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Livestock feed production and feed balance in meta-Robi District, West Shewa Zone, Oromiya Regional State, Ethiopia

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The study was carried out in Meta Robi district, West Shewa Zone, Oromia Regional State to identify the types of livestock feed resources and estimate annual feed produced, maintenance requirement and annual feed balance. Secondary data sources and field observations, key informants discussions and semi-structured questionnaire interview were employed to generate data. The district was stratified into upper, mid and lower altitudes and a total of 90 respondents (upper=30, mid=30 and lower=30) were randomly selected and interviewed individually. The results of the study indicated that the major feed resources were grazing of natural pasture (58.9%), wheat straw (42.4%), barley straw (30%) and hay (21.1%). During the dry season, 90% of the respondents feed their animals crop residues, hay (55.6%) and stubble grazing (35.6%). Natural pasture was the major feed source during the wet season. The total maintenance DM of feed requirement of the animals in the district was 388,859.8 tons while the actual DM of feed production was 212,047.15 tons. The total DM of feed produced per year fulfilled the maintenance requirement of the animals only for 6.54 months of the year in the district. According to the opinion of the sampled households, in the rest of the year, animals suffer from feed shortage which resulted in weight loses, mortality and milk reduction.

Key words: Feed production, Maintenance requirement, Feed balance

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 Growth Domestic Product (GDP) and the share to total exports is about 16% (Yayneshet, 2010). In spite of this, the productivity of livestock is low mainly due to factors such as poor genetic makeup of local animals, poor nutrition and poor veterinary care among which poor nutrition is the major limiting factor (Yeshitila *et al.,* 2008). 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).One of the major problems to low milk production in the country is associated with shortage of livestock feeds both in quantity and quality, especially during the dry season (Zewdie, 2010).The role of natural pasture grazing as a major livestock feed resource is diminishing from time to time due to shrinking grazing land size (Yayneshet, 2010). During years of good rainy season, forage is not sufficient to feed livestock in the highlands for reasons associated with restricted grazing land and poor management (Melese *et al.,* 2014).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, further restricts the availability of herbage for the grazing animal to four or five months of the wet season over most of the natural grasslands of the country (Ulfina *et al.*, 2013). In selected wheat based crop-livestock production systems of the Ethiopian highlands, the contribution of crop residues and aftermath grazing account for 70 % of the total feed supply, while native pasture accounts for only 30% of the total feed supply (Seyoum *et al*., 2001).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). In the highlands of Ethiopia, the annual DM production could satisfy only two-third of the total DM requirements of the livestock due to this during the dry season animals lose 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). Natural pasture and crop residues are the major feed sources for livestock in Meta Robi district of west shewa zone Ethiopia where this study was conducted. The total livestock population of the district was 171,177.88TLU and a comprehensive survey on the types, quantity, livestock requirement and feed balance was not carried out. With this background, this study was conducted to assess the type of feed sources, estimate annual feed produced, total maintenance requirement and annual feed balance.

MATERIALS AND METHODS

Description of the study area

Location and area coverage

The study was carried out in Meta Robi district, West Showa Zone, Oromia Regional State, Ethiopia. It is located at 101 km west of the capital city of the country. The altitude of the district ranges from 1,376–2,904 meter above sea levels (masl). The total land area of the district is about 93,769 ha; crop land = 51,762.9 ha, grazing land = 11,775.94 ha, forest land = 6,792.75 ha and land used for other purposes= 23,437.4.

Climatic condition and topography

The minimum and maximum temperatures of the district were 15 and 31^{0}C, respectively. The district receives average annual rainfall ranging from 750–1,300 mm. The main rainy season is from June to September. The topography of the district is characterized to be flat land (60%), valley (8%), mountains (9%) and ups and downs (23%) (Meta Robi district Agricultural office annual report, 2013/14).

