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Estimation of major livestock feed resources and feed balance in Moyale district of Boran Zone, Southern Ethiopia

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The study was conducted to assess the major livestock feed resources and estimating annual feed production and feed balance in Moyale district of Boran Zone, Southern Ethiopia. A simple random sampling technique was employed to select the household's (HHs) and 96 representative households were selected. Data were collected using group discussions, structured questionnaire, secondary data and personal observations. As it was identified in the study district, natural pasture, crop residues and agro-industrial by-product were major feed resources for the livestock. An average of 129,461.0156 tons of feed dry matter (DM) per year was produced in the district from the major available feed resources, and the demand for maintenance requirement of the livestock population in the district was 190,054.416 (tons DM/year) and this showed that a deficit off 60,593.4004 (31.88%) tons of DM per year in the district. Drought, feed shortage, water scarcity, disease and parasite, market and theft and predator were assessed to be the major livestock production constraints. Generally, the results from this study confirmed that the total dry matter produced from different feed resources in to the study area was not enough to satisfy the dry matter requirement of livestock to support the livestock production in to the study area, which suggest that the main focus needs to be refining the existing feed resources through restoration of tainted grazing areas, introduction compliant feedstuff production, improving feed utilization practices and introduce and promote the crop residue feed improvement.

Key words: Feed availability, feed balance, feed requirement, feed resources.

INTRODUCTION

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; Legesse et al., 2010). According to Sefa (2017) animal feeds including; natural pasture, fodder crops, fodder trees, crop residues and non-conventional feeds are used in different parts of Ethiopia. Green fodder (grazing) is

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the major type of feed (54.59%) followed by crop residues (31.60%), hay (6.81%) and industrial by-products (1.53%), (CSA, 2017).

Alemayehu et al. (2017) reported that feed in terms of both quantity and quality is bottleneck to livestock production in Ethiopia. This problem of feed shortage is more aggravated during the dry season (Zewdie, 2010). Even during years of good rainy season, forage is not sufficient to feed livestock in the highlands (Melese et al., 2014). Data from different parts of the country also indicated that available feed satisfy about 78.2% of demand (Sefa, 2017).

To obtain improvement in animal production and productivity, an assessment should be done on the types and sources of livestock feed (Endale, 2015). Further studies that aim to integrate feeds that have better nutritive values into the feeding system are required to evaluate feed intake, digestibility, level of inclusion (supplementary feeds), animal's responses, and anti-nutritional factors for more efficient utilization of these indigenous and well adapted feed resources for sustainable animal production (Deribe, 2015).

The pastoral population occupies a large area of Ethiopia mainly the arid and semi-arid lowlands that are characterized by high spatial and temporal variability in rainfall distribution and pattern (Kula et al., 2016). In these areas, livestock production is dependent mainly on natural vegetation composed of herbaceous and woody species. There is a marked seasonal fluctuation in the availability and quality of the natural vegetation. Availability of such information is paramount importance in designing the development strategies, research plans and intervention options for both livestock production and natural resource management. Therefore, this study was initiated with the objective to assess the major available feed resources, estimating annual feed production and feed balance in Moyale district of Boran Zone, Southern Ethiopia.

MATERIALS AND METHODS

Sampling procedures and data collection

This study was carried out in Moyale district of Borana Zone, Southern, Ethiopia. The district is located at 775 km south of Addis Ababa and has an area of 14,810 km^2. The altitude of the district ranges from 1150 to 1350 m above sea level. Out of the total 16 kebeles of the district, 5 kebeles were selected purposively, based on feed resources availability and livestock production potential. Simple random sampling technique was employed to select the households (HHs). The total number of households sampled for the study was calculated based on the formulas given by Cochran (1977) $n = Z^2(1.96)^2 pq/d^2$, where, *n*, desired sample size; *Z*, abscissas of the normal curve (The acceptable likelihood of error of 10%): 1.96. The value of *Z* at 90% confidence interval; *P*, estimated proportion that one is trying to estimate in the population, that is, 50% ; *q*, *1-p*; *d*, desired absolute precision level at 90% confidence interval. The primary data was collected through interview and it was supported by secondary data from associations, developmental workers, experts, local administrations, pastoralist and rural development office of the study district, and non-governmental organizations.

