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Original Research Article

Assessment of Major Livestock Forage Resource and Forage Balance in Kembata Tembaro Zone of southern Ethiopia

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Abstract: The study was conducted in Kambata tambaro Zone, centeral Ethiopia Region; with the general objective of assessing the livestock forage balance using cross-sectional study design from November 2018 to May 2019. For this study Three districts, namely Doyogana, Tambaro and Hadaro tunto were purposively selected from the study area. A total of six kebeles and 361 respondents were selected by random sampling technique from the study districts. Semi-structured questioners, focusedgroup discussion, key informant interview and personal observation were used for data collection. The data were analyzed using statistical package for social science (SPSS, version 23). Analysis of variance with Tukey test was used for mean comparison of the quantitative variables while chi-square test was employed for significance level of qualitative variables. Accordingly, the overall average landholding per respondent in Kambata tambaro was 1.79ha while the holding in the Hadaro, Tambaro and Doyogana found to be 1.86, 1.67, 1.80ha, respectively. The average livestock holding of a household in the Hadaro, Tambaro and Doyogana was 3.90, 4.06 and 4.56 TLU, respectively, with an overall average of 4.13 TLU. Households in the Doyoganadistricts possessed significantly larger ($P<0.05$) number of TLU than the households in the other two distircts while no significant difference ($P>0.05$) was reported amongdistricts in landholding size. The available feed sources ranked by the respondents in decreasing order includs straw, grazing land, hay, green fodder, maize and sorghum stover, bush and forest and concentrate. The overall average utilizable feed DM supply in the study area was estimated to be 4.74 ton with significantly higher ($P<0.001$) DM supply in the Hadaro (5.75 tons) than in the Tambaro (4.02 tons) and Doyogana (4.34 tons per respondent) areas. However, for year round feeding, the average DM demand of livestock in the Hadaro, Tambaro and Doyogana was 8.89, 9.26 and 10.41 tons per respondent, respectively with an overall average of 9.42 ton. There was a deficit of more than 45% DM supply in the study area. Detailed research work on adoptions and utilization of improved forage, non-conventional feed sources as well as determination of nutrient composition and digestibility of different available feed sources should be enacted.

Keywords: Feed Resource, DM Feed Supply, Tropical Livestock Unit.

INTRODUCTION

In Ethiopia, livestock generates more than 85% of the farm cash income. In terms of contribution to the national economy, livestock contribute about 13–16% of total Gross Domestic Product (GDP) and the share to total exports is about 16% (Yayneshet, 2010; Bewket *et al.*, 2015). Livestock farming is also vital for the supply of meat and milk and serves as a source of additional income for smallholder farmers, livestock owners and various operators (Makkar,2014).

Despite of huge population, the contribution of the sector in the national economy is below potential, owing to a range of factors including availability and quality of feed, poor genetic potential of animals for productive traits, poor health care and poor management practices, inadequate livestock policies with respect to

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credit, extension, marketing and infrastructure (Legesse, 2008; Belete *et al*., 2010; Negassa *et al*., 2011; CSA, 2015). Of these factors, shortage of feed both in quantity and quality, especially during the dry season, is thought to be the major impediment for the livestock sector (Wondatir, 2010: Shapiro *et al*., 2015).

Feed is the most important input in livestock production and its adequate supply throughout the year is an essential prerequisite for any substantial and sustained expansion in livestock production (Samuel *et al*., 2008). According to Birhan and Tolera *et al.,* (2012) feed resources can be classified as natural pasture, crop residue, improved pasture and forage; and agro-industrial by-products.

The role of natural pasture grazing as a major feed resource is diminishing from time to time (Yayneshet, 2010). A basic shortcoming of the natural grasslands as a source of feed for livestock is their low production of dry matter and the seasonality of plant growth, which is a reflection of the annual rainfall distribution pattern (Ulfina *et al*., 2013). Moreover, land allocated for grazing and crop production is being converted to other businesses. Even though increased utilization of agro-industrial by products has been reported, they are not available, affordable or feasible for most of the farmers in the highlands of Ethiopia (Benin *et al*., 2004). Hence, in the highlands of Ethiopia, the annual dry matter (DM) production could satisfy only two-third of the total DM requirements of the livestock.

However, the level of variation in the available feed resources and feed balance among the different Kembata Tembaro Zone appear to be not clearly documented. With this background, the current study is designed to assess the livestock feed balance of Kembata Tembaro Zone with the following specific objectives:-

- ✓ To identify the types of available feed resource along with livestock population in the study area.
- ✓ To estimate livestock feed balance in the study area.

MATERIALS AND METHODS

Description of the Study Area

Hadero Tunto is one of the woredas of Kembata Tembaro Zone in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. The district is bordered on the south by the Wolayita Zone, on the west by Tembaro, on the north by the Hadiya Zone, and on the east by Kacha Bira. The district is located between 37035’-37040’ E longitude and 70 10’-7 0 15’ N latitude with altitude ranging from 1501 to 2500 m.a.s.l (District report). Its mean annual maximum and minimum temperatures are 22.50C and 17.60 C, respectively. It receives a bimodal rainfall, namely the main rainy season (July to mid of September) while the short rainy season starts at the end of December and lasts up to the end of February whereas the mean annual rainfall of the district varies from 1201 to 1400 mm.

Doyogena was also one of the woredas of Kembata Tembaro Zone in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. Doyogena is bordered on the south by Kacha Bira, on the west and north by the Hadiya Zone, and on the east by Angecha. The district lies between 7°20’ N latitude and 37°50’ E longitude (Bassa, 2016). The altitude ranges from 1900-2800 meter above sea level. The average temperature ranges from 100c -160c, and the rain fall ranges from 1200-1600 mm.

