *Snowdine polystarch*), legumes (*Medicago burweed*, *Vigna vexillata* L. A. Rich) were the common species in fallow land area in study area. The average quantity of annual dry matter production obtained from fallow land of the surveyed households was 0.92 $\pm$ 0.01 and 0.70 $\pm$ 0.05tons per households in high and mid altitude area, respectively (Table 8). The dry matter production from fallow grazing land was significantly different at ($P < 0.05$) between the two agro ecologies of the study area. This was due to farmers in high altitude practiced fallow land to increase soil fertility then livestock feed. The present result was greater than [36] who reported the average dry matter production per household was 0.14 $\pm$ 0.03tons at Adami Tullu Jiddo Kombolcha district of Ethiopia.

Roadside Feed Resources

In the past the main feed resources were natural pastures (especially communal grazing land), fodder trees and shrubs, and fallow land grazing. However, this situation has been changed now due to rapidly increasing human population [37] and increases the demand for food, thus pushing for a conversion of pastures into crop land [33,38,39]. Similarly, in the study area, farmers were used different mechanisms to cope up with feed shortages, allow their livestock to graze on roadside, riverside and swampy areas. The annual dry matter production obtained from roadside grazing land of the study area was 0.54 $\pm$ 0.01 and 0.31 $\pm$ 0.02ton per household in high and mid altitude areas, respectively (Table 8). The dry matter production from roadside feed resources was significantly different at ($p < 0.05$) between the two agro ecologies of the study area. This was due to greater biomass dry matter yield of roadside grazing land in high altitude than mid altitude area. The present result was disagreed with [28] who reported the total dry matter production of roadside feed resources was 2.75tons in Metema district, North Gondar. This might be related to available roadside grazing land in the area.

Feed Resources from Crop residues and Stubble grazing

Crop Residues: Crop residues were one of the dominant livestock feed resources in the study area especially during the dry season of the year. In high altitude area, the major crop residues available for livestock feeding included residues from wheat, barley, bean, field pea and

sorghum). Among the cereal crops, field pea, barley and wheat are the major crops grown in high altitude while in mid altitude area, maize, teff, and haricot bean are the major crops produced in the area. The total area of crop land and available crop residues from teff and maize in mid altitude area were significantly higher at ($p < 0.05$) than the high altitude area. This was due to teff and maize was common family food consumption in the mid altitude than in high altitude of the study area.

The quantity of DM obtained from crop residues and stubble crops were presented in Table 8. The mean annual DM production from crop residues was 4.54 ± 0.01 tons in highland and 3.60 ± 0.19 tons midland area. The total dry matter production from crop residues was significantly different at ($p < 0.05$) between the two agro ecologies of the study area. This was due to type and amount of crop production difference in agro ecologies. Overall in the study area, the total DM production from cropping system was 4.03 ± 0.1 tons per household. The result was less than [36] who reported total utilizable DM production from cropping system was 10.9 ± 1.1 and 8.5 ± 0.5 TDM per household in rural and peri urban of Adami Tullu Jiddo Kombolcha district, respectively. This might be due to intensity of cultivation, postharvest handling and efficient utilization of crop residues in the study area.

Stubble Grazing: Stubble grazing was one of the important livestock feed sources in study area. After harvesting the crops, livestock were allowed to graze stubble of different crops (maize, sorghum, wheat, teff, barley, haricot bean and others) mainly from November to January. Linear relationship existed between areas of land cultivated and types of crops produced by households except when the difference comes due to difference in production rate of the crops and height of harvest. For the first two months, the stubble is grazed by the animals of the farm owner and later it becomes accessible to all animals in the community [40].

Fodder Trees and Shrubs: Fodder (browse) was an agricultural term for animal feed, and fodder trees and shrubs are those plants (shoots, stems of woody plants with their leaves, flowers, fruits or pods) that are raised, used and managed to feed livestock. As a source of animal feeds in the study area, fodder trees and shrubs were valued by farmers during dry season. These forage species contain appreciable amounts of nutrients that are deficient in other feed resources such as grasses during dry seasons. Fodder trees and shrubs are important components of ruminant diet and they have been found to play important roles in the nutrition of grazing animals in areas where few or no

Table 9: List of Major Shrubs and Trees Species Identified as Important to Livestock Feeds in Study Area.

