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Research Article

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Assessment of major livestock feed resources and its nutritional value in Soddo district, East Gurage zone, Central Ethiopia

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Abstract

The objective of this study was to assess livestock feed resource and nutritional values at different Agro ecologies of soddo district, east Gurage zone, central Ethiopia. The kebeles of the district were stratified in to two Agro- ecological zones and representative kebeles were selected from the two agro-ecology. .A total of 166 sampled respondents were selected Simple random and data were collected by using semi- structure questionnaire interview, and personal observation. The result of the study showed that the livestock production system in the district was a mixed crop-livestock production system. The overall family size per household was 6.72±0.27in high land agro ecology and 7.45±0.33in midland agro ecology , the average cattle population per household was 7.17±0.30 heads (6.84TLU), and the overall land holding was 1.29±0.325 ha per household in this study. . In the highland agro-ecology of the study areas, the major feed resources of cattle were crop residue, natural pasture, , Enset leaf, and leaf midribs, while it was natural pasture, crop residue, , and maize Stover in midland agro-ecology. Annual feed supply in the district satisfies 68.9%, 79.7% TDM, 44.83%, 39.36% TDCP, and 69.46%, 83.25%TME of the maintenance requirement of livestock in TLU per year in highland and midland agro-ecologies, respectively. Major livestock constraints are shortage of feed, poor genetic potential of indigenous breed, high-cost feed, inadequate extension and training service. Therefore, different intervention strategies are needed to improve the husbandry practices, mainly to improve the feed resource available and. Cattles feed deficit was serious problem and needs strong intervention and attention by the concerned bodies.

Keywords: Chemical composition, Constraints, Feed resources, Tropical livestock unit

1. Introduction

Background

Ethiopia covers 1.1million KM^2 total land area. It is the home for many livestock species and suitable for livestock production. The country is endowed with diverse agro-ecological zones and suitable agricultural environmental conditions (Shapiro *et al*. 2017). The livestock population of the country comprises of 59.5million heads of cattle, 30.7million sheep, 30.2million goats and 56.53million poultry. Ethiopia has the highest draft animal population in the continent (Zeleke, 2017). About 98.95% of the total cattle population is local breeds and the remaining are hybrid and exotic breeds (CSA 2013). The livestock sub-sector contributes to the livelihoods of 60-70% of the Ethiopian population.

The socio-economic contribution of livestock include production of human food and proteins of animal origin, generation of family income, creating job opportunities, contribution towards food security, provision of agricultural inputs and services, contributions to asset, social and cultural values and sustain livelihoods (FAO, 2018; Kebede *et a l.* 2016). At the country level, the Ethiopian livestock sub-sector contributes 17 and 39% of national and agricultural GDP respectively. If the contribution of organic fertilizer and animal power is taken into account, the livestock sub-sector contribute about 21 and 49% of the country's and agricultural GDP respectively (Shapiro *et al*. 2017).

The overall contribution of the Ethiopian livestock sub-sector is disproportionally small compared to the huge livestock population, indicating that the productivity per animal and per unite area is low due to several intricate factors such as inadequate nutrition, widespread diseases, poor genetic potential of local breeds, market problem and inefficiency of livestock development services with respect to credit, extension, and infrastructure (Benin *et al.* 2003; Jabbar *et al*. 2007; Negassa *et al*. 2011; Solomon *et al.* 2003; Sere *et al*. 2008). Among these problems feed availability and quality is the major constraints to the livestock subsector development in Ethiopia (Adugna *et al.* 2000; Ahmed *et al*. 2004; Alemu, 1997; Berhanu *et al.*2002; De Leeuw 1995; HSU, 1994; IFAD, 2008;Tesema and Halima, 1998; Tesfaye *et al.* 2008) together with determination of agro-ecology, season and resource based nutrient composition of available feed sources.