Methods of data analysis

The quantitative data collected from individual respondents were entered into the Microsoft Excel template and analyzed. Qualitative data were examined and summarized for each topic. Indexes were developed to provide the aggregated ranking of major feed resources in the study district [(5 × number of responses for 1st rank + 4 × number of responses for 2nd rank + 3 × number of responses for 3rd rank + 2 × number of responses for 4th +1× number of responses for 5th)] divided by (4 × total responses for 1st rank + 3 × total responses for 2nd rank + 2 × total responses for 3rd rank + 1 × total responses for 4th rank) the higher the rank for a given reason, the greater its importance. All the collected data were arranged, organized and analyzed by using simple descriptive statistics such as mean, frequency and percentage by using SPSS version 20.

Estimation of feed balance

Feed demand in district was estimated by considering all ruminant and non-ruminant with exception of poultry livestock species reported by the district offices of agriculture and converting to tropical livestock units (TLU) using FAO (1987) methodology. The daily DM requirement for maintenance of one TLU is estimated to be 2.5% of the body weight (ILCA, 1991). Livestock to TLU conversion factors were used (Jahnke, 1982). The feed balance for district was estimated by subtracting the demand for maintenance requirement of the livestock population in the district (tons DM/ year) from the available feed DM (tons/ year) which was acquired from pastoral development office. The amount of feed DM attained annually from diverse land use types was calculated by multiplying the hectare of land under each land use types by its conversion factors (FAO, 1984). The quantities of available crop residues produced by farmers were estimated by converting crop yield to straw yield (FAO, 1987) and (De Leeuw and Tothill, 1990) and considering 10% wastage (Adugna and Said, 1994). The potential fodder yield of shrubs and trees are estimated by using an equation of Petmak (1983). Accordingly, leaf DM yield of fodder trees were predicted using the allometric equation of log W = 2.24log DT-1.50, where W = leaf yield in kilograms of dry weight and DT is trunk diameter (cm) at 130 cm height. Available concentrate feeds also considered.

RESULTS AND DISCUSSION

Socio–economic conditions of the study community

Household characteristics

The household characteristics of the respondents are presented in Table 1. From the interviewed households 1.0, 93.8 and 5.2% were single, married and divorced, respectively. The present finding is little far apart with that reported by Bizelew et al. (2016) in Gambella regional state, southwestern Ethiopia. The observations were in line with the report of Tesfaye and Melaku (2017) from Dendi district, West Shoa zone, Ethiopia. Out of the overall respondents, 67.7 and 32.3% were male and female headed households, respectively, the result was

Table 1. Marital status, sex, ethnic group and religion of respondents in the study area.

Variable	Kebeles					Overall (n=96) %
	Buladi (n=12)	Beede (n=13)	Bokola (n=27)	Tilemado (n=18)	Dambii (n=26)	
Marital status						
Single	0.0	0.0	3.7	0.0	0.0	1.0
Married	100.0	92.3	96.3	94.4	88.5	93.8
Divorced	0.0	7.7	0.0	5.6	11.5	5.2
Household heads						
Male	58.3	69.2	59.3	66.7	80.8	67.7
Female	41.7	30.8	40.7	33.3	19.2	32.3
Religion						
Muslim	83.3	69.2	70.4	66.7	46.2	64.6
Orthodox	0.0	7.7	7.4	0.0	0.0	3.1
Protestant	0.0	15.4	11.1	5.6	15.4	10.4
Waqefata	16.7	7.7	11.1	27.8	38.5	21.9

Table 2. Educational status and main source of income of the respondents in the study area.

