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Research Article

Evaluation of livestock feed resources and feed balance in selected districts of Gamo zone, Southern Ethiopia

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Abstract

The study was conducted in Bonke, Mirab Abaya and Dita districts of Gamo Zone, Southern Ethiopia with the objectives to assess available, opportunity, constraints and copying strategy of livestock feed production and to estimate feed balance. Primary and secondary data sources and field observations, key informant interview, focus group discussions and individual interview was employed to generate data. The survey data was stratified into districts, coded and analyzed using the Statistical Package for Social Sciences (SPSS version 20) windows 10 and general linear model procedure were used to analyze data. Statistical variation of categorical data (perception data) was tested by means of cross tabulation. In study districts, the palatable and perennial fodder trees were Erythrina brucei, Arundinaria alpine, Ficus sur, Dombya torrida and Hagenia abyssinica were supported major feeds for livestock. The major opportunity related to livestock feed production in study districts was presence of different feed resource types, distinctive agro-ecologies and accessible of crop residues, but the major constraints related to livestock feed production were land scarcity, shortage of dry season forages and land degradation due to erosion. Minimize livestock number, conserving optional feeds and purchasing optional feeds were major copying strategies of feed resources in study districts. The overall mean of feed supply in terms of DM yield per year to TLU was found to be 5.782tons of DM /Hh/ annual with negative feed balance of 5.47tons. Based on the findings of the present study, low productivity of livestock in Bonke, Dita and Mirab Abaya districts is clearly associated with the meager availability of feed resources. Hence, in order to alleviate these problems, alternative feed production technologies should be undertaken, such as, farmers should practice forage development on their own crop land and collect crop residues during crop harvesting times and conserve it under shed, the nutritive value of different types of fodder trees and shrubs should be further determined in the future, feed storage methods, particularly hay and silage during an excess of feed resources available should be practiced.

Keywords: Districts; Feed balance, Feed resources

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1. Introduction

Despite the largest livestock population in Africa (Hunduma, 2012), the productivity is comparatively low in Ethiopia. The low output is principally due to many constraints (Getahun, 2012; Belay & Janssens, 2016). Among these constraints, inadequate quantity and quality feed ingredients were identified as a major warning factor to the development of livestock production in Ethiopia (Belay et al., 2011; Alemayehu et al. 2017).

Moreover, (Alemayehu, 2006; Adugna et al., 2012; Yisehak et al., 2016; Kechero & Janssens, 2014), reported that feed supply shortage were major bottle necks of farmers for livestock production in Ethiopia. From types of feed resources, natural pasture and crop residues are contributing the largest feed type (Adugna et al., 2012). Among these, in Ethiopia 95% of livestock feed is from crop residues (FAO, 2018) like teff, barley and wheat. The contribution of feed resources, however, depends upon the agro-ecology, the types of crops produced, accessibility and production system (Thornton, 2010). According to Zewdie (2010), assessment of the 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. In Ethiopia, the annual DM production could satisfy only two-third of the total DM requirements of the livestock, as result during the dry season animals drop their condition which is an indicator of feed shortage and suggests that livestock production and productivity are constrained by feed scarcity (Funte et al., 2010; Sefa, 2017).

In this regard, dry matter (DM), crude protein (CP) and metabolisable energy (ME) supplied of different feed resources were bellowed the annual requirements of the total tropical livestock unit (TLU) with negative balance (Kechero & Janssens, 2014). Hence, both energy and protein are the main limiting influences for livestock productivity (McDonald et al., 2010). A preliminary feed supply-demand assessment in Ethiopia showed that the feed deficit was 10% when expressed as DM, but it was 45 and 42% when expressed as metabolizable energy (ME) and crude protein (CP), respectively (FAO, 2018). This data highpoints the need for more forage conservation to guarantee availability and quality across seasons and regions.