District and Kebele selection

The district was selected due to the presence of relatively large number of local animals, availability of large grazing and crop lands and marginality of the district to most technological interventions as compared to the neighboring districts. Out of 41 rural kebeles, 9 kebeles representing upper altitude (3 kebeles), mid altitude (3 kebeles) and lower altitude (3 kebeles) were selected using a stratified random sampling method in consultation with the districts' livestock expert based on the Ethiopian agro-ecological classification (Dereje and Eshetu, 2011).

Assessment of feed resources availability

To determine the availability, sources and types of livestock feed in the district, data were collected both from primary and secondary sources. Secondary sources of data were collected by reviewing different documents from relevant district offices like livestock production and health agency, agriculture and land management. This was followed by group discussions with key informants containing 8-12 individuals including men, women and young households, livestock expert and development agents. One group discussion was carried out in each agro-ecology of the study district. Based on the outcomes of the two (literature review and group discussions) a semi-structured questionnaire was prepared to elicit information from the sample households. Primary data were obtained from the questionnaire survey during the course of the study. A total of 90 households from 9 kebeles (10 hh from each kebele) were selected randomly and interviewed independently. A pre-tested questionnaire was used to collect data by interviewing individual farmers at their farm gates. The survey was conducted between March- May 2014.

Estimation of annual feed availability

The quantity of feed DM obtained annually from different land use types was calculated by multiplying the hectare of land under each land use types by its conversion factors. A Conversion factors of 2.0, 0.5 and 0.7 tons DM/ha/year were used for natural pasture, aftermath grazing and forest land, respectively (FAO, 1984). The quantity of available crop residues produced by farmers was estimated by converting crop yield to straw yield (Kossila, 1984; FAO, 1987; Kossila, 1988; De Leeuw *et al.,* 1990). Accordingly, for a ton of wheat, barley and *tef* straws, a multiplier of 1.5 was used, for faba bean and field pea a multiplier of 1.2 was used (FAO, 1987), for noug seed and linseed a multiplier of 4.0 was used (Kossila, 1984; FAO, 1987**)**. For maize a multiplier of 2.0 (De Leeuw *et al.,* 1990) and for sorghum a multiplier of 2.5 was used (Kossila, 1988). The total quantity of potentially available crop residues for animal consumption was estimated by multiplying the crop residue yield by 90% assuming that 10% wastage of the feed mostly occurs during feeding and/or used for other purposes (Tolera, 1990).

Estimation of livestock population and Dry matter requirement

The total livestock population of the district was converted to tropical livestock unit (TLU) as recommended by Jahnke, (1982) for local animals. Therefore, the conversion factors for local oxen and bulls, cows, heifers and calves were 1, 0.7, 0.5 and 0.2, respectively. For sheep and goats conversion factors of 0.1, horses 0.8, donkeys 0.5, mules 0.7 and poultry 0.01 was used. The DM requirement of an animal was calculated based on the daily DM requirement of 250 kg dual purpose tropical cattle (an equivalent of one TLU) for maintenance requirement that needs 6.25kg/day/animal or 2281 kg/year/animal (Jahnke,1982).

Statistical analysis

The survey data was stratified into altitude zones coded and analyzed using the Statistical Package for Social Sciences (SPSS version 17). Mean, percentages and standard error of various parameters were calculated for each altitude zones of the study district.

RESULTS AND DISCUSSION

Land holding and land use pattern of the households

The total land holding of the respondents was the lowest in lower altitude (2.7 ha/hh) as compared to 4.5 ha/hh in the upper and 4.2 ha/hh in mid altitudes (Figure 1). In the study district, the average total land owned by the households was 3.8 hectares ranging from 0.5 to 12 ha. The average land holding of the respondents in the study district is higher than the average national land holding size (0.96 ha/hh) and Oromia region (1.15 ha/hh) (CSA, 2011). The average land size allocated for crop production varied between 1.66 to 2.27 ha while that of grazing land 0.77 to 1.45 ha. In general, the households in the study district allocated about 2.05 ha (53.1%) for crop production and 1.22 ha (31.60%) for grazing. Bedasa (2012) reported that the amount of land size allocated for crop production was 1.7 ha (70%) and grazing land was 0.4 ha (16.6%) in Jeldu district west shewa zone. The land allocation differences in these neighboring districts might be due to differences in farming system.