Tembaro Woreda is located in Kembata Tembaro Zone, SNNPR. It is located at about 400km and 180km south of Addis Ababa and south west of the capitl city of the region Hawassa, respectively. Tembaro district is bordered by Omo River in the south, Hadero Tunto zuria Woreda in the east, Soro Woreda in the west and Duna Woreda in north. Geographically, it is located between 320 98’ E to 340 29’E and 80 08’N to 80 9’N. The altitude of the Woreda ranges from 800 to 2600 m.a.s.l and the slope ranges from intermediate (3-30%) to very steep slope (above30%) The study woreda consists of three distinct agro-climatic zones, Kolla (30%), Woyna Dega (60%) and Dega (10%). The average minimum and maximum temperatures of the study area range between 14oC- 25oC. The mean annual rainfall varies between 900 and 1200 mm (Tambero Woreda Agricultural Office, 2021).

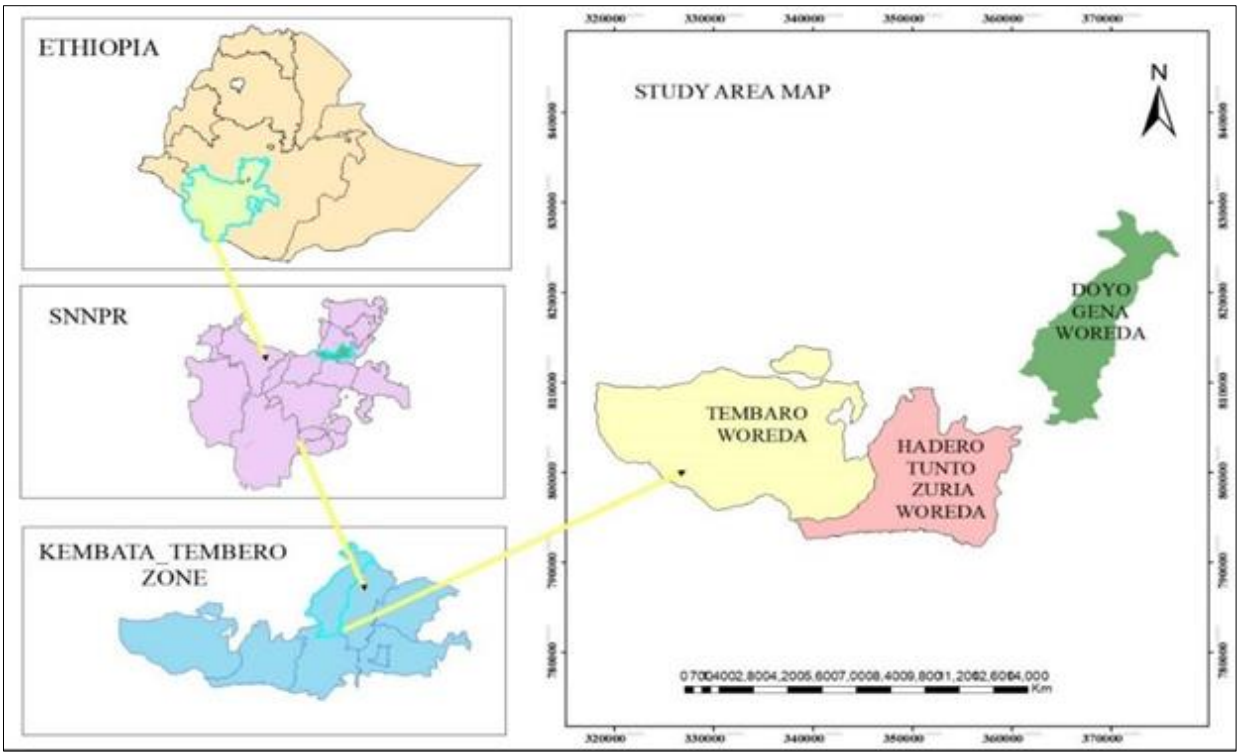

Figure 1: Location map of study area

Study Design

A cross-sectional research design supported by data recording and observation were carried out from December 2018 to march 2019 was employed to assess available feed sources, livestock population and the dry matter feed supply and demand for livestock in Kembata Tembaro Zone.

Sampling Method and Sample Size Determination

For this study Tembaro, Hadero Tunto and Doyogena districts were selected based on the assumption of potentiality of the districts and accebility. From each district 2 kabales (the lowest admistrative unit in the country) Namely Gicha, woro, Mandoye, Ajora, serero, Amacho, with a totatal of 6(six) kebeles were selected respectively. Selection of farmers or respondents in six kebeles was done after sample size determination using random sampling method. There for, from 9130 households that were found in the six kebeles, a total of 361 hosehold respondents were included in ths study following the procedure described by Yamane (1967) and assuming precission was 5%. The number of household respondents from each kebele were then selected proportionaely.

$$n=\frac{N}{1+e^2N}$$

Where

n=sample size

N=population size

e= sampling error (0.05)

$$\text{Sample size (n)} = \frac{9130}{1+0.05\ ^2(9130)}$$

n= 361 respondent

Methods and Types of Data Collection

The data required for the study were obtained both from primary and secondary sources. The Primary data were collected from the questionnaire survey using semi-structured questionnaires and focus group discussions during the Time of the study. Secondary sources of data were collected by reviewing different documents, from Kambata Tambaro Zone and respective Districts Agriculture and Natural Resource Office and Livestock Production and Health Management Office. The questionnaires were pre tested before the commencement of the actual surveying. Focused group discussions were made at each Kebele with key informants containing 7 individuals including men and women households, livestock expert and development agents to clarify issues not well addressed thought survey and to validate some information collected by individual interview.

