Full Length Research Article

Feed resources availability, feeding system and feed balance of sheep in Arba Minch *Zuria* District of Gamo Zone, Southern Ethiopia

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Abstract

This study was carried to characterize available feed resource, feeding system and feed balance of sheep in Arba Minch Zuria District of Gamo zone, Southern Ethiopia. The district was selected based on its high potential for sheep production and urgent need of feed resource assessment for sheep production. Assuming there might be feed and feeding system variability across agro-ecologies (AEZ), the study district was stratified into three distinctive agro-ecologies, namely highland (HL), midland (ML) and lowland (LL). Following probability proportional to size sampling technique, a total of 138 households were interviewed using a structured questionnaire. In addition, a Focus Group Discussion with 12 households was conducted in each agro-ecology. The data obtained through these tools were analyzed using SPSS version 20. One-way variance analysis was used for the continuous data, whereas statistical variations in categorical data were tested using chi-square and t-test, with significant differences at $P<0.05$. The major reported available feed resources for sheep were pasture, crop residue and crop aftermath grazing in both wet and dry seasons. Feeding systems widely practiced in all AEZs were tethering, stall feeding and free grazing system in both dry and wet seasons. The dry matter (DM) production of feed from pasture, crop residues, crop aftermath, foliage of fodder trees and shrubs in the study area was 115,416.5 tons per year. The total feed DM requirement for 129,736.2 TLU was 295,928.27 tons per year. From the total tropical livestock units (TLU) of the district, sheep accounts about 2,925.5 TLU and requires 6673.1 tons of feed annually. The total DM produced per year in the district can only supply the animals for approximately 6 months; in the rest of the year, animals suffer from feed shortage. Therefore, introduction and use of best practices, conservation techniques and alternative feed production technologies are highly recommended.

Key words: Feed availability, Feeding practices, Feed requirement, Sheep

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1. Introduction

Sheep are highly adaptable to a broad range of environments owned by smallholder farmers as an integral part of the livestock sub-sector (Zelalem, 2016). Ethiopia is believed to have the largest sheep population in Africa, which is estimated to be 31,302,257 million heads (CSA, 2018) with four production systems that according to Getahun (2008) include in annual crop-based systems (Northern, North-Western and central Ethiopia), in perennial crop-based systems (mainly southern and southwestern highlands), in cattle-based systems (agro-pastoral and arid areas), and small ruminants dominated systems (pastoral and arid eastern and northeastern areas.

The major feed resources for sheep in Ethiopia include grazing on communal natural pasture, private pastures, crop stubbles, fallow grazing, road side grazing, river side grazing, crop residues, browses, grains, improved forages, and non-conventional feeds, including household food leftovers, weeds from crop fields, tillers from dense crop fields, fillers (crops intentionally planted on part of crop lands or around homestead to be used as feed) and traditional brewers grains (locally known as *atella*). The importance of the different feed resources varies depending on the production system, farmers' livestock management practice and the production environment (*e.g.* availability of grazing land, climate) (Solomon *et al.*, 2010).

According to Solomon *et al.* (2010), in most production systems, agro-ecologies and geographic regions, extensive free grazing in communal grazing lands and stubble grazing are the most common practices of feeding sheep. It is estimated that natural pasture provides from 80–90%, and crop residues 10–15% of the total livestock feed intake in Ethiopia. A relatively more intensive controlled feeding is practiced in the perennial crop–livestock systems and sub moist crop–livestock system. The form of controlled feeding includes tethered grazing on private lands and marginal lands, cut-and-carry feeding on grass, tillers, fillers and weeds (Getahun, 2008).

Currently the contribution of the Subsector in Ethiopia is far below its potential. This is due to technical and non-technical limitations like inadequate feed quality and quantity, diseases, poor breeding and genetic potentials, inadequate livestock policies, veterinary service, livestock extension services, marketing and infrastructure that affect the livestock potentials (Addis, 2015).

Although sheep husbandry is the backbone of the small holder farmers in Arba Minch *Zuria* District, the feed resources and feeding system and feed balance is not yet studied. Since, availing basic information is important to improve the small ruminant sector in general and sheep production system in particular with the focuses of improved management practices, it is important to conduct targeted research in this regard in the study area. Therefore, this study is initiated to characterize feed resource availability, feeding system and feed balance of sheep production in Arba Minch *Zuria* district, Gamo zone, Southwestern Ethiopia.