Livestock population and herd composition

The total populations of livestock in the district were estimated to be 171,177.88 TLU. As shown in table 1, cattle comprised 82.11% of the total TLU of the livestock population in the district. About 36.32% of the cattle were cows followed by oxen (27.19%), heifers (20.39%) and bulls (16.08%). In agreement to the current study, in highland production system of the country, cattle comprised 92 % of total TLU and about 37% of the cattle herd was cows and steers (18%) (Funte *et al.,* 2010). In the same report, the percentage of oxen (19%) and heifers (7%) were contrasting with the current study mainly due to the purpose of the farmers keeping livestock vary according to production system. The overall average TLU of livestock per household in the study district is 7.97, 0.74, 0.46, 0.78, 1.44, 0.8 and 0.07 for cattle, sheep, goats, donkeys, horses, mules and poultry, respectively. Contrary to the current study, the average TLU of cattle (5.35), sheep (0.49), goats (0.03), donkeys (0.22), horses (1.32) and poultry (0.02) in Jeldu district were reported (Bedasa, 2012). These differences among neighboring districts might be due to the farming system and/or gazing land availability differences. The large number of sheep (0.74 TLU) than goats (0.46 TLU) owned per HH might indicate the fitness of these animals in the production system as the area is suitable for sheep production.

Major livestock feeds in the district

The major feed resources in the district are natural pasture grazing, crop residues such as wheat and barley straw, hay, *Atella* and crop aftermath which are similar to the feed resources in most highlands of Ethiopia (Lemma *et al*., 2002; Alemayehu, 2003; Tolera *et al.,* 2012). Generally, natural pasture and crop residues were the dominant feed resources in the study district but agro-industrial by products such as noug seed cake, linseed cake, molasses, brewery by products, non-conventional

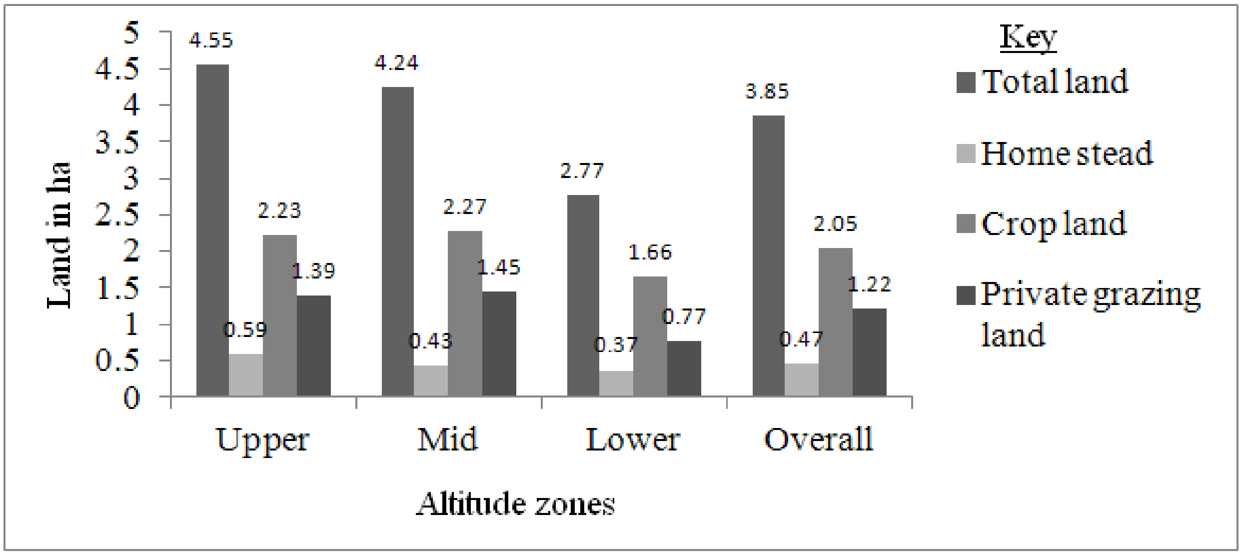

Figure 1: Land holding and use patterns of the sampled households in Meta Robi district