During the dry season, plant growth is highly suppressed; shortage of forage availability reduces growth of grazing animals. This also affects nutrient requirements and bioavailability of minerals in grazing animals. Furthermore, in the dry season, most ruminants reared on grass alone have problems in meeting their maintenance requirements and consequently lose weight gained during the wet season (Aregheore, 2001; Kassahun, 2016). Soddo district (in East Guragie zone) is one of the district of CENTRAL ETHIOPIA which suffers in feed shortage both in quality and quantity. Until now the available feed resources are not determined both in quality and quantity as many district of the country. Thus, determining the nutrient content of the available feed resources is the paramount for the district to cope the impacts of seasonal variability of the available feed resources nutrient compositions. The objectives of the study were to determine the nutrient composition and digestibility differences of the available feed resources , nutrient composition and digestibility differences

1.2. Statement of the Problem

It is evident that the majority of research projects on the assessment of feed resources in various regions of the country to date undertaken simply indicated the scarcity of feeds without identifying the major accessible feed resources, not only in Soddo district but also in the country in general. This makes it extremely difficult to provide a potential fix to cow farmers, especially during Ethiopia's severe drought seasons. In order to make recommendations for improving the existing feed resources, introducing new feed alternatives, or suggesting development and policy interventions for each agro ecology, it is

crucial to assess the existing feed resources was sampled of Soddo district Kebeles in terms of quantity and quality in relation to the requirements of cattle on an annual basis in the study area.

2. Objectives

2.1. General Objective

- To assess the available Livestock feed resource and nutritional value of the livestock feeds in Soddo district, Gurage zone, SNNPRS Ethiopia.

2..2. Specific Objectives

- To identify and estimate amount of the available livestock feed resource in study area
- To evaluate the chemical composition of livestock feeds in study area

3. Materials and Methods

3.1. Description of Study Area

The study was conducted in Soddo district, East Gurage Zone, Central, Ethiopia. The district is about 103 kilometers south of Addis Ababa. Geographically, it is located at 8.08N–8.3N and 38–38.37E, with an altitude range of 1800–3040 masl. The study area has an annual rainfall of 908.875 mm and an annual temperature range of 17.975. The district has two agro-ecologies: mid-altitude (1800-2300 masl) agro-ecologies (65percent of total district area) and highland agro-ecologies (above 2300 masl) agro-ecologies (35percent).Topographically, the district comprises 40, 23, 7, and 7percent plains, ups and hills, ranges, and mountains, respectively. The total area of the district is 684.7 square kilometers. The total population of the district (77308 males and 76848 females). Among the population, 93.5 % are rural, and the rest, 6.5%, are urban residents The district has 7 municipal and 35 rural Kebeles (peasant associations), among which 12 Kebeles are located at high altitude (*Dega*) while the rest are at mid-altitude (*Weyna Dega*) (SWPDO 2024).

3.2. Selection of Participating Households

The Woreda was stratified in to two-agro-ecological zones i.e. highland and midland based on MoA (2000). A total of 14 Kebeles (1/3 from the total), in which 5 from the highland such as AmawuteGiftige, Gereno Betet Wenz, fatto , Genete Maryam,and Eshekede & 9 from midland such as Anati, Firshi, Buee Zuria, Semero, Adazer, Wudegetena Gefersa, Soloke, Adele Silasie,and Dugida Goro will randomly be selected for the study. The number of HHs for interview were:

$$N = 0.25/SE^2$$

Where N = number of sampled HHs, SE = standard error (Arsham, 2007).

By considering standard error of 3.86 percent at a precision level of 5 percent and 95 percent confidence interval, about 168 HHs respondents were selected. Farmers in each Kebele was selected based on systemic sampling. Finally all the required data aimed at identifications of the major feed resource was collected using the questionnaire shown in Annex I. The data to be collected on feed resource was include background information of the respondents, livestock population and species, seasonality and categories of feed resources, feeding system , water availability, coping mechanisms of feed and water shortage , land holding and use patterns, human population , livestock production system and other related parameters.

3.3. Feed Resource Sampling

Among the 14 Kebels for survey work, 3 Kebels from high altitude and 3 Kebels from mid altitude, totally, 6 Kebeles were randomly selected using *Simple Random Sampling* (On the basis of farmers' response, major feed source which were have respondents score value more than 5 percent, samples were collected. Using the information about sown crop species in selected Kebeles,1kg

samples from farmers' residue/Stover stock was collected. Those collected samples were sun dried and chopped and reserved in plastic bags. For the natural pasture sample, samples from closed land at both agro-ecologies in different locations were harvested. Additionally, sample from stubble source was collected.