The crude protein (CP) content of pastures is lower than the value of forage crude protein content of (7%), which would cover the maintenance requirements of ruminants (McDonald et al., 2010). Due to the high number of human populations across the regions in Ethiopia increasing demand for cropping land to yield food for humans diminishes the amount of land available for natural grazing and forage production (Alemayehu, 2005; Adugna et al., 2012). As result, the role of natural pasture grazing land size diminishing and shrinking (Yayneshet, 2010). In case of Bonke, Dita and Mirab Abaya Districts, as related other densely populated Zones of Ethiopia, production of major feed resources is declining throughout the year. That is, of course, linked to the meager availability of feed resources. Hence, assessment of feed resources helps to guide the development of effective intervention strategies to improve quality of feeds, feed use efficiency and livestock productivity. Thus, this study was carried out to assess the opportunities, constraints, and coping strategies of livestock feed resources and estimate the balance between total dry matter, crude protein and energy supply and the requirements of the nutrients of livestock in Bonke, Dita and Mirab Abaya districts of Gamo Zone of Southern Ethiopia.

2. Materials and Methods

2.1. Description of the study area

The study was conducted at Bonke, Dita and Mirab Abaya districts, which are located in Gamo Zone of the Southern Ethiopia. Bonke district is located at 9°00'N latitude, 38°30'E longitude at an altitude of 600-4200 meter above sea level. The human population in district is 205,739 and livestock population is 558,759. In this district, the widely cultivated crops are barley, wheat, enset, maize, teff, beans and potatoes. The vegetation types in area are forest, woodland, bush and shrubs. Whereas Dita district is located at 7°16'N latitude, 37°18'E longitude at an altitude of 1,744 meter above sea level. The human population in district is 83,987 and livestock population is 319,878. In this district, the widely cultivated crops are barley, wheat, enset, maize, teff, beans and potatoes. The vegetation types in area are forest, woodland, bush and shrubs. Whereas Mirab Abaya district is located at 5°57'N latitude, 37°32'E longitude at an altitude of 1170 – 2700 meter above sea level.

The range annual rainfall of 900-1000mm and mean annual temperature of 23℃. The human population in district is 95,837 and livestock population is 368,270. In district, the widely cultivated crops are barley, wheat, enset, maize, teff, beans and potatoes. The vegetation types in area are forest, woodland, bush and shrubs. Land use in three districts almost similar that is Crop cultivation, livestock grazing, woods or forest and residential use.

2.2. Study design

Both primary and secondary data were collected following qualitative and quantitative research methodologies involving structured questionnaire, field measurement, individual interview and group discussion. Primary data on household, household herd, land holding, major feed resources, opportunity, constraints and copying strategies of feed resources were collected. Secondary sources of data focused on climate, topography, agro-ecology, human population and livestock population was collected from the office of districts and other documents. The group discussions were involved one group in each *kebele* and the researchers were facilitated the discussions at all sites.

For this study, multistage sampling techniques were followed. In the 1ststage, the purposively sampling technique was applied to select districts based on livestock potential. In the 2ndstage, 3 *kebeles* were selected from each district by using stratified sampling technique based on altitudes range. In the 3rd stage, a list of households in each *kebeles* was selected random sampling techniques and taken by the chief of *kebeles* and estimated by using probability proportional (Eq. 1) to sample size technique (Cochran, 1977).

$$no = \frac{Z^2 * (p)(q)}{d^2} \quad (1)$$

Where, no = Desired sample size according when population greater than 10,000, Z =1.96 for 95% confidence level, P = 0.1 for 10% proportion of the population, q= 1-0.1, d =degree of accuracy desired at 5% error term. A total of 162 (54 households from each) from three districts were interviewed.

2.3. Livestock population data

In order to estimate the feed balance of the study districts, the livestock population data was collected through questionnaire as well as from secondary data sources (in the office of wereda) and converted in to total tropical livestock unit (TLU) using (FAO, 1987; Gryseels, 1988; FAO, 2002) methodology.