Table 1: Livestock population of Meta Robi district

Animals species	Population	TLU equivalent *	Total TLU
Cattle			140,561.3
Cow	72,944	0.7	51,060.8
Oxen	38,222	1	38,222
Heifer	57,333	0.5	28,666.5
Bulls	22,612	1	22,612
Sheep	59,321	0.1	5932.1
Goat	58,105	0.1	5810.5
Donkey	11,181	0.5	5590.5
Horse	15,213	0.8	12,170.4
Mule	590	0.7	413
Poultry	70,008	0.01	700.08
Bee Colonies	20,182	-	-
Total			171,177.88

* Jahnke (1982)
Source: Survey result

feed and improved forage were uncommon and rarely used. The major feed types in the upper altitudes of the district are natural pasture, wheat straw, *teff* straw, maize stover and hay whereas in mid altitude natural pasture, *teff* straw, wheat straw and barley straw in their descending order. In lower altitude *teff* straw, wheat straw, sorghum and maize stover contributed the most in their descending order.

Feed resources during dry and wet seasons

During dry season, 90% of the respondents use crop residues followed by hay (58.8%) and stubble grazing (56.1%) (Table 4). According to Abate *et al.* (2010) straw from maize, sorghum and teff was used mainly during the dry season in south eastern parts of the country. Contrary to the current study, Tesfaye (2008) reported that the major dry season feed resources for cattle in Metema district were natural pasture (55.7 %), crop residues

Table 2: Mean local cattle holding size of the sampled households in three altitude zones of Meta Robi district in TLU

Altitudes	Oxen		Cows		Bulls		Heifers		Calves	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	mean	SE
Upper	3.00	2.13	2.33	1.51	1.92	1.29	1.05	0.5	0.5	0.3
Mid	2.63	1.35	2.17	1.14	1.74	0.93	1.27	0.56	0.32	0.2
Lower	2.36	0.91	1.35	0.7	2.09	0.83	0.93	0.5	0.3	0.16
Overall mean	2.66	1.54	1.95	1.23	1.92	1.05	1.09	0.55	0.35	0.24

Table 3: Small ruminants, Equine and Poultry holdings of the respondents in TLU

Species	Upper		Mid		Lower		Overall mean	
	Mean	SE	Mean	SE	Mean	SE	mean	SE
Sheep	0.98	0.82	0.65	0.25	0.31	0.09	0.74	0.95
Goats	0.37	0.26	0.45	0.32	0.47	0.32	0.46	0.31
Donkey	0.85	0.32	0.77	0.29	0.72	0.36	0.78	0.33
Horses	1.67	0.97	1.12	0.76	1.00	0.4	1.44	0.9
Mule	1.19	0.45	-	-	0.8	0.00	0.8	0.00
Poultry	0.06	0.03	0.04	0.02	0.08	0.03	0.07	0.03

Table 4: Dry and wet seasons feeds in the study district

Feed type	Dry season				Wet season			
	1^{st}	2^{nd}	3^{rd}	4^{th}	1^{st}	2^{nd}	3^{rd}	4^{th}
Crop residues	90%	8.25%	-	-	-	30.6%	20%	-
Hay	10%	58.8%	21.05%	-	-	36.7%	31.4%	-
Fodder	-	3.52%	3.5%	9.5%	-	8.16%	21.70%	13.3%
Stubble grazing	-	24.7%	56.1%	9.5%	-	2.04%	-	-
Concentrates	-	2.35%	7.01%	23.8%	-	-	2.85%	6.66%
Natural pasture	-	-	1.75%	-	100%	-	-	-