3.4. Sample Preparation

Collected samples were dried by sun and chopped by knife and kept in bags. Then samples were weighed for DM estimation. Then samples were dried in an oven at 105^0C for 16hs. Weighing of feed samples for chemical analysis was done directly as taken from oven (hot weighing procedure) to protect moisture that has effect on the weight of samples. The sample was ground by Thomas–Wiley Laboratory mill (Model 4).

3.5. Chemical Analysis

Chemical analyses of samples were determined using standard analytical methods. Dry matter and ash contents of samples were determined according to the procedures of (AOAC, 2005). Kjeldahl method (AOAC, 2005) were used to determine total nitrogen (N) and crude protein (CP) calculation as N x 6.25. Neutral detergent fiber (NDF) was analyzed using the detergent extraction method as described by Van Soest. And acid detergent fiber (ADF) and acid detergent lignin (ADL) was analyzed according to Van Soest *et al.,* (1991) using Ankom

3.6. Methods for Calculation of Feed Requirements

3.6.1. Dry matter Requirement of Animals

The livestock number of different livestock species were converted to Tropical Livestock Units (TLU; 250 kg = 1 TLU) by taking factors of 0.7, 0.1, 0.1, 1, 0.5, 0.7 and 0.9 for cattle, sheep, goat, camel, donkey, mule and horse respectively Jahnke, 1982, Gryseels, 1988, (Yadessa *et al*., 2016b). Since absence of concrete information regarding indigenous / hybrid / exotic chickens, assessment and quantification feed sources for chicken were taken hazardous and omitted.

3.6.2. Metabolizable energy Requirement of Animals

3.6.2.1. Cattle and sheep

For these animal species, IPCC (2006) methodology based on estimation of Net Energy (NE) and then conversion to Gross Energy (GE) was followed. Thereafter, GE was converted to Metabolizable Energy (ME) using the factor of 0.81. For cattle and sheep, NE for maintenance, activity and growth was calculated. Also for cattle, NE for annual milk production and for sheep, NE for milk production equation used from the IPCC(2006) was included in the respective NE. For calculation of NE for activity according to IPCC (2006), milking cows were assigned to moderate grazing, dry cows and bulls to extensive grazing and draught animals were considered to work 6 h/day. The feed dry matter digestibility, estimated for diets generally consumed by livestock in Ethiopia was be taken as 46.5 percent FAO & NZAGGRC (2017) or calculation of NE for activity according to IPCC (2006) sheep of < 6 month of age was assigned to moderate grazing (1 km/day) and sheep > 6 months of age to extensive grazing (5 km/day).

3.6.2.2. Goat

Daily ME in MJ required for maintenance of 0.452 (body weight, BW)$^{0.75}$; and for growth, ME of 27.7 MJ/kg BW gain was taken (Salah *et al*., 2014). For estimation of ME for activity (grazing): for goat of < 6 months, it was taken as zero; for goats of age > 6 months and < 1 year, it was taken as 25 percent of maintenance; and for adult goats, it was 50 % of maintenance.

3.6.2.3. Horses

The DE of maintenance was taken as 33.3 kcal/kg BW (0.139427 MJ/kg BW) and ratio of ME to DE was 0.87 Ralston (2016), NRC (2007). Adult weight of horses used for calculation was 250 kg. For work, an additional 40 percent of the maintenance energy requirement was taken.

3.6.2.4 Donkeys and mules

For donkeys, maintenance requirement as DE, MJ/day was calculated as per NRC (1989) = [0.9 75+ (0.021*BW in kg)]*4.187. Adult weight of donkey used was 150 kg. For work, an additional 40 % of the maintenance energy requirement was taken. The DE was converted to ME by multiplying by a factor of 0.87. The approach used for mules were the same as donkeys except that the mature body weight taken was 200 kg. ME requirement for growth was not taken into consideration for horses, donkey and mules because of unavailability of reliable growth data.