Total available DMs from natural pasture, crop residues, crop aftermath and fallow land, fodder tree and shrubs, improved forages and non-convectional feed stuffs were compared to the annual DM requirements of the livestock populations in the study area. Data of livestock population were obtained from the questionnaire of household heads during the survey. To compare the number of livestock populations in the area with the DM requirements of the livestock population according to the daily DM requirements for maintenance of 1 TLU (Kearl, 1982) where the daily DM requirement for maintenance of 1 TLU (250 kg livestock) which consumes 2.5% of its body weight is 6.25 kg DM/d or 2281 kg DM per year and a crude protein (CP) content of 160 g/kg DM and 32.1 MJ ME/kg DM diet is used, (MAFF, 1975; Jahnke, 1982).

2.4. Estimation the quantity of available feed resources

The quantity of feed resource in three districts of study area was estimated using the information on crop residues, grazing lands, fodder trees and shrubs, improved forages, and non-convectional feed stuffs collected from the respondents during survey. The amount of crop residues, used as source of livestock feed was estimated using established conversion factors developed by different investigators. The conversion factors developed for wheat, barley and teff straw is 1.5 per unit weight grain yield, while the factor for maize and haricot bean are, 2.0 and 1.2, respectively (FAO, 1987).

The dry matter (DM) output of grazing pasture was estimated based on FAO (1987) multiplier factor, which is 2.0 tons/ha. Crop aftermath grazing potential was estimated by using a mean of 0.5 tons/ha, while improved forages, fallow grazin land was 8 and 0.7 tons/ha/yr respectively (FAO, 1987; Alemayehu, 2002).

Quantity of other non-convectional feed stuffs which haven't clear conversion factors also can increase the quantity of DM for livestock based on respondents information. The quantity of potentially available DM from leaf and leaf midribs of enset (*E. ventricosum*) used for animal consumption was estimated by considering a mean of 8 tons/ha of enset growing land.

The biomass yield of shrubs and trees' potential fodder yield was estimated by measuring stem circumference using measuring tape and using the equation of Petmak (1983). Accordingly, leaf yield of fodder trees was estimated by 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 from: $DT = 0.636C$; where the C = circumference in centimetre (cm). For the leaf yield of a shrub the allometric equation is $\log W = 2.62\log DS -2.46$. Where DS is stem diameter in cm at 30 cm height.

2.5. Data analysis

All perceived and measured data were analyzed using the Statistical Package for Social Sciences (SPSS) version 20. Statistical variation of categorical data (perception data) was tested by means of cross tabulation (chi-square procedure), assuming significant differences when $P < 0.05$; while the descriptive statistics for the numerical data were compared by employing to the general linear model (GLM) procedure of SPSS, whereas post hoc multiple mean comparisons was employed to analysis feed balance by using Tukey procedure and assuming significant differences when $P < 0.05$. Descriptive statistics, such as means, percentages and standard error of the means were used to present the results of perceptions and measurements. The appropriate statistical model for assessment (Eq. 2) of livestock feed resources and feed balance is:

$$Yij = \mu + \alpha i + \varepsilon ij \quad (2)$$

Where, Y_{ij}= Total feed DM, CP and ME yield from three districts; μ = overall mean; $\boldsymbol{\alpha}_i$ = the effect of i^{th} locations (1-3) and $\boldsymbol{\varepsilon}_{ij}$ = random error

For parameters required ranking, indices were calculated by using Microsoft office Excel 2007 to provide ranking of opportunities, constraints and coping strategy for the livestock feed resources produced in the study districts. Index was computed (Eq. 3) with the principle of weighted average according to the following formula as employed by (Musa et al., 2006):

$$Index = Rn*C1+Rn-1*C2+....+R1*Cn/\sum Rn*C1+ Rn-1*C2....R1*Cn \quad (3)$$

Where; Rn = Value given for the least ranked level (example if the least rank is 5^{th} rank, then Rn=5, Rn-1=4 and … R1= 1). Cn = Counts of the least ranked level (in the above example, the count of the 5th rank = Cn, and the counts of the 1st rank = C1).