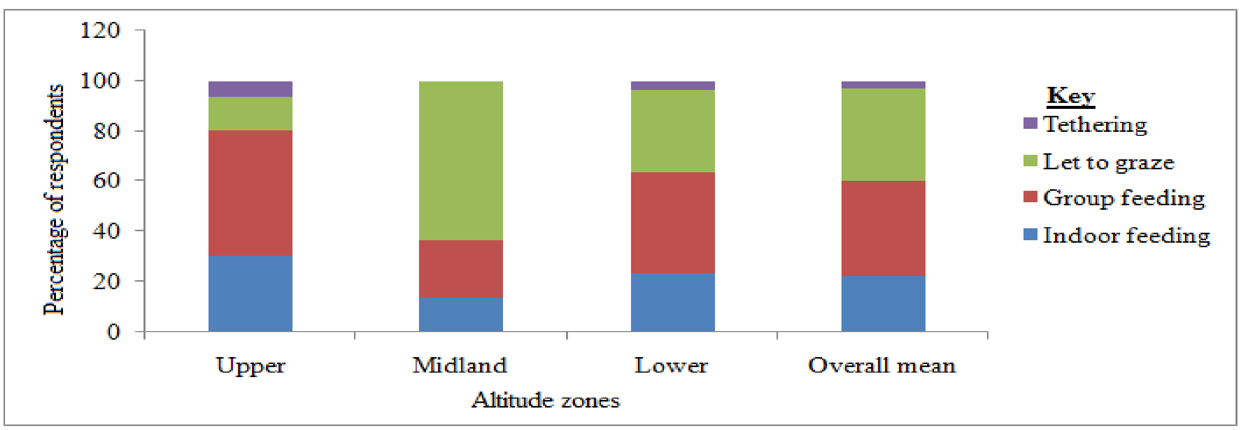

Figure 2: Livestock feeding systems in Meta Robi district

(20.7%), stubble (14.3 %) and hay (9.3 %) and this is mostly due to agro- ecological and farming systems differences between the two districts. In wet seasons, all the respondents (100%) in the three altitudes use natural pasture followed by hay and crop residues to feed their animals (Table 4).

Table 5: Grazing systems practiced in the district

Types of grazing	Upper altitude	Mid altitude	Lower altitude	Overall mean
Continuous	43.3%	60%	83.3%	62.2%
Differed	56.7%	40%	13.3%	36.7%
Zero grazing	-	-	3.3%	1.1%

Table 6: Watering systems and frequency of watering in the study district

Watering system	Upper Altitude	Mid Altitude	Lower altitude	Overall mean
Group watering	83.3%	100%	80%	87.8%
Individual watering	-	-	16.7%	5.6%
Both system	16.7%	-	3.3%	6.7%
Frequency of watering				
Once in a day	48.27%	3.3%	66.7%	39.42%
Twice in a day	51.72%	93.3%	13.3%	52.77%
Ad libitum	-	3.3%	20%	7.8%

Livestock feeding and grazing systems

Livestock owners follow different feeding systems for efficient utilization of the available feeds. In the study district, 22.2, 37.8, 36.7, and 3.3% of the respondents feed their animals in indoor, group feeding, let to graze and tethering, respectively (Figure 2). In Jeldu district 94.5, 4.4 and 1.1% of the respondents practiced let to graze, cut and carry and tethering, respectively (Bedasa, 2012). As indicated above, large percentage of farmers practiced group feeding system and in that feeding system all age categories of animals feeding together so that it is difficult for younger animals to satisfy their daily dry matter requirement as some of the animals can consume more than others. Similarly, the percentage of farmers allowing their animals to grazing land are also high (36.7%) and in this feeding system, the farmers could not know either the daily dry matter requirement of the animals is fulfilled. In the study district, tethering is only practiced by 3.3% of the households and mostly practiced by farmers having small number of animals, labor shortage and practicing fattening of the animals.