Variable	Kebeles					Overall (n=96)%
	Buladi(n=12)	Beede (n=13)	Bokola (n=27)	Tilemado (n=18)	Dambii (n=26)	
Educational status						
Illiterate	91.7	30.8	88.9	61.1	46.2	64.6
Reading and writing	8.3	30.8	7.4	27.8	26.9	19.8
Elementary	0.0	23.1	3.7	0.0	7.7	6.2
Secondary	0.0	15.4	0.0	11.1	19.2	9.4
Main source of in come						
Crop selling	0.0	7.7	0.0	0.0	0.0	1.0
Livestock selling	0.0	15.4	0.0	5.6	0.0	3.1
Livestock products selling	66.7	53.8	92.6	77.8	84.6	79.2
Both livestock and their products selling	33.3	23.1	7.4	16.7	15.4	16.7

slight similarly with that of Gebreegziabher et al. (2016) indicated that 79.6 and 20.4% were male and female, respectively, from Humbo district of Wolaita zone, southern Ethiopia. These findings are not in close with reports of Zewdie and Yoseph (2014) who reported that 93.35 and 6.65% were male and female, respectively and Amistu et al. (2017) who stated that 82 and 18% were male and female, respectively, from the central rift valley of Ethiopia and Gibe district of Hadiya zone, southern Ethiopia respectively. From the overall respondents 64.6, 3.1, 10.4 and 16.7% of them was Muslim, orthodox, protestant and Waaqefata, respectively (Table 3).

Educational status and main source of income

Educational level and main source of income of respondents is presented in Table 2. Accordingly, the results pertaining to the educational status of the respondents indicate that most (64.6%) of the respondents were illiterates. The findings were not in close accordance with that of Belete et al. (2017) (27.67%), but in close with those of Amistu et al. (2017) (72%) and Gashe et al. (2017) (56.7%) from Bale zone, Oromia regional state, Gibe district of Hadiya zone, southern and Gozamen district, east Gojam zone, Amhara region, Ethiopia respectively. High level of illiterate demand for better appropriate livestock husbandry extension services which can be easily followed by the respondents (Mulugeta et al., 2015).

The proportion of respondents capable of reading and writing was 19.8%; few of the respondents have attended elementary school (6.2%) and secondary school (9.4%) education. A similar result was reported for pastoral

Table 3. Land holding size (Mean ± SE), trend of land holding (%) and the reason for land holding change (%) in the study area.

Variable	Kebeles					Overall (n=96)
	Buladi (n=12)	Beede (n=13)	Bokola (n=27)	Tilemado (n=18)	Dambii (n=26)	
Total land holding (ha)						
Homestead	0.1±0.05	0.04±0.04	0.1±0.04	0.1±0.04	0.1±0.03	0.1±0.02
Crop land	0.8 ± 0.2	0.8 ± 0.1	1.1 ± 0.1	0.7 ± 0.1	0.8 ± 0.1	0.9 ± 0.1
Grazing land	0.6± 0.3	0.3± 0.1	0.2 ± 0.1	0.5 ± 0.2	0.4 ± 0.1	0.4 ± 0.1
Trend over time						
Decreasing	58.3	23.1	81.5	50.0	65.4	60.4
Increasing	0.0	0.0	0.0	0.0	0.0	0.0
No change	41.7	76.9	18.5	50.0	34.6	39.6
The reason for change						
Settlement	33.3	23.1	81.5	44.4	61.5	55.2
Tribal conflicts	16.7	0.0	0.0	0.0	0.0	2.1
Variability of rainfall	8.3	0.0	0.0	5.6	0.0	2.1
Other(demarcation)	0.0	0.0	0.0	0.0	3.8	1.0

n= number of respondents, SE= standard error.

production system in Gambella regional state, southwestern Ethiopia (19.4, 26.1 and 7.8%), reading and writing, elementary school and secondary school, respectively, by Bizelew et al. (2016).