2. Materials and Methods

2.1 Description of the Study Area

Arba Minch *Zuria* District is characterized as described in Table 1.

Table 1. The brief description of the study area

Climatic conditions	**Arba Minch *Zuria Woreda,* Gamo Zone, Ethiopia**
Major agro-ecological zones	Below 1500 masl (27.6%) **(Lowland)**, 1500- 2300 masl (41.4%) **(midland),** and 2300 – 3300 masl (31%) **(highland)**
Mean Annual T^0	$16.3\text{-}30.6^0C$
Mean annual R.F	800 – 1600 mm
Sheep Farming system	Mixed with crop production

Source: Arba Minch *Zuria* District livestock and fishery office (2019)

2.2 Sampling size and sample technique

The sampling happened in different stages. Firstly, having followed multi-stage sampling procedures, three distinctive agro-ecologies (altitude-based regions) that were known for sheep farming were randomly selected. These three strata are low lands (<1500 masl), midlands (1500-2300masl), and highlands (>2300masl) (MoA, 2000). Secondly, based on reconnaissance survey and participatory rural appraisal (PRA) information, one representative farmers' administrations (*kebeles)* from each stratum and three from the district were selected using stratified random sampling technique. Thirdly, individual household heads having sheep were identified and selected using systematic random sampling technique. A list of households in each survey site was identified with the help of the chief of *kebeles* and agricultural development agents. The identified household heads were questioned using a pretested structured questionnaire. The total sample size for household interview was determined using probability proportionate to size-sampling technique (Cochran, 1977).

$$no = \frac{Z^2 * (p)(q)}{d^2}$$

Where; no, desired sample size when population (household, HH) greater than 10,000; Z, standard normal deviation (1.96 for 95% confidence level); P, 0.1 (proportion of population to be included in the sample i.e. 10%); q, 1-P i.e. (0.9); d, degree of accuracy desired (0.05) or 5% error term. As a result, 138 respondents were selected for the survey.

3. Data Collection

3.1 Feed resources and feeding practices

The available feed resources and feeding system of sheep in the study area were collected using a pre-tested structured questionnaire. In addition, a focus group discussion consisting of 12 farmers was conducted in each agro-ecology. The focus group included model sheep farmers, laggards, and development agents at each agro-ecology. Furthermore, the researchers had their own field observations of feed types and feeding systems.

3.2 Estimation of Feed Supply

3.2.1 Dry matter yield of pasture

The total amount of DM available in the pastures was determined by multiplying the average value of grazing land holding with a conversion factor of 2tDM/ha/year (FAO, 1987& 1995). The amount of DM obtained from communal grazing land was factored into total communal grazing areas for each total household and their associate TLU suitable to graze on this land unit.

3.2.2 Dry matter yield of crop residue, fallow land and after math grazing

The quantity of available crop residues (DM basis) was estimated from the total crop yields of the households, which was obtained from questionnaire survey based on FAO (1987) conversion factor. The conversion factors are 1.5 for barley, wheat, tef (*Eragrostistef*); 2 for maize, 1.2 for pulse and oil crop straws and 2.5 for sorghum. The quantities of available DM in fallow land and aftermath grazing were determined by multiplying the available land by the conversion factors of 1.8 for fallow land and

0.5 for grazing aftermath. Quantification of DM yield from road sides, bush/wood lands of common and private sources and household compounds were done following direct assessment (Yisehak and Geert, 2014). DM yield from crop thinning and crop weeds were assessed through questionnaire and direct measurement.

3.2.3 Quantity of trees and shrubs

The potential fodder yield of shrubs and trees were estimated by measuring stem diameter using measuring tape and applying the equation of Petmak (1983). Accordingly, leaf DM yields of fodder trees were predicted using the allometric equation of $\log W = 2.24\log DT - 1.50$, where W = leaf yield in kilograms of dry weight and DT is trunk diameter (cm) at 130 cm height. Similarly, trunk diameter (DT) was obtained by $DT = 0.636C$; where C = circumference in centimeter (cm). For the leaf DM yield of a shrub this allometric equation was used, that is, $\log W = 2.62\log DS - 2.46$, where DS is the stem diameter in cm at 30 cm height. In quantifying tree feed resources from common property resources (e.g., open forest areas) similar approaches as communal grazing area mentioned earlier, was used.