In the study district, among the grazing systems, continuous grazing, deferred grazing, and zero grazing systems were practiced by 62.2, 36.7 and 1.1%, respectively (Table 5). In the upper and mid altitudes, only continuous and differed grazing was practiced. Generally, in the study district, the percentage of respondents practicing continuous grazing are the highest (62.2%) which indicate that the grazing land could be over grazed and degraded through time unless correction measures are taken.

Watering system, source of water and watering frequency

The watering systems in the upper, mid and lower altitudes were almost similar where 83.3, 100 and 80% of the respondents practicing group watering system, respectively (Table 6). In the study district in general, the majority (87.8%) of the respondents practiced group watering system and livestock get water from river (97.8%) and pond (2.2%). In the present study, livestock get water on average distance of 1.4 km. Getting water sources at the nearest distance can save their energy that is otherwise wasted in searching water. About 52% of the respondents water their animals twice a day, 39.42% once a day and 7.8% *ad libitum*. This indicates that water availability and sources was not a major problem. Similar to this study, Belay *et al.* (2012) reported that in Ginch area there are three water sources and these include rivers, streams and springs and majority of the households (98%) water their animals at river. On the same report, during the dry season, watering takes place almost all at rivers and streams and 80.3% of the respondents water their animals once in a day whereas 19.7% twice a day.

Estimation of annual feed availability

Natural pasture production

In the district, about 12,979.5 ha of grazing lands is available and therefore, the total dry matter production from natural pasture is 25,959 tons per year. The amount of natural pasture produced by the respondents was

Table 7: Estimated quantity of feed DM obtained from different land use types

Land use type	Area in hectare	Conversion Factors*	Total DM Production(tones)
Grazing lands	100.5	2	201
Aftermath grazing	185.02	0.5	92.51
Forest lands	16.7	0.7	11.69
Subtotal			**305.2**

* FAO (1984) and FAO (1987)
Source: 2013/14 Annual Report of Meta-Robi district Agricultural office

Table 8: Crop and straw yield production in Meta Robi district

Crop type	Total land plowed (ha)	Grain yield in tones	Conversion factor*	Crop residues yield in tones
Maize	4308	15,600.22	2.0	31,200.44
Sorghum	6296	17,823.4	2.5	44,558.5
Teff	9873	22,066.6	1.5	33,099.9
Wheat	9308	35,778.9	1.5	53,668.35
Barley	1129	3360.4	1.5	5040.6
Oats	105	120.5	1.7	204.85
Bean	2060	4089.6	1.2	4907.52
Pea	1926	3278.9	1.2	3934.68
Noug	1119	1040.8	4	4163.2
Total				**180,778.04**

* Kossila (1984); FAO (1987); Kossila (1988); De Leeuw *et al.* (1990)
Source: 2013/14 Annual Report of Meta-Robi district Agricultural office.

estimated from the pasture land holding of the respondents. The pasture land holding of the respondents in upper, mid and lower altitudes was 37.75, 42.15 and 20.25 ha, respectively. Therefore, the DM feed production in the upper, mid and lower altitudes was 75.5, 84.3 and 40.5 tons/year, respectively which sums up to a total of 201 tons dry matter per year (Table 7).

Crop residues production

Crop residues are one of the dominant feed sources in most parts of Ethiopia especially during the dry season of the year. A total of 180,778.04 tons of crop residues were produced from different crop types in the district (Table 8). According to Tolera (1990), 10% of the crop residue loss is expected due to several factors. According to Tolera (1990), 10% of the crop residue loss is expected due to several factors. Therefore, 162,700.23 tons of dry matter of crop residue was obtained from the total crops produced in the district. The total crop residues produced per year in the upper, mid and lower altitudes was 243.39, 239.95 and 157.33 tons, respectively. The proportion of crop residues as animal feed (76.72%) is higher as compared to other feed types in the district, this result is in agreement with Yeshitila *et al*. (2008) who reported that of all feed resources produced, crop residues alone accounted 78.72% of livestock feed supply.