Scientific name	Vernacular Name (Afan Oromo)	% of respondents(n)	Edible parts	Livestock species	Type of fodders
<i>Rhoicissus tridentate</i>	Laaluu	85.71%(150)	Leaf, twigs	Cattle(calf), sheep, goats	Shrubs
<i>Acanthus polystachius Delile</i>	Sokorru	82.85%(145)	Leaf, twigs	Goats & sheep	Shrubs
<i>Teclea nobilis</i>	Gurshane	62.85%(110)	Leaf, twigs	Cattle, sheep & goats	Shrubs
<i>Combretum paniculatum</i>	Baggee	65.71%(115)	Leaf	Cattle, goats	Shrubs
<i>Myrsine africana L.</i>	Qacama dima	68.57%(120)	Leaf	Cattle sheep and goats	Shrubs
<i>Zehneria scara</i>	Hidda reffa	63.42%(111)	Root	Cattle	Shrubs
<i>Sapium ellipticum</i>	Bosoqa	94.42%(164)	Leaf, twigs	Cattle, sheep & goats	Tree
<i>Ficus sur Fossk</i>	Harbu	82.28%(144)	Leaf, pods	Cattle & goats	Tree
<i>Combretum collinum</i>	Dhandhamsa	65.71%(115)	Leaf	Cattle, sheep, goats	Tree
<i>Ficus ovate</i>	Dambi jabbi	65.12%(117)	Leaf, twigs	Cattle, sheep & goats	Tree
<i>Mcraceae (family name)</i>	Madalle	74%(129)	Leaf, twigs	Cattle, sheep & goats	Tree
<i>Ficus thonningii Blume</i>	Dambii	69.14%(121)	Leaf	Cattle, sheep & goats	Tree
<i>Albizia gumifera</i>	Ambabeessa	73.14%(128)	Steam	Cattle, sheep & goats	Tree
<i>Vernonai amygdalina</i>	Ebicha	82.71%(144)	Leaf, twigs	Cattle, sheep & goats	Tree
<i>Rubus apetalus Poir</i>	Goraa	78 %(138)	Leaf	Cattle, sheep & goats	Tree

alternatives are available.

The common shrubs and fodder trees important for potential livestock feed resources during dry season were presented in Table 9. Almost all plant species were browsed by livestock but the degree of palatability varies from season to season and species to species. The most favorable time to utilize browse in the study area was late in the dry season between late February to April, when the grazing and other feed resources are at their poorest condition or even non-existent. Cattle and sheep selected the most palatable grasses and legumes during the wet season, while goats browsed on trees and shrubs. As the herbaceous component become more abundant and nutritious during the wet season, cattle and sheep are less attracted to the browse

species. However, during the dry season, the herbaceous components are less abundant and often become more fibrous. In this season, cattle and sheep depend first on leaves and succulent twigs of browse species. As the dry season progresses, however, less palatable species are also browsed by livestock during the critical dry season.

In the study district, the most widely utilized browse species, as indicated by the interviewed households were presented in Table 9. Some of most palatable species by livestock were *Sapium ellipticum* (94.4%), *Rhoicissus tridentata* (85.1%), *Vernonai amygdalina* (82.71%), *Ficus sur Fossk* (82.28%), *Acanthus polystachius Delile* (81.8%), *Rubus apetalus Poir* (78%), *Albizia gumifera* (73.3%), and others. The result was agreed with [41] who reported the potential fodder trees and shrubs in mid rift valley of Ethiopia. The potential available resources of fodder trees and shrubs in different areas were reported by different of authors [42-45]. The contribution of browse species as a source of animal feed is influenced by a number of factors such as the natural distribution of the browses within the agro-ecological zones, the distribution, type and importance of livestock, their integration and role within the farming system and availability of alternative sources of fodder for livestock in the study district.

The biomass yield of shrubs and fodder trees in mid altitude area was higher than high altitude area of the study

Table 10: The Biomass Yields (Kg) of Selected Indigenous Fodder Trees at the 80cm Height and Shrubs at 10cm Height of the Two Agro Ecologies.