3. Results and Discussion

3.1. Household characteristics of respondents

The overall mean of family householding size in the present study districts was about 5.72 headed (Table 1). The average family size of each district was significantly different (P<0.05). Generally, in the study districts, the average family size of the respondents was higher than the national average family size of rural areas (4.9) per household (CSA, 2011) and closely related to Emana et al. (2017) who reported that the average family size of 5.37 in the Abol district of the Gambella Region, Ethiopia.

There was a significant difference (P<0.05) in the educational status of respondents among districts. Accordingly, the highest level of illiteracy was recorded in Dita district (79.6 %) and the lower level of illiteracy was observed in Mirab Abaya district (53.7 %). These illiteracy levels of the society are the challenges on modernization of livestock feed production that requires a continuous training to enable the livestock productivity to move forward. Similar finding was reported by Yisehak et al. (2013) in three districts of Jimma zone, Southwest Ethiopia.

3.2. Livestock holding in tropical livestock unit (TLU) of sampled households

In the current study, the overall mean of livestock in the sampled households was 4.934 TLU per households as indicated in Table 2. The mean of livestock in TLU in Bonke district

(5.672) was higher than Dita (4.809) and Mirab Abaya (4.319). The high mean value of livestock in Bonke district might be due to relatively higher grazing land resources holding size and also rearing of the high number of livestock as a social value rather than production purpose. The overall means of current result was lower than a research result reported by Sisay (2006) in Debark (5.10), and Layarmachiho (5.60). However, larger than Mergia et al. (2014) (3.3) in Baresa watershed and Mengistu et al. (2016) which was (3.05 ± 0.15). The effects of districts were significant (*P*<0.05) on sheep, horse, local oxen and cross bull numbers. This may be due to the nutritional factors, such as grazing land, feed types, availability of feed and the production purpose of farmers.

Table 1. Household characteristics of the respondents in the study districts

Characteristics		Study districts			Overall	*P*- value
		Bonke	Dita	M/Abaya		
Sex of the household (%)	Male	66.7	44.4	48.1	53.1	0.04
	Female	33.3	55.6	51.9	46.9	0.04
Age (years)	15-30	27.8	44.4	31.5	34.6	0.40
	31-50	57.4	40.7	51.9	50.0	0.40
	>50	14.8	14.8	16.7	15.4	0.40
Mean of family holding size	Mean	5.39 ^{a}	5.54 ^{b}	6.24^{c}	5.72	0.01
Educational status (%)	Literate	35.2	20.4	46.3	34.0	0.02
	Illiterate	64.8	79.6	53.7	66.0	0.02

^{abc}Means with different superscript in the same row of altitude are significantly different (P <0.05)

This overall result of sheep and horse was greater than the findings of Mohammed *et al.* (2016) in which sheep (0.10±0.01), horses (0.05±0.02) and mules (0.06±0.03). The result of current study was lower than Teshager et al. (2013) who reported relatively the smaller TLU values of livestock species in Bacho, Algie-Sachi and Chewaka districts.

3.3. The opportunity, constraint and copying strategy of feed resources

The major livestock feed resources opportunity and constraints are presented in Table 3. In the study districts, accessibility of different feed resource types such as crop residues, natural pasture, fodder trees and shrubs, industrial by products and forages were major opportunity in the study area. The index score of presence of different feed stuffs for livestock was ranked first in study districts. Next to presence of different feed stuffs, having different agro ecology and presence of different forage varieties were ranked second and third respectively. Even though, many opportunities that enhance livestock feed resources production in the study area, there are also a couple of constraints to hinder the productivity of feed resources.

Table 2. The mean livestock holding size in tropical livestock unit of the sample households