Crop aftermath

The contribution of crop aftermath in livestock feeding is significant especially in dry season when feed availability is limited to crop residue, hay and aftermath grazing. In the district, a total of 37,266 ha of land were covered by different crop types. The conversion factor of stubble gazing into total dry matter yields is 0.5 (FAO, 1987). Therefore, 18,633 tons of feed was obtained per year from crop aftermath in the district. In the upper = 33.5; mid= 34.2 and lower= 24.91 tons of crop aftermath was produced. These crop aftermath are majorly obtained from wheat, barley, *teff* and maize stover in the upper and mid altitudes whereas *teff*, wheat, maize and sorghum stover in lower altitude.

Forest land dry matter production

In the district, the total area of land covered by forest was 6,792.75 ha (Annual report of 2013/14 of Agricultural office). The conversion factor used to get total dry matter production from forest land is 0.7 (FAO, 1987). Therefore, a total of 4,754.92 tons feed dry matter was produced. The total dry matter production from forest land in the upper altitude is (10.29 tons), mid (2.62 tons) and lower altitude is (2.1 tons). This indicates that forest land availability which could be the source of livestock feed in the upper altitude was relatively higher.

Dry matter requirement of livestock in the district

The DM requirement is calculated based on the daily DM requirement of 250 kg dual purpose tropical cattle (an equivalent of one TLU) for maintenance requirement that needs 6.25kg/day/animal or 2281 kg/year/animal (Jahnke, 1982). Therefore, the total dry matter requirement of 170,477.8 TLU is 388,859.8 tons per year. The annual dry matter requirement of livestock in upper altitude is (710 tons), mid (593.03 tons) and lower altitude (486.08 tons). From this result, the total dry mater requirement in the upper and mid altitudes is higher than lower altitude. This is due to relatively large number of livestock in upper and mid altitudes.

Estimated annual feed balance

The current dry matter production of feed from natural pasture grazing, crop residues, crop aftermath grazing and forest and uncultivated land in the district was 212,047.15 tons per year. The total dry matter requirement for 170,477.80 TLU is 388,859.86 tons per year. The total dry matter produced per year in the district, can only supply the animals for 6.54 months. In the rest of the year, animals suffer from feed shortage. In upper, mid and lower altitudes, the total dry matter of feed obtained per year was 362.68, 360.71, and 224.84 tons, respectively whereas the total TLU in upper, mid and lower altitudes were 311.27, 259.99 and 213.1, respectively. Therefore, the total dry matter produced in these areas can only supply the animals for 6.12, 7.29 and 5.55 months in the year in upper, mid and lower altitudes, respectively. In agreement to this study, in Metema district, the existing feed supply on a year round basis satisfies only 72.7% of the maintenance DM requirement of livestock (Tessema *et al.,* 2003). Bedasa (2012) also indicated that the annual dry matter production was below annual livestock requirements in the highlands of the Blue Nile basin.

CONCLUSION

The current study was carried out to assess the prevailing feed resources and feed balance in Meta Robi district, central highland of Ethiopia. The total livestock population of the district is 171,177.88 TLU of which 82.11% are cattle. The major feed resources in the district were natural pasture grazing, crop residues such as wheat and barley straw, hay, *Atella* and aftermath. During dry season, 90% of the respondents use crop residues followed by hay (58.8%) and stubble grazing (56.1%) while during wet season all the respondents (100%) in all altitudes use natural pasture. The annual DM feed production in the district is sufficient only for 6.54 months. In the upper, mid and lower altitudes the total DM feed production can only support the animals for 6.12, 7.29 and 5.55 months, respectively. According to the opinion of the sampled households, in the rest of the year, animals suffer from feed shortage which resulted in weight loses, mortality and milk reduction. Even though, the available feed recourses are reported to be adequate only for about half of a year, the contribution of other feed resources like bushes and shrubs should not be ignored as this feed types were not considered during the study period due to lack of information.

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