Tree species	Biomass yield/tree(kg)	Shrubs species	Biomass yield/shrub(kg)
High altitude			
<i>Sapium ellipticum</i>	13.67	<i>Rhoicissus tridentate</i>	1.51
<i>Ficus ovate</i>	14.23	<i>Combretum paniculatum</i>	2.36
<i>Rubus apetalus Poir</i>	6.35	<i>Ricinus comiunis</i>	2.06
<i>Vernonai amygdalina</i>	8.64	<i>Ficus palmata Forsk</i>	1.18
<i>Ficus sur Fossk</i>	25.96	-	-
<i>Cordial Africana</i>	11.84	-	-
Mid altitude			
<i>Ficus thonningii Blume</i>	22.68	<i>Myrsine africana L.</i>	1.83
<i>Madalle</i>	19.42	<i>Acanthus polystachius</i>	3.40
<i>Combretum collinum</i>	20.98	<i>Teclea nobilis</i>	3.98
<i>Ficus vasta Forssk</i>	36.06	<i>Coronopus didymus</i>	1.78
<i>Syzygium guineanse</i>	25.36	-	-
<i>Grewia ferruginea</i>	8.04	-	-

area. The variation among species in biomass yield suggests differences in potential biomass yield that may be associated with differences in growth of the species and availabilities. It also appeared that there was variation in biomass yield among kebeles within each species, which might be related to spatial differences and associated variation in climatic factors and soil fertility. Generally, the biomass dry matter yields of fodder trees and shrubs were 6.35 - 25.69kg/ tree and 1.18 - 2.36kg/shrub in high and 8.04 - 36.06kg/tree and 1.78 - 3.98kg/shrub in mid altitudes of the study area (Table 10). The result was lower than who reported the biomass yields of selected indigenous fodder tree/shrubs 24.55kg/ tree/shrubs to 958.76kg/tree in Wolayta zone, southern Ethiopia. This difference might be due to tree density and cutting interval since total biomass production can be manipulated by tree density and long cutting interval which results in a high DM yield per hectare.

Improved Forage Feed Resources: The use of improved forages as livestock feed resources was not well adopted by farmers in both agro ecologies of the study area. The proportion of improved forages available was 1.48% in highland and 0.67% midland, with overall 1.07% of proportion in the study area. Only few farmers in both agro ecologies of the study area had grown *Sesbania sesban*, *Leucaena*, *Vernonai amygdalina* and *Rubus apetalus* at the back yard and *Pennisetum purpureum*, *lablab purpureas* and vetch at the small plot of land used for the purpose of livestock feeds. [46] reported that oats and vetch were conventionally cultivated in arable lands either in pure stand or in mixture, while most other forage crops were established in the backyards, fence lines, field borders and stock exclusion areas.

Cultivated forage and pasture crops are mainly important as cut and carry sources of feed and as a supplement to crop residues and natural pastures [47] and higher feed quality of paramount importance in mixed crop livestock systems [25]. However, in the study area, almost all of the farmers did not established and utilized improved forages as livestock feed. According to the respondents in the highaltitude area, the reasons why they did not adopted an improved forages were lack of land to grow improved forage, shortage of improved forage seed and depends on purpose of livestock production. While in the mid altitude area, communal grazing land perception, lack of awareness and lack of improved forage seed were the potential problems identified.

Non-conventional Feed Resources: Some of the non-conventional feed resources in the study area were

Table 11: Major Non-Conventional Feed Resources Reported by Respondents in Percentages (N=175).