Livestock in TLU	Districts (mean)			Overall	*P*-value
	Bonke	Dita	M/Abaya		
Sheep	0.624	0.507	0.189	0.440	0.01
Goat	0.141	0.15	0.144	0.145	0.98
Donkey	0.037	0.074	0.139	0.083	0.07
Mule	0.130	0.117	0.052	0.099	0.30
Poultry	0.071	0.089	0.066	0.075	0.47
Horse	0.785	0.474	0.074	0.444	0.00
Local cow	0.563	0.593	0.563	0.573	0.93
Cross cow	1.500	1.133	1.033	1.222	0.13
Local heifer	0.111	0.125	0.166	0.134	0.58
Cross heifer	0.111	0.125	0.166	0.304	0.30
Local oxen	0.244	0.265	0.509	0.340	0.01
Cross oxen	0.422	0.317	0.176	0.305	0.21
Local bull	0.143	0.081	0.224	0.149	0.17
Cross bull	0.141	0.176	0.457	0.258	0.02
Local calf	0.078	0.189	0.111	0.127	0.00
Cross calf	0.078	0.189	0.111	0.235	0.00
Total livestock	5.672	4.809	4.319	4.934	0.01

The major constraints for livestock production ranked by respondents in the study districts were land scarcity due to high human population, shortage of dry season forages and land degradation due to erosion. This is similar to Belay et al. 2011) and Azage et al. (2013) who reported that shortage of land was the most limiting factor to livestock production. As responses of respondents in the study districts, minimize livestock number, conserving optional feeds and purchasing optional feeds were major copying strategies of feed resources in study districts ranked from first to third respectively.

Table 3. Livestock feed resources opportunity, constraints and copying strategy (n=12)

Opportunity/constraint/strategies	Districts						Overall	Rank
	Bonke		Dita		M/Abaya			
	Index	Rank	Index	Rank	Index	Rank		
Opportunity								
Agro ecology	0.264	2	0.264	1	0.333	2	0.287	2
Presence of d/t forage varieties	0.208	3	0.333	2	0.222	3	0.253	3
Presence of d/t feed stuffs	0.528	1	0.403	3	0.444	1	0.458	1
Constraints								
Land scarcity	0.486	1	0.403	1	0.375	2	0.421	1
Shortage of dry season forages	0.278	2	0.319	2	0.388	1	0.328	2
Land degradation due to erosion	0.236	3	0.278	3	0.236	3	0.250	3
Copying strategies								
Minimize livestock number	0.444	1	0.444	1	0.430	1	0.439	1
Conserving optional feeds	0.333	2	0.361	2	0.347	2	0.347	2
Purchasing optional feeds	0.222	3	0.194	3	0.222	3	0.213	3

3.4. Dry matter production of different feed resources

3.4.1. *Dry matter yield of natural pasture*

Table 4 shows that the effect of districts was no significant (*P*>0.05) on the mean of DM production utilization of communal and private grazing lands in the study areas. Accordingly mean of DM in tons obtained from communal grazing land through the survey was 0.314, 0.504 and 0.407 tons of DM per year of Bonke, Dita and Mirab Abaya districts, respectively.

The overall mean of DM produced from communal grazing land in the study areas was 0.409 tons DM/year. There was a no significant difference (*P*>0.05) on the mean of DM production of private grazing land utilization across districts in the study areas. The mean of DM produced from private grazing land at Bonke, Dita and Mirab Abaya was 0.146, 0.221 and 0.258 tons per year, respectively. The result of private grazing land obtained in this study is lower than the report of Sisay (2006) 1.15 tons for Layarmachiho *Woreda* and the same finding was 0.68 tons per household for Debark *Woreda*. The finding of the current study was also lower than the report of Zewdie & Yoseph, (2014) (3.7) for Adami Tullu Jidokombolcha.

3.4.2. Dry matter yield of crop residues

The overall mean of dry matter of crop residues produced per year by sampling households of different crop types in Table 4 was 1.217 tons DM/year. The effect of districts was significant (*P*<0.05) on the crop residues of barley in the study area. The mean yield of crop residue of barley was higher in Dita (0.569) than the Bonke (0.481) and Mirab Abaya (0.222). This difference may be due to genetic variety and environmental factors that affect the yield of barley.