Estimation of Livestock Population and Feed Dry Matter Demand

The number of TLU per household in the study area was estimated by using conversion factors developed by FAO (1987) and Jahnke (1982). Therefore, for TLU of ox or bull, cow, heifer and calves conversion factor of 1, 0.70, 0.5 and 0.2 were used, respectively. For TLU of sheep and goat a conversion factor of 0.10 was used, while conversion factors of 0.80, 0.70, 0.5 and 1 were used for the horse, mule, donkey and camel, respectively. The DM requirements of the livestock were calculated according to the daily DM requirements for maintenance of 1 TLU (Jahnke, 1982). For the standard TLU of 250kg dual purpose tropical cattle a DM demand of 2.5% of its live body weight/day equivalent to 6.25kg

DM/day or 2.281ton/year was used as an assumption for requirement of feed.

Estimation of Annual Feed Balance

Total available DM from natural pasture, crop residues, crop aftermath and other supplementary feeds were compared to the annual DM requirements of the TLU in the sampled households. Data of TLU in the sampled respondent households was obtained from the interview of household heads during the survey. To determine the annual livestock feed balance of the study area, total livestock units of the respondents and their annual maintenance requirements were estimated. In addition to this total feed produced from different feed sources were estimated in the three distiricts and overall the study area. Then, the annually maintenance requirement or demand of the TLU was calculated and subtracted from the annual feed produced in the study areas.

Method of Data Analysis

The collected data were edited, managed and organized with MS-Excels (2010). One way analysis of variance (ANOVA) following the procedure of the General Linear Model (GLM) using Statistical Package for Social Sciences (SPSS) (version 23) was used to analyze the collected data. Descriptive statistics such as frequency, tabulation and percentages were employed to present the data obtained. The qualitative data were analyzed by using chi-square test. When the analysis dictated the existence of statistically significant diference between factors, mean comparisons were carried out using Tukey test. Levels of significance were considered at $P \leq 0.05$. The foollowing statistical model was used to analyz the quantitative variabl.

RESULTS AND DISCUSSION

Demographic Characteristics of the Household

The household characteristics of the respondents in the present study area were presented in Table 2. The overall average age of the respondents in the current study was 50.72 years which higher than the average age of 40.3, 45.1 and 42.9 reported by Bedesa (2012) for Dinga, Jelidu and Fogera districts, respectively. This might be due to favorable environment condition and lower disease prevalence in the current study area. As clearly noted in Table1, the average age of the respondents in Tanbaro, Hadaro tunto and Doyogena districts of the present study area was 48.10, 51.70 and 53.70, respectively. In all districts the age of the respondents is found to be in the range of productive age groups (15 -64). Despite this, the average age of the respondents in the Tambaro was significantly higher ($P<0.001$) than the respondents in the Hadaro tunto while no significant difference was observed between the respondents in the Doyogana district.

The average family size of the respondents in the current study was 5.29. This result was little bit lower than the reports of (Abebe *et al*., 2014 which says average family size of 6 person for Ezha district of Guragie zone. The small family size in the present study area may be attributed to effective awareness creation towards family planning program and having many family members is considered as risk for food insecured households.

However, the family members in the study area is considered as an asset for extensive farm activity such as herd feeding and watering, barn cleaning, feed collection, and livestock herding. According to, result of group discussion held with farmers indicated that, male children followed by men were dominantly responsible for livestock herding and herd feeding and watering activities while women followed by female children were predominantly responsible for barn cleaning. On the other hand, men and female children were highly responsible for livestock feed collection. The current study result agrees with labour division for livestock management in Meta Robi district, west Shewa zone reported by Eendale (2015) and in Ilu Aba Bora Zone, Oromia Region by Ayalew *et al.*, (2013). Current study also observe that number of productive family member (adult group) per household was significantly higher ($P< 0.01$), while no significant difference at ($P>0.05$) beween the two dicticts. The study further idefied that the proportion of the old age group (> 60 years) per family in the Doyogana district was significantly higher at ($P<0.001$) compared with the proportion in the rest two districts. This is beouse of the most proportion of the district was located at highlands and The existence of more proportion of old age group per household in the highland might be due to the favorable environmental condition and less probability of disease prevalence in the highland agro-ecology which tends to increase the life expectancy of inhabitants.

As persented in Table1. The overall average educational level of the respondent in the study area was illiterate (0.58) and literate (0.42). This indicated that the literate respondents was significantly lower at Hadero tunto ($P<0.01$) than the later two districts. This study was reletd with that of(Hussen *et al*., 2016), who state that 80% of illiterate and 20% of literate reported in the Gilgel gibe Catchment of Jimma Zone. But revers with that of (Wondatir and Mekasha, 2014), who state that 18.3% of illiterate and 81.7% of literate respondents were reported in central rift valley of Ethiopia. Education plays vital role for the adoption and promotion of new technology to the users. Hence, households with high educational levels usually adopt new technologies more rapidly than less educated ones.

Table 1: Household characteristics of the respondents in the study areas

Parameter	Tembaro (N=165)	HadrroT (N=108)	Doyogena (N=111)	Overall (N=361)	P-value
TFS	5.18±0.12	5.47± 0.15	5.3± 0.15	5.29±0.08	0.40
Male	2.65±0.10	2.84± 0.13	2.82±0.14	2.80±0.08	0.28
Female	2.52±0.08	2.65± 0.10	2.49± 0.10	2.60±0.06	0.80
Young group	1.52±0.05[b]	1.77±0.07[a]	1.63±0.07[a]	1.62±0.04	0.000
Adult group	3.46±0.07[a]	3.52±0.10[a]	3.17±0.07[b]	3.39±0.05	0.001
Old group	0.18±0.03[b]	0.19±0.04[b]	0.51±0.06[a]	0.28±0.03	0.000
TNPAG	1.70±0.06[c]	1.94±0.08[b]	2.14±0.10[a]	1.90±0.05	0.000
AAHH	48.1±0.63[b]	51.70±0.99[a]	53.7±1.02[a]	50.72±0.50	0.000
Education					
Illiterate	0.64±0.04[a]	0.58±0.05[b]	0.50±0.05[b]	0.58±0.03	0.005
Read and write	0.25±0.03[b]	0.32±0.05[a]	0.36±0.05[a]	0.30±0.02	0.020
Primary school	0.10±0.02	0.07±0.03	0.11±0.03	0.09±0.02	0.043
Junior school	0.01±0.01	0.02±0.01	0.02±0.01	0.02±0.006	0.238
High school	0.00±0.00	0.00±0.00	0.03±0.02	0.01±0.004	0.453
Total literate	0.36±0.04[b]	0.42±0.05[a]	0.51±0.05[a]	0.42±0.03	0.004