3.2.4 Estimating available concentrates

The quantity (DM basis) of conventional and non-conventional concentrates (supplements) available for each household was obtained by interviewing the farmers during the cross-sectional questionnaire survey.

3.3 Estimation of balance between feed supply and feed requirement

Total available DM in the main dry season from natural pasture, crop residues, crop aftermath, tree legumes and concentrates compared to the annual DM requirements of the sheep population in the sampled households. Data of livestock population in the sample households were obtained from the interview of household heads during the survey. To compare, the number of sheep population was converted into tropical livestock units (TLU) using the conversion factors of Varvikko *et al*. (1993). The DM requirements of the sheep population were calculated according to Kearl (1982).

3.4 Statistical Analysis

All the surveyed data were analyzed using SPSS version 20. Statistical variations in categorical data were tested by means of cross tabs with significant differences at $P \leq 0.05$ while the descriptive statistics for the numerical data was subjected to analysis of variance using the general linear model procedures of SPSS. Mean comparisons were carried out using Turkey's HSD test and significant differences were declared when $P \leq 0.05$. The data were presented using tables, figures, percentages, mean, and standard error in the process of examining and describing the feeding and feed resources. The statistical model used was $Y_{ij} = \mu + \alpha_i + \Sigma_{ij}$

Where, μ is the overall mean; $\alpha_{i,}$ the effect i^{th} location (i = 1, 2, 3), $\Sigma_{ij,}$ random error

4. Results and Discussion

4.1 Feed resource availability

The common forms of available feed resources are presented in Table 2. From the interviewed household in the AEZs 38.6%, 54.3% and 46.8% were utilizing communal grazing ($P<0.000$), respectively. Crop residues and aftermath grazing were dominant sheep feed resources, which were not significantly different from AEZs. In the same way, a number of researchers (Tesfaye, 2008; Funte *et al.*, 2010; Hassen *et al.*, 2010; Fsahatsion *et al.*, 2013) indicated that natural pasture is the main source of feed for livestock species in Ethiopia.

Table 2. Commonly available of feed resources

Available of feed resources	**Agro-ecology, %**			
	HL	**ML**	**LL**	**P-value**
Communal grazing	38.6	7.1	54.3	0.000
Road side grazing	18.9	46.8	34.2	0.000
River side grazing	30.7	41.6	27.7	0.023
Grazing aftermath	30.1	49.6	25.9	0.004
Private pasture grazing	30.7	41.6	28.7	0.329
Crop residues	30.7	51.6	20.7	0.033

HL, highland; ML, lowland; LL, lowland

4.2 Common supplements of sheep

Supplementary feeding of sheep was a common practice during the dry season at the time of feed shortage in the study area. The flock holders during the dry season provide feed supplements in the afternoon when the animals return home. The most common supplements were indicated in Table 3. According to the focus group discussion results, feed shortage was occurring mainly during the dry season (from January to April). From December to April for highland and midland, flock holders feed *Enset* leaves while in the lowland they feed banana leaves. In the three AEZs, the respondents feed their sheep flocks (young lambs, ewes given birth and fattening sheep) with food leftover. Different kinds of grains were fed for fattening as well in the AEZs ($P<0.001$). The frequency of feeding style was similar to Yilikal (2015) who reported comparable results in Chencha and Mirab Abaya districts, but supplementary feed provisions were found to be higher than his findings.

Respondent farmers in the lowland and mid altitude feed sweet potato roots for fattening sheep and ewes to overcome feed shortage periods. In the highland about 22.3% fed root and tubers while 35.2% fed *Enset* roots to the flocks. Concentrate feeding was not common in the highland and midland but in the low land 100% fed wheat brain purchased from markets. Similarly, *atella* was not in highland and midland but in the low land about 100% fed *atella* during dry season. They do not feed *atella* to the sheep during the rainy season for fear of edema on sheep. Most of the highland respondents feed their flock mineral soil/bole purchased from the market. About 100% respondents in highland have this experience but in mid and low land respondents did not feed mineral soil/salt. The frequency of supplementation of all supplements in all altitudes was carried out when the supplement feeds are available, except *Enset* and banana leaves which they feed one to two times a day during dry season.