Table 4. The crop residues yield of dairy cattle in sampled households (tons)

Crop residues	Districts				
	Bonke	Dita	M/Abaya	Overall	*P- value*
Barely	0.481^{a}	0.569^{a}	0.222^{b}	0.431	0.020
Wheat	0.375^{b}	0.639^{a}	0.278^{b}	0.428	0.016
Teff	0.057^{a}	0.000^{c}	0.197^{b}	0.084	0.011
Sorghum	0.002^{c}	0.021^{b}	0.164^{a}	0.013	0.020
Pulse and oil	0.192^{b}	0.306^{a}	0.283^{b}	0.261	0.003
Total	1.107^{b}	1.535^{a}	1.144^{b}	1.217	0.032

Means with different superscript in the same row of districts ($^{a, b, c}$) are significantly different (P<0.05)

The majority of farmers in highland area were cultivated barley crop than midland. This may be due to environmental factors. The effect of districts was also significant (*P*<0.05) on the crop residues of wheat, teff, sorghum pulse and oil crops in the study areas. Therefore, these crop types that yield different production across the districts was consequently varies the crop residues in the areas. This result was in agreement with Berihu et al. (2014) who reported that crop residues from wheat, Maize, barley, bean, and peas are important feed sources in Ganta Afeshum woreda Eastern zone of Tigray especially during the dry season when availability of pasture is low.

3.4.3. Dry matter yield of crop aftermath grazing land

After harvesting the crops, livestock are allowed to graze the stubble of different crops such as Maize, teff, sorghum, wheat, barely, bean, pea etc. The conversion factor of 0.5 was used for stubble gazing (aftermath) into total dry matter yields (FAO, 1987). Therefore, the overall mean of 0.083 tons of DM feed were obtained per year from crop aftermath in the study districts.

The effect of district variation was significant (*P*<0.05) on the amount of stubble grazing land utilization Table 5 in the current study. This may be due to differences in landholding size of respondents. Based on survey information, 0.158, 0.048 and 0.042 tons of DM per year for crop aftermath were produced in the Bonke, Dita and Mirab Abaya districts, respectively. This crop aftermath was mainly obtained from left of wheat, barley, bean and pea straw in the highland altitudes whereas, at mid altitude from *teff*, wheat, maize and sorghum Stover. The findings of the present study were found to be lower than the study conducted in Meta Robi District (Endale, 2015).

3.4.4 Dry matter yield of fallow land

The quantities of available DM of fallow land were determined by multiplying the available land by the conversion factors of 1.8 for fallow land grazing (FAO, 1987). The effect of variation of districts was significant (*P*<0.05) on fallow grazing land dry matter production. Based on household survey data, the mean of fallow grazing land DM yield Bonke, Dita and Mirab Abaya districts was 0.383, 0.024 and 0.102 tons per year, respectively. This may be due to the farmers production purpose and allocation of land for cultivation for crops for livestock may be varies. The overall mean of fallow land DM production, all districts was 0.169 tons per year.

3.4.5 Dry matter yield of woodland/forestland

The conversion factor used to get total dry matter production from forest land is 0.7 (FAO, 1987). Therefore, overall mean of 0.075 tons of feed dry matter was produced in the districts per year. The effect district vary was significant (*P*<0.05) on dry matter production from forestland. According to the survey result, the mean of dry matter production from forest land was 0.003, 0.045 and 0.179 tons in Bonke, Dita and Mirab Abaya districts, respectively. The high production of DM at Mirab Abaya districts was due to high landholding as compared to other districts. In the other study reported by Endale (2015) in the Meta Robi District, west Shewa zone, Oromia regional state indicated that the total dry matter production from forest land was 10.29 tons and 2.62 tons higher than current study.