The major sources of income for all respondents were livestock product sale, and both livestock and their product sale (79.2%) and (16.7%), respectively (Table 4). This finding were similar with a review of Kula et al. (2016) who stated that livestock rearing is the main means of livelihoods and source of income. Furthermore, the findings show that most of the respondents in the study area is pastoral and partially dependent on agronomic activities, the production of crop was too small and that is not exceed for house consumption.

Land holding

In Moyale district the mean total land holding per household was 1.4ha, out of which, the size of homestead, crop land and grazing land were 0.1, 0.9 and 0.4 ha, respectively (Table 3). There was no significant (P>0.05) difference in land holding among the studied kebeles. The total land holding of the study was comparable with total land holding of 1.34 ha and 1.3 ha respectively, reported by Bizelew et al. (2016) and Jimma et al. (2016) in Gambella regional state, southwestern Ethiopia and SNNPRS of Ethiopia, respectively. However, the present result was lower than the values of 1.8 ha reported by Gebreegziabher et al. (2016) in Humbo district of Wolaita zone, Southern Ethiopia and 3.23 ha reported by Kenenisa and Meles (2016) in Adami Tullu Jiddo Kombolcha district, Oromia regional state, Ethiopia. The present study indicated that the crop land was higher than other land holding types due to the grazing land and homestead area were occupied by people for settlement, there was illegal inhibition of land, locally called *kaloo* as informal reported by the respondents.

Out of the overall respondents, the majority (60.4%) reported that there was decrease in land holding size in the district while, 39.6% of the respondents reported no change. The reasons for the changes of land holdings were settlements (55.2%), tribal conflicts (2.1%), rainfall variability (2.1%) and illegal inhabitation (1.0%), (Table 3). The results of the present study also showed that most of the respondents could access communal grazing lands.

Available feed resources in Moyale district

In the present study, three major different feed resources were identified and categorized into (1) natural pasture (grasses, browse and herbaceous legumes), (2) concentrates (wheat bran) and (3) crop residues. However, the contribution of agro-industrial by products such as noug seed cake, linseed cake, molasses, brewery by products, non-conventional feed resources like food refusal, vegetable refusal, sugarcane residue and improved forage were uncommon and rarely used. These findings were similar to the reports of Yadessa

et al. (2016) in Meta-Robi district, West Shewa zone, of Oromiya regional state, Ethiopia.

Seasonal variations in the availability of feed resources

The respondents were asked to identify and rank the major feed resources in both dry and wet seasons (Table 4). Accordingly, fodder trees, hay, crop residues, concentrates and stubble grazing were ranked 1st, 2nd, 3rd, 4th, and 5th, respectively, during the dry season. During the wet season, natural pasture (1st), fodder trees (2nd), hay (3rd), crop residues (4th) and stable grazing and concentrates (5th) were ranked by the respondents. The major feed resources identified in the present study were in agreement with the reports of Emana et al. (2017) in Abol and Lare district of Gambella region, Ethiopia; Dawit et al. (2013) in Adami Tullu Jiddo Kombolcha district, Oromia regional state, Ethiopia and Kassahun et al. (2015) from Horro and Guduru districts of Oromia regional state. In consistent with results of the present study, Alemayehu (2004) reported fodder trees and shrubs are important feeds in Ethiopia especially in the arid and semi-arid areas; and Sefa (2017) reported crop residues are the main feeds during the dry season. Moreover, Andualem (2016) stated that, most browse species have the advantage of maintaining their greenness throughout the dry season when grasses dry up and deteriorate in quality and quantity.