[a,b,c] *means with different superscripts in a row are significantly different; N = number of respondent ,TFS= Total family size, TNPAG=Total non productive age group, AAHH = Average age of household*

Land Holding and Land Use Pattern

The overall average land holding in the study area was 1.79ha per household and it was, 1.86, 1.74 and 1.80 ha for Tambaro,H/tunto and Doyogana districts, respectively. The overall land holding per household was in line with 1.95ha reported by Gashe *et al*. (2017) in Gozamen district, East Gojam Zone but, relatively higher than 1.34 ha reported in Abobo district, Gambella Region (Gelayenew *et al*.,2016). However, these values are relatively less than 2.18ha reported in the watershed of North Achefer (Selamawit *et al*.,

2017), 2.13 ha in Gilgel Gibe catchments of Jimma Zone *(*Hussen *et al*., 2016). Moreover, land holding in the present study area was much lower than 2.91ha reported in Essera district, Dawuro Zone (Andualem *et al*., 2015). The lower landholding per respondent in the present study area compared to other many areas might be attributed to the tendency of the parents to share their fixed land size to their families which is agreed with findings reported by Kebreab *et al*. (2005), difficult topographical feature to use for different land use patterns and also may be high population density in the zone could be the factor.

On the other hand, the present study average land holding was relatively higher than the 0.93 ha reported in Goma district (Belete, 2009) and 0.9 ha reported in Ezha district, Guragie Zone(Abebe *et al*.,2014). Moreover, the overall average size of landholdings per respondent reported in the current study was comparably higher than the estimated national average landholding of 1.77ha but,(CSA and World Bank, 2013). No significant difference (P> 0.05) in the average landholding per sampled respondent was found among the three distircts of the present study area.

The present study further confirmed that about 52% of the total land of a household at the Zonal level was allocated for crop production while the rest was used for grazing, forest or bush, fallow land and forage production. The overall crop land owned per respondent households (0.95ha) in the present study area was found to be nearly comparable with 1ha reported in Essera district, Dawuro Zone (Andualem *et al*., 2015) but, the value is higher than 0.654 ha reported in Haramaya district (Gilo and Berta, 2016).

The overall average grazing land holdings of the respondent households was 0.47 ha comparable with the 0.51 ha reported in Bahir Dar Zuria (Asaminew, 2007), 0.54 ha in Horro and Guduru districts, Oromia Region (Kassahun *et al*., 2015) and 0.42 ha reported in Essera district, Dawuro Zone (Andualem *et al*., 2015). On the contrary, a relatively lower average value (0.35 ha) was reported in Alaba district (Yeshitila, 2008) and much lower grazing land size (0.05 ha) was found in Gozamen district, East Gojam (Gashe *et al*., 2017).

Table 2: Land holding and land use system of the respondent household (Mean +SE)

Parameters	Study Ares				
	Tanbaro (N=165)	HadaroT (N=108)	Doyogena (N=111)	Overall (N=384)	P-value
TL	1.86±0.03	1.74±0.03	1.80±0.03	1.79 ±0.03	0.342
CL	0.98±0.01[b]	0.78±0.02[b]	1.08±0.02[a]	0.95 ±0.02	0.000
TGL	0.43±0.01[b]	0.49±0.01[b]	0.55±0.01[a]	0.47± 0.01	0.001
PGL	0.17±0.01[b]	0.23±0.01[b]	0.30±0.01[a]	0.23±0.01	0.000

CGL	0.26±0.007	0.26±0.01	0.2±0.01	0.24±0.01	0.920
FL	0.02±0.004	0.03±0.01	0.04±0.01	0.03±0.00	0.084
IFL	0.02±0.003[b]	0.02±0.01[b]	0.05±0.01[a]	0.02± 0.00	0.002
BFRTL	0.4±0.01[a]	0.33±0.01[a]	0.08±0.01[b]	0.29± 0.01	0.000

[a,b,] *means with different superscripts in a row are significantly different, N=sample size, S.E=standard error, TL=Total land ,CL= Crop land, TGL=Total grazing land, PGL= Private grazing land ,CGL= Communal grazing land, FL=Fallow land, IFL= Improved forage land, BFRTL=bush and Forest land*

Livestock Holding and Herd Composition

Table 4 blow shows the livestock holding and composition per respondent household in the study area. As elsewhere in the mixed crop livestock production systems of the country, livestock are important components of the agricultural practices in the study area. Accordingly, most of the respondent households in the study areas owned more than one species of domestic animals. The respondents perceived that owning more than one livestock species, specially, cattle, shoat and equine is the simple means of having multiple purposes in agricultural production and socio-economic aspects. The overall mean TLU for all livestock species in the present study area was 4.13 (Table 3). This figure was nearly comparable with 4.53 TLU reported in Dand district (Duguma *et al.*, 2012) and 3.78 TLU reported by Funte *et al.*, (2010) in Umbulo Wacho watershed in Southern Ethiopia.