3.4.6. Biomass yield of fodder trees and shrubs in mean leaf weight (in tons)

The fodder trees and shrubs were potential to support livestock in the study districts through the year, especially during dry season. The overall mean of the estimated biomass yield of trees and shrubs presented in Table 6 was 1.851tons DM per year. In sampled households the mean estimated biomass yield of trees and shrubs were produced 1.967, 1.571 and 2. 017 tons DM per year in Bonke, Dita and Mirab Abaya districts respectively. In the Bonke district of current study, the palatable and perennial trees were *Erythrina brucei* and *Ficus sur* supported feed for livestock whereas Dita district *Ficus sur and Arundinaria alpina* were dominant fodders. However, the potential of fodders supported livestock in Mirab Abaya district was *Ficus sur*, especially during dry season. Some fodder trees and shrubs were found all districts, some are found both districts. The effect of districts was significant ($P<0.05$) on the *Moringa, Arundinaria alpina, and Erythrina brucei* types of trees in the study area. This type of trees and shrubs were more obtained and support livestock in areas. This may be due to adaptation case of species. *Ficus* species contributes a higher proportion than other types of trees and shrubs at both Bonke Dita districts. This may be due to adaptation of *Ficus* species specially *ficus sur* which are mostly found both in highland and midland of the study area and contains high canopy leaf weight.

Table 5. Biomass yield of trees and shrub in mean leaf weight (in tons) across districts

		Districts				
Scientific name	Browses	Bonke	Dita	M/Abaya	Overall	*P*- value
Erythrinabrucei	Trees	0.609	0.117	0.085	0.27	0.000
Ficus sur	Trees	0.676	0.935	1.15	0.921	0.112
Arundinaria alpine	Trees	0.333	0.243	0.033	0.203	0.000
Dombeya torrid	Trees	0.114	0.072	0.063	0.083	0.050
Hygenia abyssinica	Trees	0.195	0.193	0.144	0.177	0.085
Moring	Trees	0.001	0.005	0.534	0.179	0.000
Oxytenanther abysca	shrubs	0.002	0.004	0.004	0.003	0.144
Total		1.967	1.570	2.017	1.851	0.821

3.4.7 *Dry matter of non- conventional feeds*

According to the face-to-face interview of respondents in the study districts, non-conventional feed resources were among the important livestock feeds which presented in Table 6. In the current study, it is not possible to get a clear conversion factor, but measuring real data from households' response that consumption of non-conventional feeds to their livestock. As result, utilization of non-conventional feeds like *enset* stem, residues of *areke, tela and kitchen* left over were supporting livestock feed requirements. Accordingly, the result of survey data, the overall mean of 0.078 tons of feed dry matter was produced in surveying households of districts per year. The effect of districts was significant (P<0.05) on dry matter production from forestland. According to survey result, the mean of dry matter production from non-conventional was 0.002, 0.021 and 0.213 tons in Bonke, Dita and Mirab Abaya districts, respectively.

Table 6. Different feed resources available

Feed supply	Districts			Overall	P-Value
	Bonke	Dita	M/Abaya		
Improved forages	0.118	0.078	0.064	0.087	0.207
Enset leaves	0.151^{b}	0.226^{a}	0.063^{c}	0.147	0.001
Crope resudues	1.294	1.514	1.314	1.374	0.750
Private grazing lands	0.146	0.221	0.258	0.208	0.572
Fodder trees& shrubs	1.967	1.570	2.017	1.851	0.821
Aftermath grazing	0.158^{a}	0.048^{b}	0.042^{b}	0.083	0.000
Forestland	0.003^{b}	0.045^{b}	0.179^{a}	0.075	0.000
Fallow land	0.383^{a}	0.024^{b}	0.102^{b}	0.169	0.000
Communal grazing	0.314	0.504	0.407	0.409	0.515
Non convetional feed	0.002^{c}	0.021^{b}	0.213^{a}	0.078	0.021
Total	5.635	5.846	5.861	5.782	0.724

Means with the different superscript ($^{a, b, c}$) in the same row of districts are significantly (P<0.05) different

3.4.8 Nutrient supply, requirements and estimated balance of livestock

According to the daily DM requirements for maintenance of 1 TLU (250 kg livestock) which consumes 2.5% of its body weight is 6.25 kg DM/d and a crude protein (CP) content of 58 g/kg DM and 5.2 MJ ME/kg DM diet is used (Kearl, 1982), whereas 1 LSU (450 kg livestock) which consumes 10 kg DM/day/animal and crude protein content of 70 g/kg DM and 8.368 MJ ME/kg DM diet for maintenance is used (Winrock, 1992). So, in the current study dry matter, crude protein, and metabolizable energy availability, requirements and estimated balance of feeds of livestock were presented in Table 7.