(**) =Not known as livestock feed; (*) not available; (-) not palatable in the season

Feed resources	Agro ecology					
	high altitude (n=94)		mid altitude (n=81)		Over all mean (n=175)	
	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
Banana steam & leaf	-	15.20	-	11.25	-	13.25
Enset	-	40.5	-	9.52	-	24.87
Mango kernel, papaya	*	11.30	6.45	14.21	6.45	12.58
Sugar cane leaf	-	4.30	2.15	10.1	2.15	7.2
Coffee pulp	**	**	**	**	**	**
Atela(local extraction)	10.00	10.20	10.6	25.7	10.3	17.95
Chat leaf	-	12.70	5.8	6.40	5.8	8.55
Pumpkin	*	6.50	*	8.70	*	7.6
Straw & pod of pulse crops	12.60	8.70	2.2	7.30	7.4	8.0

banana leaf, enset, sugar cane leaf, mango kernel, waste of local areke (Atela) and others (Table 11). Most non-conventional resources were usually regarded as waste which is an inaccurate description in the study area. Utilization of the non-conventional feeds resources in different agro ecologies was different. In the study area enset and banana leaf were utilized by 40.5 % and 15.20% of the respondents in the high altitude and banana leaf and local extraction (atela) were more utilized in the mid altitude by 11.25% and 10.6% of respondents, respectively. [35] identified non- conventional feeds and it includes residues of local drinks coffee, areke, atela, chat left over called geraba, fruits and vegetables reject.

Feed calendar: The seasonal availability of feed resources in the study area was shown in Figure 2. In the study area, different feeding periods were identified and these periods have different characteristics. In the first period, during the main rainy season (May - November) feed resources are adequate both in quantity and qualities. Natural pastures grazing are the main feed resources in the seasons. But later it become diminished and completely lost in dry season from November to April in early rainy season. Similarly, most authors recommend feed supply from natural pasture fluctuates following seasonal dynamics of rainfall [48,49]. Forage availability and quality are not favorable yearround and hence gains made in the wet season are totally or partially lost in the dry season [33]. Therefore, the producers must know feed supply calendars and use

Figure 2: The Seasonal Availability of Feed Resources in study area.

conservation mechanisms. In the study area, stubbles grazing like wheat, maize, barley and teff were also the major feed resources following the cessation of the main rain season (November to December). During this period, the amounts of feeds and their qualities are progressively decreased. [28] reported the shortage of feed begins from the end of November and the months of January, February and March are the driest months when the productivity of the natural pasture and fodder shrubs were dwindles.

Second period is dry period (in most cases from January to early in March), which characterized by feed supply from crop residues but poor in qualities. Crop residues like maize Stover, teff straw, wheat straw, haricot bean straw and barley straw were the major feed supply in this season. In this dry season the availability and quality of pasture reduced to such an extent that livestock may not fulfill the energy requirement to maintain their bodyweight. Then productivity of the livestock was completely reduced. [50] reported feed scarcity resulted in body weight loss and reduction of milk yield. The third period is the late dry season especially from late March to April, the critical time for livestock when all feed resources completely utilized in the area. Only browse trees and non-conventional feeds are available to utilize in the late dry season of the study district. [51] reported that feed shortage is common particularly during the latter part of the dry season (April to June) and at the start of rainy season at the time when crop residues are limited.

Feeding calendar is important for management and utilization of available feed resources in the study area. Silage making was not known and hay making was not practiced in the study area. Thus, the effective collection, conservation and proper utilization of crop residues and hay making might increase the quantity of available feed, and looking for other alternatives options such as, use of urea

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treatments and silage making and scale-up of improved forage species with participatory approach will improve the nutritional quality of available feed for dry season in study area.

Evaluation of livestock feeding system: The evaluation of feeding system in the study area was shown in Figure 3. Depending on availability of feed in terms of type, quantity and quality, and physiological stage of the animal and production objectives, farmers feed their livestock in different ways. The type of feeding is also influenced by the season of the year. In the study area, about 67%, 13%, 16% and 4% of respondents fed their animals in free grazing, tethering, split feeding, and cut and carrying, respectively. [25] reported that the feeding system practiced in Jeldu district was grazing (94.5%), cut and carry systems (4.4%) and tethering (1.1%). [15] also identified indoor, group feeding, let to graze and tethering were the types of livestock feeding system practiced in Meta Robi of west Shewa zone.