On the other hand, the present study result was lower than 6.81TLU reported in the watershed of north Achefer district (Selamawit *et al*., 2017), 7.5 TLU in Kersa Malima district (Ketema, 2014), 7.40 TLU in Jimma Zone (Worku *et al.*, 2016).

The smaller TLU per respondent household in present study area could be attributed due to shrinkage of grazing land and small family size not adequate for effective livestock management (feed collection, feeding and watering activity, herding) which cause for small livestock holding.

The overall mean TLU of livestock oxen comprised the highest proportion followed by cows and shoats in that order (Table 3). The discussion with the key informants disclosed that the number and type of livestock holding depends on the type of the farming system and the size of farm land holding of households. In this regard a great majority of farmers own at least one ox as it can be used for draft power (ploughing and threshing).Cows are used as source of milk and calf for replacement of ox, and sometimes for draft power. Shoats in the study area are reared for social value, meat production and savings. This current finding was in line with the purpose of livestock keeping reported in water shade of north Achefer by Selamawit *et al.*, (2017) and in Sekota district, Waghimira zone by Zinash (2015).

Table 3: Livestock holding TLU and composition per household in the study area (Mean ±SE)

	Agro-ecological zones				
Livestock Type	**Lowland (N=165)**	**Midland (N=108)**	**Highland (N=111)**	**Overall (N=384)**	**P-value**
Cow	0.92±0.05	0.81±0.06	0.78±0.05	0.85±0.03	0.620
Oxen	1.42±0.05[a]	1.33±0.05[b]	1.24±0.05[c]	1.34±0.03	0.000
Calves	0.19±0.03[b]	0.17±0.03[b]	0.22±0.04[a]	0.18±0.02	0.000
Heifers	0.15±0.03	0.16±0.03	0.14±0.03	0.15±0.02	0.600
Bulls	0.05±0.02[b]	0.06±0.02[b]	0.25±0.04[a]	0.11±0.02	0.000
Total Cattle	2.69±0.9[a]	2.48±0.08[a]	2.61±0.08[b]	2.61±0.05	0.011
Sheep	0.07±0.03[c]	0.52±0.1[b]	0.59±0.09[a]	0.35±0.04	0.000
Goat	0.52±0.09[a]	0.45±0.09[a]	0.16±0.04[b]	0.4±0.05	0.004
Shoat	0.6±0.1[b]	0.97±0.013[a]	0.75±0.1[a]	0.75±0.06	0.000
Horse	0.00±0.00[b]	0.00±0.00[b]	0.76±0.05[a]	0.22±0.02	0.000
Donkey	0.30±0.04[b]	0.49±0.05[a]	0.35±0.04[c]	0.37±0.02	0.000
Mule	0.05±0.02[b]	0.09±0.03[a]	0.21±0.04[a]	0.11±0.02	0.000
Equine	0.4±0.04[c]	0.59±0.05[b]	1.26±0.07[a]	0.70±0.03	0.000
Camel	0.22±0.03[a]	0.00±0.00[b]	0.00±0.00[b]	0.22±0.03	0.000
Total	3.9±0.15[b]	4.06±0.21[b]	4.56±0.17[a]	4.13±0.1	0.01

[a,b,c,] *means with different superscripts in a row are significantly different; N= Sample size*

Major Constraints of Livestock Production

The respondent households were asked to name and rank the major constraints which could limit/hinder the productivity of livestock in the study area. Accordingly, in the order of importance shortage of feed, animal health problem, low genetic potential of livestock, water scarcity, shortage of labor and predator were described as the main problems facing the livestock agriculture in the study area (Table 4). The livestock production constraints reported in the present study area

were in line with findings reported in the highlands of Blue Nile basin by Ayele (2012), in Sekota district, Waghimra zone by Zinash (2015), in Ethiopia by Birhan and Adugna (2014), in Fogera District by Belete *et al*., (2010) and in the Highland and Mid Altitude Areas of Horro and Guduru district, Oromia Region by Kassahun *et al.,* (2015).

Table 4: Major constraints of livestock production in the study area

	Agro-ecological zones											
Type of constraint	**Tambaro (n=165)**			**Hadero (N=108)**			**Doyogana (N=111)**			**Overall (N=384)**		
	Score	Index	Rank	Score	Index	Rank	Score	Index	Rank	Score	Index	Rank
1. Feed shortage	941	0.27	1	629	0.27	1	642	0.28	1	2212	0.28	1
2. Health problem	852	0.25	2	547	0.24	2	561	0.24	2	1660	0.21	2
3. Low genetic potential	558	0.16	3	333	0.15	4	401	0.17	3	1292	0.17	3
4. Water scarcity	545	0.15	4	398	0.17	3	336	0.14	4	1279	0.16	4
5. Shortage of labour	399	0.10	5	247	0.10	5	268	0.11	5	914	0.12	5

Priority index for the major constraints of livestock in overall the study area and districts = sum of livestock constraint i.e (7*1st ranked constraint of livestock)+(6*2nd ranked constraint of livestock)+(5*3rd ranked constraint of livestock)+(4*4th ranked constraint of livestock)+(3*5th ranked constraint of livestock)+(2*6th ranked constraint of livestock)+(1*7th ranked constraint of livestock) divided by ranked constraint of livestock of all sum ranked constraint mentioned.

Available Feed Sources

Table 5. Shows ranks of the major livestock feed resources available in the study area in general and the three districtis in particular. According to the information solicited from the respondent households, the major available feed resources were grazing land, bush and forests, crop residues (stover of maize, straw of teff, wheat, barley and pulse crop) and crop aftermath. The current study result was agrees with the feed sources which are common in the highland parts of Ethiopia (Tolera *et al*, 2012), in Adami Tullu Jiddo Kombolcha district, Estern Shewa Zone (Dawit *et al*., 2013), in Haramaya district (Gilo and Berta, 2016) and available feed sources in magnitude reported in the watershed of North Achefer district (Selamawit *et al*., 2017). This might due to similar farming system and agro-ecological condition.