Estimation of annual feed availability and feed balance

Dry matter production from different land types

According to Pastoral Development Office (2016) report, there are different land types; around private (individual) grazing land (8,284.52 ha), open/communal grazing land (24,559.58 ha), fallow land (1,340.88 ha) and forest land (1502 ha) in the study area. From this area of land, the higher tons of dry matter (49,119.16) were produced from open grazing land, and whereas, approximately the lowest tons of dry matter (1,051.4) feed was produced from forest land (Pastoral Development Office of Moyale, 2016). Productivity (t/ha) were obtained by multiplying the hectare of land under each land use types by its conversion factors for private (individual) grazing land (3.0), open (communal) grazing land (2.0), fallow land (1.8) and forest land (0.7) (FAO, 1984). Productivity of DM t/ha from different land types are shown in Figure 1.

Grazing land dry matter production

Rendering to data adapted from pastoral development office of the study area (2016), the total hector of communal and individual grazing lands were 24,559 and 8,284.52 ha, respectively. Besides the total amount of DM available in natural pasture was determined by multiplying the average value of grazing land holding with conversion factor of 2t DM/ha/year for communal grazing land and 3tDM/ha/year for individual grazing land (FAO, 1984). Amount of DM obtained from communal grazing land and individual grazing land was factored into total communal grazing areas of the district. Accordingly, 49,119.16 and 24,853.56 tDM/ha/year were produced from communal grazing land and individual grazing land, respectively.

Forest land dry matter production

Conferring to data obtained from pastoral development office of study area (2016), the total hector of forest land 1,502 ha. Moreover, the total amount of DM available in forest land was determined by multiplying the average value of forest land holding with conversion factor of 0.7 t DM/ha/year (FAO, 1984). Amount of DM obtained from forest land was factored into total forest land areas of the district. Accordingly, 1051.4 t DM/ha/year were produced from forest land.

Fallow land dry matter production

According to data obtained from pastoral development office of study area (2016), the total hector of fallow land was 1,340.88 ha. Moreover, the total amount of DM available in fallow land was determined by multiplying the average value of fallow land holding with conversion factor of 1.8 tDM/ha/year (FAO, 1984). Amount of DM obtained from forest land is factored into total forest land areas of the district. Accordingly, 2413.584 t DM/ha/year were produced from fallow land.

Crop residues dry matter production

The crop and natural resource office of Moyale district (2016) report had demonstrated that 19,726 ha of land are covered by cropping land. The agro pastoral communities in study area currently have been produced crop residues from maize, teff and haricot bean. The total area of different crop types grown is 18,109, 1,154.8 and 461.92 ha, for maize, haricot bean and teff, respectively. The crop residues (38,296.64 tons) are the second dominant feed resource in Moyale district next to open grazing land with supply of 49119.16 tons of DM from crop residues to feed livestock. Crop residues dry matter productions are shown in Figure 2.

Crop aftermath dry matter production

Rendering to crop and natural resource office of

Table 4. Major feed resources during both dry and wet seasons in the study area.

District (n=96)	Priority levels					index	Rank
	First	Second	Third	Fourth	FIFTH		
Feed types in dry season							
Natural pasture	0	0	0	9	87	0.07	5
Crop residues	12	38	29	18	0	0.23	3
Hay	32	32	28	3	0	0.26	2
Fodder trees	40	23	28	6	0	0.27	1
SG and concentrate(WB)	12	3	11	60	9	0.16	4
Feed types in wet season							
Natural pasture	96	0	0	0	0	0.33	1
Crop residues	0	1	15	36	44	0.11	5
Hay	0	2	50	36	8	0.17	3
Fodder trees	0	90	6	0	0	0.26	2
SG and concentrate (WB)	0	3	25	24	44	0.12	4

SG=Stubble grazing, WB= wheat bran, n= number of respondent, Index = [(5 × number of responses for 1st rank + 4 × number of responses for 2nd rank + 3 × number of responses for 3rd rank + 2 × number of responses for 4th +1× number of responses for 5th)] divided by (4 × total responses for 1st rank + 3 × total responses for 2nd rank + 2 × total responses for 3rd rank + 1 × total responses for 4th rank) the higher the rank for a given reason, the greater its importance.