feed resources in the study area. Especially for crop residues, less attention has been given to storage, excessively dumped during harvest period; house construction and way of feeding were some of the problems identified in both agro ecologies of the study area. On other hand, the major uses of crop residues in the area was of course as a feed value but considerable households surveyed alternatively use crop residues for fuel, roof shatter, fences and any of their combinations as the need arises and this puts maximum pressure on the dry matter yield obtained from crop residues besides of failure to collect, store, treat and conserve it properly. This might be attributed to less attention given to post harvest management of crop residues. [52] reported that shortage of feeds for livestock utilization problem contributes to more than 30% loss in Gilgel Gibe catchment of Ethiopia. Traditionally farmers had developed not only storage and minor quality improvements but also had to reach a level where they could formulate their own ration from mixes of crop residues, indigenous browse and a non-

Figure 3: Livestock feeding systems in the study area.

In both agro ecologies of the study area, farmer practiced livestock feeding in split feeding (early in the morning and evening) due to lack of grazing land and lack of labor in wet season. During the dry season, farmers were providing crop residues to their livestock let to graze from the stacks or given small quantities in the morning and evening, and for working oxen, before and after work. In addition, farmers provided fodder trees by climb up and cut the branches or use stick to shake down pods and leaves to feed their livestock.

Constraints and Opportunities of Livestock Production in Relation to Feed Resources

Efficiently Utilization of Feed Resources

Utilization efficiency had great problems to the available

conventional feed supplements hence crop residues and stubble could constitute the major feed in dry season in the area.

In wet season, grazing lands were overgrazed in small plot of lands during the time when crops are planted from April to September and indigenous browses were rarely lopped down for animals as feeds. [35] reported that on top of shortages of feeds for livestock utilization problem contributes to more than 20% loss in Alaba district of southern Ethiopia. When feed resources are surplus silage making and hay making was also not practiced in the area. In other way, the quantity and quality of feed obtainable from natural pastures declines as the dry season progresses. The protein content and digestibility of most grass species decline rapidly with advancing physiological maturity of the plants and reaches very low levels during the dry season.

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Low digestibility associated with low nitrogen content of the feed limits intake and animals on these diets are often in negative energy and nitrogen balance. Enhance the efficient utilization of feed resources also has to take into account the combined knowledge post-harvest managements, packages of storages, preservation area, processing and improvement in feed quality. There are different techniques by which the quality of a feed could be improved by physical treatments like, chopping, grinding and pelleting and chemical treatments, especially the latter improves the nutritive value of crop residues. To alleviate feed shortage, enhancing feed storage during availability in the form of silage and hay preservation is the possible solution in the study area.

Other constraints

The other constraints related to feed resources were shortage of grazing land, land degradation and low biomass yield, low quality and variable of feed across the season, weak adoption of improved forage production, shortage of family labor and poor extension service in both agro ecologies of the study area. This result was agreed with the reports of [25] in highland of Blue Nile Basin of Ethiopia. Nutritional problems like bloating and diseases are other contributing factors affecting livestock production.

Conclusion and Recommendations

The current study has shown that availability of livestock feed resources and its quality are affected by agro-ecology and season of the year. In the study area, the major livestock feed resources were natural pasture, crop residues, fodder trees and shrubs, stubble crops and non-conventional feed in their descending order of magnitude. Free grazing/browsing, tethering, split feeding, cut and carrying were the types of feeding system practiced in the study area. Based on this investigation, scarcity of feed was identified as the major constraints of livestock production in the study area in terms of quantity and quality. Shortage of grazing land, land degradation and low biomass yield, low quality and variable of feeds along the seasons are the major constraints affecting livestock population in the study area. Conclusively, improper utilization of available livestock feed resources in the study area could be one of the contributing factors affecting livestock productivity. Therefore, based on the above conclusive statements, the following recommendations are forwarded:

- Improve the ways of feeding system thus, cut and carry system and tethering of livestock should be encourage for better livestock production and productivities.

- Fibrous feeds, like crop residues, with low digestibility constitute the major proportion of feeds under smallholder farmers in study area. Therefore, to improve the digestibility, improving harvesting time and storage as well as feed treatment should be employed.
- Study on ant nutritional factors of browse species like tannin content, alkaloids, cyanogens and evaluate invitro and in Sacco dry matter digestibility of available feeds in the area is highly needed.

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