Based on the ranking made by the respondents for the overall study area straw comes first followed by grazing land, hay, maize stover, green fodder, bush and forest and concentrate, in that order. Contrary to the current study, it was reported in Kersa Malima district that communal grazing land considered being the major feed source to livestock followed by crop residue and hay (Ketema, 2014) and in Gilgel gibe Catchment, Jimma zone, natural pasture was the primary feed source followed by crop aftermath and crop residue (Hussen *et al.*,2016). Likewise, Seid (2012) reported in Burji district, Segen zuria zone, SEPR confirmed natural pasture was ranked first followed by crop, residues, stubblegrazing and brows etypefeedsources.

Priority index available feed source in the overall the study area = sum of available feed source i.e (7*1st ranked available feed source) + (6*2nd ranked available feed source) + (5*3rd ranked available feed source) + (4*4th ranked available feed source) + (3*5th ranked available feed source) + (2*6th ranked available feed source) + (1*7th ranked available feed source) divided by ranked available feed source of all sum ranked source mentioned.

Table 5: Rank of Available Feed Sources in the Study Area

	Agro-ecological zones											
Feed Source	**Low land (n=165)**			**Midland (N=108)**			**highland (N=111)**			**Overall (N=384)**		
	Score	Index	Rank	Score	Index	Rank	Score	Index	Rank	Score	Index	Rank
MS	1134	0.25	1	316	0.10	5	0.0	0	0	1450	0.14	4
Straw	996.0	0.22	2	744	0.24	1	760.0	0.27	1	2500	0.24	1
Grazing land	819.0	0.18	3	659	0.20	2	652.0	0.23	2	2130	0.20	2
Hay	680	0.15	4	541	0.17	3	590.0	0.20	3	1811	0.17	3
Bush and forest	348	0.08	6	217	0.07	6	247.0	0.09	5	812	0.08	6
Green fodder	460	0.10	5	432	0.14	4	410.0	0.15	4	1302	0.12	5
Concentrates	181	0.04	7	117	0.04	7	162.0	0.06	6	460	0.04	7

MS= Maize stover, N= Number of respondents

Forage Production

Forage Species of Natural Pastures

Forage production (DM) from natural pasture in the study area is practiced in Table 6, 33 major species were identified which is used as livestock feed sources based on primary information from the key informant interview and focused group discussion. The communal and private natural pastures are inhabited by grass species (poaceae), legume species (fabaceae), sedge (cyperaceae) and heterogeneous plants species like Podocarpeceae and Euphorbaceae family.These forage species of natural pasture were contributed as livestock feed sources mostly felt during long dry season of the year where most available grasses are lignified in the study area. Moreover, among these forage species, indigenous forage types are the main source of feed for goats in same low land areas while in midland areas used as feed sources for goats and cattle. The current study result was comparably agrees with findings reported by Gelayenew *et al*. (2016) in Gambella Regional state, Southern Ethiopia.

Table 6: Major Livestock forage species available in AEZs

Family name	Scientific name	Local name	Growing location
Indigenous browse tree species			
EUPHORBIACEAE	*Euphorbia tirucalli*	Kinchibit	Lowland
FABACEAE	*Acacia abyssinica*	Habesha Girar	lowland & midland
RHAMNACEAE	*Zitiphas spihachiristi*	Kurkura	Lowland
BOAGINACEAE	*Cordial africana*	Wanza	Lowland & midland
APOCYNACEAE	*Carisa spinarum*	Agam	Lowland & midland
PODECARPACEAE	*Podocarpus flactus*	Zigiba	highland
MORACEAE	*Ficus sycomnus*	Shoal	Lowland & midland
SAPINADACEAE	*Allophylus abysssinicus*	Embs	Lowland & midland
FABACEAE	*Acacia seyal*	Girar wacho	Lowland & midland
EUPHORBIACEAE	*Croton macrosiachyus*	Bisana	Lowland & midland
LAMIACEAE	*Thymus schimperi*	Tosign	Lowland & midland
FABIACEAE	*Acacia negrii*	Tedecha	Lowland
CACTACEAE	*Opuntia ficus-indica*	Kulkual	Lowland & midland
MORACEAE	*Ficus vasta*	Warka	Lowland & midland
MORACEAE	*Ficus palmate*	Beles	Lowland & midland
MORACEAE	*Ficus thonningii*	Chibiha	Lowland & midland
LOGANACEAE	*Buddlia polystachya*	Anfar	Lowland & midland
FABACEAE	*Acacia polyacantha*	Gimarda/gumero	Lowland & midland
Indigenous grass forage species			
POACEAE	*Andropagon gayanus*	Gaja	Highland
POACEAE	*Avena sativa*	Oat/aja/	Highland
POACEAE	*Dijitaria abyssinica*	Wariat	Midland
POACEAE	*Pennisetum sphacelatum*	Geta/sendedo	Highland
POACEAE	*Cynodon genus*	Serdo	All
POACEAE	*Setaria sphacelataa*	Asendabo	Midland & highland
POACEAE	*Hyparrhenia genus*	Senbeliet	Lowland & midland
CYPERACEAE	*Cyperus longus*	Gicha	Highland
Local and improved legume forage species			
FABACEAE	Vicia villosa	Meno guaya	Highland
FABACEAE	Trifolium pratense	Wazgima/maget	All
Improved browse tree species			
FABACEAE	Cajanus cajan	Yergib ater	Lowland
FABACEAE	Sesbania sasban	Shiwshiwie	lowland & midland
FABACEAE	Chamacynthesis palmensis	Meno zaff	Highland
FABACEAE	Vigna unguiculata Leucaenia	Yelam ater	Lowland & midland
FABACEAE	leucocephala	Lukinia	Lowland

Improved Forage Production Practices and Major Constraints

Table 7, depicts data on improved forage production status of households in the study area.