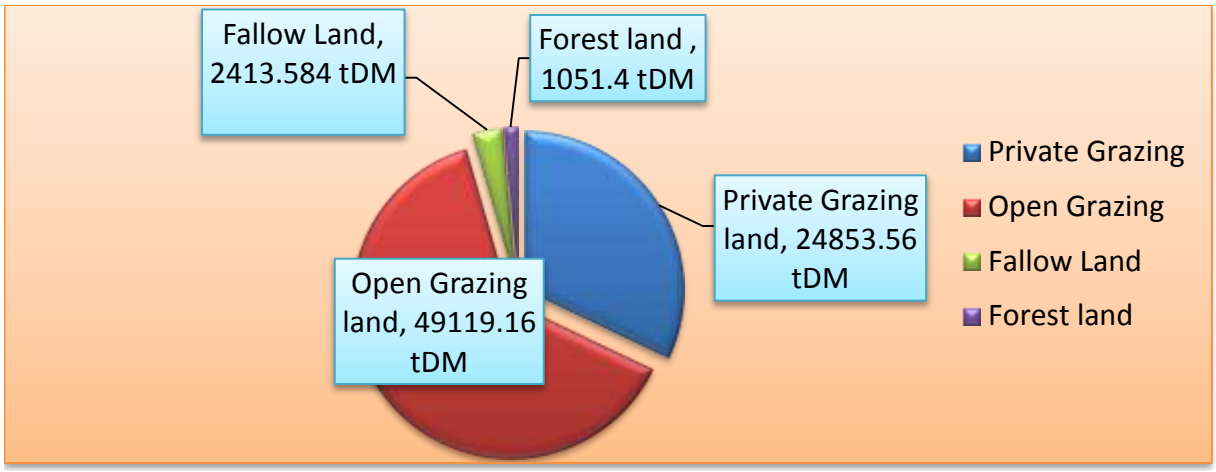

Figure 1. Total DM productivity (ton) from different land types in the study area (own computed).

Moyale district (2016) report had demonstrated that 19,726 ha of land covered by the cropping land. The quantities of available DM in crop aftermath grazing were determined by multiplying the available land by the conversion factors of 0.5 for grazing aftermath (FAO, 1987). Accordingly, 9,863 tons DM/ha/year was produced from crop aftermath.

Contribution of concentrate feed (wheat bran)

The quantity (DM basis) of concentrates (wheat bran) available for each household was obtained by interviewing the farmers during questionnaires survey. Accordingly, 1.3216 tons of DM was obtained from wheat bran in the study area; the contribution of wheat bran was very little as compared to other feed resource.

Trees and shrubs dry matter production

The potential fodder yield of shrubs and trees were estimated by measuring stem diameter using measuring tape and applying the equation of Petmak (1983). In quantifying tree feed resources from common property resources (e.g. open forest areas) at individual household