Table 3. Common supplements offered to sheep

Supplements	Agro-ecology, %			P value
	HL	ML	LL	
Green fodders (*enset* & banana leaves)	35.2	11.3	53.5	0.000
Food leftover	35.2	11.3	53.5	0.050
Grains	0.0	59.6	40.4	0.000
Roots and tubers	22.3	47.1	30.6	0.000
Concentrates	0.0	0.0	100.0	0.000
Atella	0.0	0.0	100	0.000
Bole (mineral soil)	100.0	0.0	0.0	0.000

HL, highland; ML, lowland; LL, lowland

4.3 Feeding systems of sheep

The traditional feeding systems of sheep in the study area is presented in Table 4. Herding, tethering and zero grazing were the commonly feeding systems of sheep. Sheep spent on free grazing for about nine hours a day. Sheep were grazing in the field alone or together with other livestock species. This was witnessed by 31.8%, 56.3%, and 43.9% of the respondents in the highland, mid altitude and lowland, respectively ($P<0.001$). In wet the season, about 30.6%, 46% and 23.4% of the respondents in highland, midland and lowland, respectively maintain their animals on tethered grazing system ($P<0.000$) while in low land about 90.5% of the respondents used to combine tethering, and cut and carry system of feeding. This result was in agreement with Fsehatsion *et al.* (2013) in that tethering, herding and zero grazing are the common feeding systems of sheep in many parts of Ethiopia.

Table 4. Grazing management practices of sheep in the study area

Grazing management practices	**Agro-ecology, %**			*P-value*
	HL	ML	LL	
Sheep alone	31.8	24.2	43.9	0.000
Together with other animals	31.0	56.3	12.7	0.000
Dry season				
Fully kept/tethered	30.6	46.0	23.4	0.001
Partly kept/tethered	50.0	0.0	50.0	0.010
Herding	23.1	45.5	31.4	0.000
Free grazing	31.3	30.3	38.4	0.04
Zero grazing	9.5	0.0	90.5	0.000
Use of supplementary feeds	92.9	100	100	0.051
Wet season				
Fully tethering	30.6	46.0	23.4	0.000
Partly tethering	12.6	47.4	40.0	0.001
Free grazing	11.6^{a}	0.0^{b}	88.4^{c}	0.000
Herding	45.0^{a}	22.5^{b}	32.5^{a}	0.000
Paddock	28.6^{ab}	42.9^{b}	28.6^{ab}	0.003

4.4 Estimation of Feed Supply

The annual feed supply was estimated from various feed resources. The dry matter feed production from grazing resources in the highland, midland and lower altitudes was found to be 250.1, 150 and 35.8 tons/year, respectively which sums up to a total of 435.9 tons dry matter per year (Table 5). Hence, the dry matter production from fodder trees and shrubs in highland and midland was found to be 2.58 and 3.5 tons, respectively.

Table 5. Estimated quantity of feed DM (t/year) obtained from different land use types

Land use types	Agro-ecology, area			Total (ha)	Conversion factor	TDM production (tons)			Total
	HL	ML	LL			HL	ML	LL	
Grazing land	23.8	29.9	0	53.6	2	47.5	59.8	0	107.3
Aftermath grazing	12	28.9	11.7	52.6	0.5	6.0	14.5	5.8	26.3
Forest land	3.7	5	0	8.7	0.7	2.6	3.5	0	6.0
Fallow land	97	36	15	148	2	194	72	30	296
Sub total	136.5	99.8	26.7			250.1	150	35.8	436

HL, highland; ML, lowland; LL, lowland

A total of 207.76 tons of crop residues were produced from different crop types in the sampled households across agro-ecologies (Table 6). As reported in Tolera (1990), 10% of the crop residue loss was expected due to several factors in many areas of southern Ethiopia except Segen areas. The total crop residues used by animals for the total produced per year in the high, mid and low altitudes was 47.54, 75.84 and 63.6 tons, respectively. Further research is required to assess the residues that are "actually" available for feeding purpose on a year-round basis.