Generally, less adoption of improved forage production, accounting only 30.5%, was noted in the study area though repeated attempts were reported to be made by governmental and non-governmental organizations in disseminating the technology. The overall level of adoption rate in the current study area was comparably higher than the adoption rate of 5%, 2%, and 6.7% of respondents in Gambella Region, Jimma town and Chire district reported by Gelayenew *et al*., (2016), Duguma *et al.*, (2016) and Geremew *et al*., (2017), respectively. On the contrary, the adoption rates in the current study was lower than 44.6% reported in Gilgel Gibe catchment of Ethiopia (Yisehak and Janssens, 2014), 75.6% in Wolaita Zone (Zereu and Lijalem, 2016) and 72 % adopters found in central highlands of Ethiopia (Mesfin *et al*., 2012).

A comparison among the different distirctis indicated that only 14.5%, 32.4% and 52.7% of the respondents in the Hadero, Tambaro and Doyogana respectively practiced improved forage production. Therefore, in the current study no special attention is made to cultivate improved forage production by farmers and stakeholders. As a result all livestock including cattle, shoats and equines mainly depend on natural pastures and crop residue. Fortunately, all the farmers engaged in improved forage production in the present study area were also well aware of its importance for soil and water conservation, fencing and wind break, which corroborated with the findings of Assefa *et al*., (2015) in Shashogo district, Hadiya Zone, Southern Ethiopia. However, table 7, revealed that, overall the study area shortage of land was ranked as the major limitation (47.1%) to forage production followed by shortage of seed (12%) and lack of awareness (10.4%). Among those identified reasons by respondents' shortage of land was the major challenge in the Hadaro (67.90%), Tambaro (38.90 %) and Doyogana (24.30%) rather than other factors.

Table 1: Percentage of respondents participating in improved forage production

	Distiricts of Zone					
Parameters	**Hadaro (N=165)**	**Tambaro (N=108)**	**Doyogana (N=111)**	**Over all (N=384)**	**X^2**	**P-value**
DYPIF					4.80	0.000
Yes	24(14.5)	35(32.4)	58(52.3)	117(30.5)		
No	141(85.0)	73(70.1)	53(52.9)	267(69.5)		
Total	165(100)	108(100)	111(100)	384(100)		
RNPIF					7.81	0.000
SHL	112(67.9)	42(38.9)	27(24.30)	181(47.1)		
HNA	17(10.3)	15(13.90)	8(7.20)	40(10.4)		
SHS	12(7.3)	16(14.80)	18(16.6)	46(11.9)		
Total	141(85.0)	73(67.6)	53(47.7)	267(69.5)		

N=Number of respondent, %=percentage, DYPIF=Do you plant improved forage, RNPIF=Reason not planting im'proved forage, SHL=Shortage of land, HNA=Have no awareness, SHS=Shortage of seed

Overall Feed DM Supply from Available Feed Sources

The overall average DM supply and contribution of the available feed sources in the study area is presented in Table 8. The average utilizable DM supply from the available feed sources (crop residue, grazing land, crop aftermath, bush and forest, forage land and fallow land) per respondent at the zonal level was 4.74 tons. Crop residues constituted the highest proportion (59.5%) of the supply followed by grazing land (20.7%), crop aftermath (10.1%), bush and forests (5.5%), fallow land (0.8%) and improved forage land (4.2 %), respectively. In agreement to the current study, Yadessa *et al*., (2016), Dawit *et al*., (2013) and Hussen *et al*., (2016) whose reported crop residue contributes from the total feed supply about 76.72 %,74.57% and 67.1% in Meta-Robi district, West Shewa Zone, and Jimma Zone, and Adami Tullu Jido Kombolcha district, respectively. Similarly, Kassahun *et al.*, (2015) found 74 and 81 % crop residue supply in the highland and midland areas of Horro and Guduru district, Oromia Region. On the contrary, findings reported by Yisehak and Janssens (2014) in Gilgel gibe catchment of watershed, Duressa *et al*., (2014) in three vilages of dinga district and Geremew *et al*., (2017) in Chire district, crop residues constituted 32%, 13% and 29.02% of the total feed supply, respectively. Yisehak and Janssens (2014) and Duressa *et al*., (2014) further confirmed that grazing lands in their study areas accounted for 41% and 81% of the total feed supply, respectively; both of which are higher than the value reported in th.

Table 8: Overall DM supply from the available feed sources

	Distiricts								
Feed source	**Hadaro T (N=165)**		**Tambara (N=108)**		**Doyogana (N=111)**		**Over all (N=384)**		**P-value**
	Tdm	%	Tdm	%	tDM	%	tDM	%	
Utilzable crop residues	3.82±0.18[a]	66.4	2.12±0.11[b]	52.7	2.16±0.10[b]	49.8	2.82±0.10	59.5	0.000
Crop aftermath	0.49±0.02[b]	8.5	0.39±0.02[b]	9.7	0.54±0.02[a]	12.4	0.48±0.01	10.1	0.000
Grazing land	0.94±0.02[b]	16.3	0.90±0.02[b]	22.4	1.07±0.03[a]	24.7	0.98±0.03	20.7	0.001
Fallow land	0.03±0.01	0.5	0.05±0.01	1.2	0.06±0.02	1.4	0.04±0.01	0.8	0.104
Improved forage land	0.19±0.03[b]	3.3	0.19±0.03[b]	4.7	0.49±0.10[a]	11.3	0.20±0.04	4.2	0.005
Utiizable bush &forest	0.36±0.01[a]	6.3	0.29±0.02[a]	7.2	0.06±0.01[b]	1.4	0.26±0.01	5.5	0.000
Total DM	5.75±0.24[a]	100	4.02±0.15[b]	100	4.34±0.16[b]	100	4.74±0.13	100	0.000