The overall mean of dry matter supply of feed from natural pasture grazing, crop residues, crop aftermath grazing, fallow land, woodland grazing, fodder trees and shrubs was

5.635, 5.846 and 5.86 tons /year in three districts. The overall mean of annual DM, CP and ME requirement of livestock was 11.255tons, 10.422tons and 69.074tons, respectively. But the overall mean of annual DM, CP and ME supply of livestock feed was 5.782tons, 0.925tons and 36.429tons, respectively. The overall mean dry matter of feed supply in the study districts for livestock was below the requirements which indicated that 51% livestock were not satisfied in the study area. So, the requirements of livestock were not balanced with the yield from different feed resources in study districts. The effect of districts was significant ($P<0.05$) on the mean of DM, ME and CP requirement and balance in the study areas. This may be due to the chemical composition of feed types. However, it was not significant ($P>0.05$) on the mean of DM, ME and CP supply of livestock. In agreement with current study, Bedasa (2012) also indicated that the annual dry matter production was below annual livestock requirements of the Blue Nile basin in Ethiopia.

Table 7. Nutrient availability, requirements & estimated balance of feeds of livestock

Estimated nutrients (ton)	Districts			Overall	P Value
	Bonke	Dita	M/Abaya		
DM supply	5.635	5.846	5.86	5.782	0.965
DM required	12.939^{a}	10.972^{ac}	9.85^{c}	11.255	0.002
DM balance	-7.29^{a}	-5.126^{b}	-3.99^{c}	-5.47	0.044
DP supply	0.902	0.935	0.93	0.925	0.965
DP required	13.482^{a}	9.760^{bc}	8.02^{c}	10.422	0.002
DP balance	-12.58^{a}	-8.83^{bc}	-7.08^{c}	-9.497	0.002
ME supply	35.506	36.832	36.950	36.429	0.965
ME required	95.182^{a}	61.492^{bc}	50.547^{c}	69.074	0.002
ME balance	-59.677^{a}	-24.66^{bc}	-13.507^{c}	-32.644	0.006

Means with the different superscript ($^{a, b, c}$) in the same row of districts are significantly different

4. Conclusion

The fodder trees and shrubs were a potential to support livestock in the study districts throughout the year, especially during dry season. The overall mean and standard error of the estimated biomass yield of trees and shrubs was 1.369±0.108 tons DM/HH/year. In highland area, the palatable and perennial fodder trees were *Erythrina brucci, Ficus sur Arundinar alpina, Ficus sure, Dombeya torrida* and *Hagenia abyysinica* supported feed for livestock. The overall mean of DM, ME, and the CP requirement of livestock was higher than the actual feed produced, hence negative balance was recorded in all study districts. The overall mean of livestock population of 4.934 TLU of sampled households was needed 11.255 tons of dry matter feed per year for maintenance requirement alone, but the current production was only 5.782 tons that support livestock only. The existing feed supply can satisfy only 51 % of the annual maintenance

DM requirement of livestock units in study districts. Therefore, to overcome these feed shortages during the critical time of the year, the respondents were undertaking destocking, conserving crop residues and purchasing other feed types from local farmers as solution of the feed shortage problem in the study districts. Feed shortage is critical and it exists throughout the year in the study area. The existing feed supply cannot satisfy the optimum livestock. Since feed conserving practices, feed quality improvement strategies and development of indigenous and improved forage production should be taken, further research and development works should be designed to increase the development of indigenous and improved forage production should be taken. The contribution of improved forage in livestock feed was low in the current study may be due to land shortage, lack of awareness, lack of forage seeds and lack of interest. To alleviate this problem, nursery sites should be established in potential *kebeles* of the districts and to share knowledge as well as to disseminate these feeds among farmers. The most respondents were using different types of fodder trees and shrubs for their livestock feeding, but the nutritive value of such feeds not known so its quality should be further determined in the future.

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