Table 6. Crop residue production estimates from crop yield

Crop type	Total land cultivated(ha)			Grain yield (t/ha)			Conversion factors	Crop residues yield (t/year)
	HL	ML	LL	HL	ML	LL		
Barley	8.67	4.08	-	24.28	11.42	-	1.5	53.56
Wheat	3	6.5	-	10.5	22.75	-	1.5	49.88
Tef	-	1.5	0.713	-	1.8	0.86	1.5	3.98
Sorghum	-	2.35	-	-	4.22	-	2.5	10.56
Maize	-	5.8	9	-	2.14	33.3	2	70.88
Faba bean	0.08	0.075	-	0.15	0.15	-	1.2	0.36
Pea	0.22	0.12	-	0.39	0.21	-	1.2	0.72
H.bean	-	8.5	1.94	-	12.53	2.33	1.2	17.82
Total	11.97	28.93	11.65	35.32	55.23	36.48		207.76

HL, highland; ML, lowland; LL, lowland; ha, hectare; t, tone

The contribution of crop aftermath in livestock feeding was important, especially in dry season when feed availability was limited to crop residue and aftermath grazing. In the study area; the total of 52.55 ha of land was covered by different crop types (according to the respondents). The conversion factor of stubble gazing into total DM yields is 0.5 (FAO, 1987). Therefore, 26.275 tons of DM feed were obtained per year from crop aftermath in the study area. About 5.99, 14.47 and 5.83 tons of DM crop aftermaths were produced in the highland, midland and lowland, respectively. Crop aftermath was majorly obtained from wheat, barley, *tef* and maize stover in the highland and mid altitudes whereas the aftermath is obtained from *tef*, wheat, maize and sorghum stover in lower altitude. In the District, a total of 16284 hectares was covered by different crops. Hence, 8142 tons of feed were estimated from crop aftermath in the study area.

In the District, the total area of land that was covered by bushlands was 15,501 ha as the annual report of Agriculture and Natural Resources Office (2019). Therefore, a total of 10850.7 tons of feed DM was produced from forest land in the district. According to the respondents, the total DM production from forest land was 2.58, 3.5 and 0 tons in the high land, mid and lower altitude. This indicated that forest land availability which could be the source of livestock feed in the mid altitude was the highest as compared to the high land and lowland. About1.1 tons of DM in the three AEZs of the study area were obtained from fodder trees and shrubs, that in turn were supplemented to sheep feeds. The available fodder trees and shrubs that were known by the farmers are listed in Table 7. Fodder trees and shrubs supplementation to sheep is common in the dry season.

Table 7. The estimated biomass yield (t DM/year) of indigenous fodder trees and shrubs

Scientific name	**Browse type**	**Average C**	**Average W**
Coffee arabica	Shrub	32.3	35.34
Terminalia brownii	Tree	75.1	41.28
Ficus sur	Tree	291	159.95
Cordia africana	Tree	82	45.38
Croton macrostachyus	Tree	76	43.17
Vernoniya amygadilina	Shrub	89	97.4
Acacia nilotica	Tree	51.2	28.34
Millettia ferruginea	Shrub	25.7	22.25
Arundinaria alpine	Shrub	32	17.59
Erythrina brucei	Tree	317	174.24
Hagenia abyssinica	Tree	310.5	170.67
Arundo donax	Shrub	10.3	11.27
Balanites aegyptiaca	Tree	99	54.42
Maesa lanceolate	shrub	97.7	106.89

In the study district, utilization of non-conventional feeds other than local liquor waste (*Atella*) and food left over was very low. In the highland, midland and lowland dry matter production was 1, 1, and 3 tons per year, respectively. In highland and midland area farmers practice stalls feeding of sheep for fattening purpose, and mainly use non-conventional feed supplements.