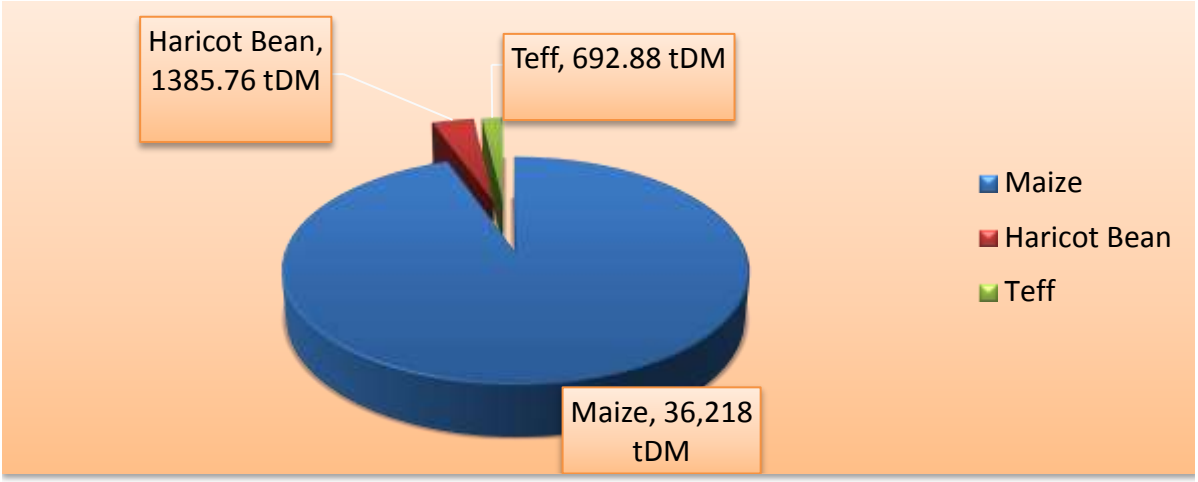

Figure 2. Crop residues dry matter production in the study area (own computed).

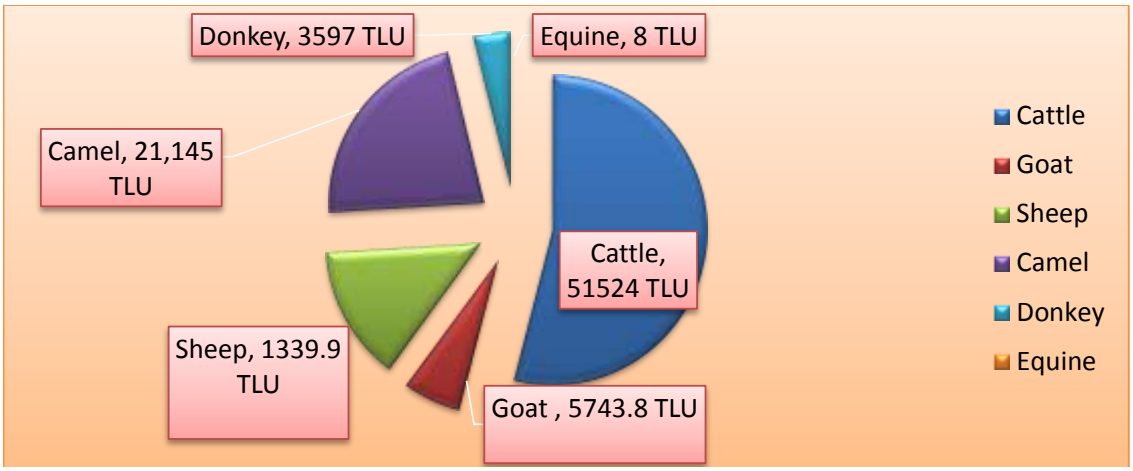

Figure 3. Different species of livestock population (TLU) in the study area (own computed).

level similar approaches, as communal grazing area mentioned earlier, was used. Empirical evidence from WBISPP (2004) suggests that only about 75% of all available DM is accessible by livestock for use and therefore this study area was used the same accessibility factor to quantify total DM utilized by livestock from grazing and browsing areas. Accordingly the total DM production of shrubs and trees in the study was 3,862.35 tons obtained from communal and forest land.

Total tropical livestock unit (TLU) and their dry matter requirement

Based on the reported data of pastoral development office of livestock (2016) of Moyale district, the district had an average (83,357.2) tropical livestock unit (TLU); comprising (51524 cattle, and 5,743.8 goats, 1,339.9 sheep, 21,145 camels, 3,597 donkey and equine, 7.5), (Figure 3). Assuming that DM requirement for maintenance of one TLU is 6.25 kg/day (2.28 ton/year/TLU) (ILCA, 1991). Accordingly, the estimated total annual requirements of DM by the dominant livestock species were cattle (117474.72), goat (13095.8 64), sheep (3054.972), camel (48210.6), donkey (8201.1 6) and equines (17.1). Totally about 190,054.416 tons of DM per year for different livestock species is required in the district. Different species of livestock population (TLU) in the study area are shown in Figure 3.