[a,b,c] means with different superscripts in a row are significantly different, N=number of respondent,%=percentage, tDM=Total dry matter

Feed Shortage and Its Coping Mechanisms

Season of livestock feed shortage in the study area was presented in Table 9.There were some seasons in which livestock feed available in excess amount while season of feed scarcities have the largest share in the study area. As coud be seen in the table overall the study area 59.4% of the respondents experienced livestock feed shortage faced during long dry season followed by main rainy season 21.1% while the rest 15.4% respondents experienced feed shortage during both long dry and rainy season followed short rainy season (4.2%). According to the respondents reported that the occurrence of feed shortage during main rainy season might due to presence of rain and traction of grazing lands along with muddy nature of the available grazing lands; while shortage during dry season attributed to its dryness nature dried of the alternative green feed sources to support the available feed sources. The current study result agrees with farmers experienced feed shortage during long dry and wet season reported in North East Ethiopia (Asaminew and Eyasu, 2009) and in Burie district, west Gojjam (Yenesew, 2010). Likewise, Endale (2015) and Funte *et al*., (2010) who confirmed dry season is characterized by scarcity of grazing resources in Meta Robi district, West Shewa zone and in Umbulo Wacho Watershed in Southern Ethiopia, respectively. Contrary to this, in Jimma town, Ethiopia reported by Duguma *et al*., (2016) 98% of the respondents that experienced feed shortage during dry season because of land scarcity (55.6%) followed by land shortage along with poor feed availability (42.4%).

In all study districts, the availability of feeds varied in seasons with respect to quantity and type of feed. As depicted in Table 9 blow, among the total respondent households of the respective districts, about 92(55.7%), 72(66.6%) and 64(57.7%) respondents in Hadaro tonto, Tambaro and Doyogana, respectively faced acute feed shortage during long dry seasons while 41(24.8%), 13(12.0%) and 27(24.3%) experienced the problem during the main rain season.

Table 9: Feed shortage seasons in the study area

	Study districts					
Feed shortage seasons of the year	**Hadaro(N=165)**	**Tambaro (N=108)**	**Dyogana (N=111)**	**Overall (N=384)**	**X^2**	**P-value**
Long dry season	92(55.7)	72(66.6)	64(57.7)	228(59.4)		
Long rainy season	41(24.8)	13(12)	27(24.3)	81(21.1)	10.95	0.09
BLDRS	23(13.9)	21(19)	15(14.0)	59(15.4)		
Short rainy season	9(5.5)	2(1.9)	5(4.5)	16(4.2)		
Total	165(100)	108(100)	111(100)	384(100)		

N=Number of respondents, X^2=Chi square, BLDRS=Both long dry and rainy season

Taking the prevailing feed deficit facing the farmers in the study area into consideration, the respondents were asked to name the possible feed shortage coping mechanisms employed by the farming community of the study area. Accordingly, four major coping strategies were found to be practiced as presented in Table 10. Hence, it is possible to note from the table that majority of the respondents (57.0%) rely on purchasing forage from other smallholder farmers with having surplus feed sources. Destocking of livestock was reported to be the second strategy in the study area. Contrary to this, findings reported by Duguma *et al*., (2016) in Jimma town confirmed, farmers adopted coping strategies for feed scarcity includes use of industrial by products and concentrate mix (87%) use of conserved hay (74.13%) use of non conventional feeds (50%) purchasing green feeds (14.8%) and reducing herd size (3.7%).

Regarding the tendency of trekking livestock to feed accessible areas, the study revealed that only 9.70% of the respondents in the Hadaro were found practicing

this mechanism. On the other hand, a little over 20(18.5%) of the respondents in Tambaro and nearly 19(17.1%) of the respondents in the Doyogana were practiced conservation of forage in the form of hay. According to the result of the group discussion, alternative feed source like indigenous browse trees have vital roles in alleviating the feed in the study areas.

Table 10: Coping mechanism of livestock feed shortage in the study area

	Study districts					
Feed shortage coping mechanism	**Hadaro (N=165)**	**Tambaro(N=108)**	**Doyogana(N=111)**	**Overall (N=384)**	**X^2**	**P-value**
Feed Purchase	96(58.2)	65(60.2)	58(52.3)	219(57.0)		
Destocking	53(32.1)	23(21.3)	34(30.6)	110(28.6)	54.28	0.09
Shift to other area	16(9.7)	-	-	16(4.2)		
Feed conserve as hay	-	20(18.5)	19(17.1)	39(10.2)		

N=number of respondents, %=Percentage, X^2 Chi square

CONCLUSIONS AND RECOMMENDATIONS

Cattle are the dominant livestock species kept in the study area followed by shoat and equine and. These livestock rely on crop residue, natural pasture, hay, crop aftermath, bush and forest tree and improved forage feed sources for their existence. Unfortunately, the DM supply from the available feed sources is in short of the livestock DM demand. The scarcity of feed for livestock maintenance requirement is more serious in the study areas.

Feed deficit both in quantity and quality is thought to be one of the most limiting factors for livestock production in the study area. Therefore, based on above conclusionthe following are recommended for future development directions;

- ✓ Intensive extension work should be deployed so as to create awareness about alternative feed production, proper feed conservation and handling practice, and treatment of forage and crop residues.
- ✓ There should be quality forage seed supply along with production of forage crops integrated with food crops production and natural resource management activities.
- ✓ There should be livestock feed quantity and quality improvement demonstration and implementation program by governmental and non-governmental organizations at farm level.

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