Table 8. Feed resources category and their DM supply(t/year)

Nutrient	Feed supply	Agro-ecology, yield			Total
		Highland	Midland	Lowland	
DM	Grazing feed	247.5	146.3	35.8	429.6
	Forest land grazing	2.6	3.5	-	6.1
	Crop residues	47.54	75.84	63.6	186.98
	Indigenous fodders and shrubs	0.37	.37	.36	1.1
	No-conventional feed sources	1	1	1.5	3.5
	Concentrate	-	-	1.5	1.5
	Total	299.01	227.01	102.76	628.78

4.5 Dry matter requirement of sheep

The daily DM requirement of 250 kg for one TLU for maintenance that needs 6.25kg/day/animal or 2281 kg/year/animal (Jahnke, 1982). Based on the respondents, TLU value were 157.9, 158.9 and 129.1 in the high land, mid altitude and low altitudes, respectively. The TLU annual DM requirement was 360.17, 362.51 and 294.5 tons in the highland, midland and lower altitudes, respectively. From this result, the total DM requirement in the highland and mid altitudes was higher than lower altitude. This was due to the relatively large number of sheep in highland and mid altitudes.

4.6 Estimated annual feed balance

According to respondents in the highland, mid and lower altitudes, the total DM of feed obtained per year was 299.01, 227.01, and 102.76 tons, respectively, whereas the total DM requirement for TLU 157.9, 158.9 and 129.1 is 360.17, 362.51 and 294.5 tons in highland, mid and lower altitudes, respectively. Therefore, the total dry matter produced in these areas can supply the animals for 6 months, 6.22 months and 4.05 months per year in highland, mid and lower altitudes, respectively. In the study area, the existing feed supply on a year-round basis could satisfy only 61.2% of the maintenance. The DM requirement recorded in the present study is lower than the findings of Tessema *et al. (*2003), Endale (2015), and Yisehak and Geert (2013) who reported larger feed balance values for their respective study areas.

Table 9. Yearly feed balance between feed resource availability and dietary requirement

Nutrient	Feed supply	Agro-ecology, yield			total
		HL	ML	LL	
DM	Available tone	299.01	227.01	102.76	628.78
	Required tones	360.17	362.5	294.5	1017.17
	Balance tone	-61.16	-135.49	-191. 74	-388.39

Conclusions

The available annual feed dry matter supplies and feed demands of the sheep did not match at the study area which was characterized by smallholder mixed crop–livestock production system. Sheep feed insufficiency unanimously affects the whole group of smallholder farmers irrespective of wealth status. However, the wealthier group of farmers who owned larger size of livestock collected more quantity of feed on-farm and acquired additional feed through purchase. Yet they found to suffer more in terms of feed deficit than the poor farmers, when livestock feed balance was assessed. Scarcity of grazing lands due to the expansion of cultivation on grazing lands coupled with low productivity of biomass from grazing and food-feed crops production further exacerbate the mismatch between feed supply and demand. Crop residues which are claimed to have suboptimal feeding value due to the high fiber content and low digestibility comprised the major portion of annual feed supply, and thus the inherent limitations of CR should not be ignored. The present evidences implied that unless the feed deficit is relieved through increasing the availability and quality of feeds and practicing strategic feeding, the productivity of sheep will be more profoundly affected.

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Competing interests

The authors declare that they have no competing interests.

References

Addis, G. (2015). Review on Challenges and Opportunities Sheep Production: Ethiopia Department of Animal Production and Extension, Faculty of Veterinary Medicine, University of Gondar, Ethiopia.

Arba Minch *Zuria Wereda* livestock and fishery office (2019) updated record. Arba Minch, Zuria woreda, Arba Minch, Ethiopia.

Cochran, W.G. (1977). Sampling techniques (3rd Ed.) New York: John Wiley & Sons.

CSA (Central Statistical Agency) (2018) Ethiopian Agricultural Sample Survey Volume II Report on Livestock and Livestock Characteristics (Private Peasant Holdings).

Endale Yadessa Dandessa (2015). Assessment of feed resources and determinations of mineral status of livestock feed in Meta Robi district,West Shewa Zone,Oromia Regional state, Ethiopia. MSC. Thesis submitted to school of Graduate studies, Ambo University.

FAO (Food and Agricultural Organization of the United Nations) (1987). Master Land Use Plan, Ethiopian Range Livestock Consultancy Report Prepared for the Government of the Peoples Republic Development, Ethiopia. Technical Report.AG/ETH/82/020/FAO, Rome, 94pp. Morrilton, Arkansas.