Feed balance

The open grazing land, private grazing land, fallow land

Table 5. Major constraints to livestock production in the study area.

Constraints	Priority levels						Index	Rank
	First	Second	Third	Fourth	Fifth	Sixth		
Drought	87	7	3	0	0	0	0.28	1
Water scarcity	2	14	44	13	11	16	0.17	3
Feed shortage	6	75	10	0	0	0	0.22	2
Disease and parasite	1	0	35	55	4	1	0.16	4
Market and theft	0	0	3	21	54	18	0.10	5
Predator	0	0	1	7	27	61	0.07	6

n= number of respondent, Index = [(5 × number of responses for 1st rank + 4 × number of responses for 2nd rank + 3 × number of responses for 3rd rank + 2 × number of responses for 4th +1× number of responses for 5th)] divided by (4 × total responses for 1st rank + 3 × total responses for 2nd rank + 2 × total responses for 3rd rank + 1 × total responses for 4th rank) the higher the rank for a given reason, the greater its importance.

and forest land, concentrate feed (wheat bran), indigenous browse, shrubs and crop residues were used to calculate feed supply for livestock in the study area. The total of 81,300.054 tons of DM per year was produced from different land use types with exception of crop land; concentrate feed (wheat bran) and aftermath grazing which produce 38,296.64, 1.3216 and 9,863 tons of DM per year, respectively.

As it had been calculated the total DM produced in the study area from different feed resources was 129,461.0156 tons and the demand for maintenance requirement of the livestock population in the district was 190,054.416 (tons DM/ year). The feed balance for the district was estimated by subtracting the demand for maintenance requirement of the livestock population in the district (tons DM/ year) from the available feed DM (tons/ year), and this showed that a deficit off 60,593.4004 (31.88%) tons of DM per year in the district. In general, the feed balance data showed that the DM produced in the study area per year was imbalanced with the minimum maintenance requirements of dominant livestock species. Similarly, in previous studies, challenges in Ethiopia showed that the dry season is characterized by inadequacy of grazing resources, because of which animals are not able to meet even their maintenance requirements and lose of substantial amount of their weight (Aster et al., 2012). This further recalls that there is need to introduce the feed improvement interventions in the study area in order to save the livestock.

Major constraints to livestock production

Livestock production in the study area has been primarily hampered by drought (mean rank 0.28), feed shortage (0.22), water scarcity (0.17), disease and parasite (0.16), market and theft (0.10) and predator (0.07) (Table 5). Furthermore, drought was one of the main constraints which lead the farmers to travel a long distance in search of feed. In agreement to the results of the present study, Hidosa and Tesfaye (2018) reported that climate change is one of the non-technical livestock feed production constraints, which has been affected livestock production through induce decline in pasture availability. Furthermore, Bizelew et al. (2016), Gebreegziabher et al. (2016), Kenenisa and Melese (2016) and Amistu et al. (2017) reported that feed shortage is one of the major constrains to livestock production in Ethiopia, which is in support of the results of the present study.

CONCLUSION AND RECOMMENDATIONS

The natural pasture, crop residues and agro-industrial by-product are major feed resources in the study area. Drought is one of the main constraints which lead the farmers to travel along distance for feeding livestock. Moreover, as it had been calculated the total DM produced in the study area from different feed resources was 129,461.0156 tons and the demand for maintenance requirement of the livestock population in the district was 190,054.416 (tons DM/ year). The annual feed DM production in the district could not satisfy 31.88% of the DM requirement of livestock kept in the area. The study described that the contribution of the open grazing area is declining from time to time and livestock may not fulfill the DM requirements. Therefore, this calls for interventions that improve the productivity of declining grazing areas such as rehabilitations of retreated grazing area through the introduction and promoting area closures, over sown with locally adaptable legume forages and fertilization with livestock dungs and droppings. For more efficient utilization of the available feed resources such as crop residues feed treatments should be introduced and practiced.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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