FAO (1995). FAOSTAT.PC Data Base.Food and agriculture Organization, Rome, Italy.

Fsahatsion, H., Aberra, M., Sandip, B. (2013). Traditional sheep production and breeding practice in Gamogofa Zone, Southern Ethiopia Department of Animal Production and Technology, Aksum University, Tigray, Ethiopia Hawassa University, PO Box 05, Hawassa, Ethiopia. International Journal of Livestock Production Research, 1(3):26-43.

Funte, S., Negesse, T., Legesse, G., (2010). Feed Resources and their Management Systems in Ethiopian Highlands: The Case of Umbulo Wacho Watershed in Southern Ethiopia. Tropical and Subtropical Agro-ecosystems, 12(1): 47-56.

Getahun, L. (2008). Productive and Economic performance of Small Ruminant production in production system of the Highlands of Ethiopia. Ph.D. dissertation. University of Hohenheim, Stuttgart-Hoheinheim, Germany.

Hassen, A., Ebro, A., Kurtu, M., and Treydte, A.C., (2010). Livestock feed resources utilization and management as influenced by altitude in the Central Highlands of Ethiopia. Livestock Research for Rural Development, 22: Article 229.

Kearl, L.C. (1982). Nutrient Requirements of Ruminants in Developing Countries. Utah Agricultural Experimental Station, Utah State University, International Food Stuff Institute, Logan, USA.

MOA (Ministry of Agriculture) (2000). Agro ecological Zonation of Ethiopia. Addis Ababa, Ethiopia.

Petmak, M. (1983). Primary productivity, nutrient cycling and OM turnover of tree plantation after agricultural intercropping practices in north east Thailand. PhD thesis, University of Philadelphia, Los Banos Philadelphia, pp: 228.

Solomon, G., AzageT., Berhanu G., Dirk H. (2010). Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement Improving Productivity and Market Success (IPMS) of Ethiopian Farmer Project, International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia.

SPSS (Statistical Procedures for Social Sciences) (2009). SPSS (Version 20). Statistical Procedures for Social Sciences (SPSS) INC. Chicago, Illinois, USA.

Tesfaye, D., (2008). Assessment of feed resources and rangeland Condition in Metema district of north Gondar zone, Ethiopia. An MSc. thesis submitted to the department of Animal sciences, school of graduate studies Haramaya University, pp.161.

Tessema, Z., Aklilu, A. and Ameha, S. (2003). Assessment of the Livestock Production System, Available Feed Resources and Marketing Situation in Belesa Woreda: A Case Study in Drought Prone Areas of Amhara Region. In: Proceedings of the 10th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 21-23, 2003.

Tolera, A. (1990). Animal production and feed resource constraints in Welayita Sodo and the supplementary value of Desmodium intortum, Stylosanthes guianensis and Macratyloma axillare when fed to growing sheep on a basal diet of Maize Stover. M.Sc. Thesis. Agricultural University of Norway, 133p.

Varvikko, T., G.M. Kidane, G. Geda (1993). Importance of early hay making in improving the standard of dairy cow feeding on small holder farms in the Ethiopian highlands. Proceedings: VIIth world congress on animal production, Edmonton, Canada.

Yilikal, T. (2015). Small ruminant production and marketing: constraints and opportunities in Chencha and Mirab Abaya woreda, Southern Ethiopia. Department of animal science, Arba Minch University, Ethiopia.

Yisehak and Geert (2014). The Impacts of Imbalances of Feed Supply and Requirement on Productivity of Free-Ranging Tropical Livestock Units: Links of Multiple Factors Department of Animal Sciences, Jimma University, P.O. Box 307 Jimma, Ethiopia Laboratory of Animal Nutrition, Faculty of Veterinary Medicine, Ghent University, Heidestraat 19, 9820, Merelbeke, Belgium.

Zelalem, A. (2016). Review of the Reproductive Performances of Indigenous Sheep in Ethiopia Bonga Agricultural Research Center. Bonga, Ethiopia Journal of Biology, Agriculture and Healthcare, Vol.6, No.9