3.7. Crude protein Requirement, mm of animals

3.7.1. Cattle

For maintenance, a value of 3.2 g digestible crude protein (DCP)/kg BW $^{0.75}$; and for growth, DCP requirement of 0.3 g DCP/g of average daily weight gain, ADG (Salah *et al*., 2014) values for tropical animals was used to calculate the requirement of DCP of maintenance and growth. These values was converted to CP requirement by taking CP digestibility of 52 %. Therefore, the values of 6.15 g CP/kg $BW^{0.75}$ for maintenance and 0.58 g CP/g ADG for growth was taken.

3.7. 2. Sheep

For maintenance, a value of 2.8 g digestible crude protein (DCP)/kg BW $^{0.75}$; and for growth, DCP requirement of 0.2 g DCP/g of average daily weight gain, ADG (Salah *et al*., 2014; values for tropical animals) was used to calculate the requirement of DCP of maintenance and growth. These values was converted to CP requirement by taking CP digestibility of 52 %. Therefore, the values of 5.38 g CP/kg $BW^{0.75}$ for maintenance and 0.3846 g CP/g ADG for growth was taken.

3.7.3. Goat

For maintenance, a value of 2.9 g digestible crude protein (DCP)/kg $BW^{0.75}$; and for growth, DCP requirement of 0.2 g DCP/g of average daily weight gain, ADG (Salah *et al*., 2014) values for tropical animals) were used to calculate the requirement of DCP of maintenance and growth. These values was converted to CP requirement by taking CP digestibility of **52** %t. Therefore, the values of 5.58 g CP/kg $BW0^{.75}$ for maintenance and 0.3846 g CP/g ADG for growth was taken.

3.8. Statistical analysis

Collected data was managed and organized with MS-Excel and was analyzed using statistical package for Social Science (SPSS) version 20 (SPSS, 2014). The nutrient content of feed resources and animal body weight difference was calculated. The statistical model used to fit the feed resource data was:

$Yij=\mu +Ti+ \varepsilon ij;$

Where,

Yij = measurable variable,
μ = overall mean of the nutrient
Ti = feed source type, animal species, agro
eij = random error term

4. Results

4.1. House Hold Characteristics

The household characteristics of the study area are presented in table 1. The proportion of male household heads(96.8%) was higher than female household heads(3.2%). This might indicate that males are more involved in the livestock production. Regarding to the age grouping, majority of respondents(47.9%),(44.1%), (8%) were at the age of 41-60 years and followed by 21-40 and 61-80 years, respectively. This result showed that about 92% of the respondents were at the age of 21-60 years which is good opportunity towards obtaining of workable labour power in the areas of agriculture in general and in animal husbandry in particular. However, there was significant difference ($P< 0.05$) between the two agro-ecological zones in terms of age categories.

Majority of the sample households (85.1%) in both agro ecologies of the study areas had opportunities of getting different level of education. Conversely, households of about 18.02% in the highland agro ecology and 11.7% in the midland areas were not in a position to get educational opportunities as the result they remain illiterate. About 81.91% of the farmers in highland and 88.29% of households in mid altitude areas have got the opportunity of education (Table 2). The educational level showed significantly difference (P< 0.05) between the two agro-ecologies. This variation might be associated with accessibility to schools.

The overall marital status of the respondents in the current study showed that majority of them (96.8%) were married while the rest (3.2%) were unmarried. Marital status didn't show significant (P>0.05) variation between the two agro-ecological zones. The cattle production system in the study area was identified as mixed crop-livestock production system which was characterized by production of livestock and cereal grains including Wheat, Barley, Bean, Pea and Enset (*Ensete ventricosum*) in high land and mid land areas of the study. Family size of respondents in the study area is indicated Table 2. The overall family size of the study area was 6.72±0.20. The average family size in the highland was 5.82±0.19, while it was 7.63±0.21in mid land. Out of the total population in the study area about 47.47% and 52.53 was male and female respective.

Table 1 Household characteristics of the study area in highland and mid agro-ecological
N=number households; n = number of households in each agro-e

Characteristics		Agro-ecology				Overall		χ 2 - value	p- valu e
		Highland		Midland					
		(n =71)	%	(n =95)	%	(N= 166)	%		
Sex	Male	69	95.8	93	97.8	161	96.9	1.38	0.19
	Female	3	4.2	2	2.2	5	3.1		
Age/year	21-40	26	36.6	48	50.5	74	44.5	7.50	0.02
	41-60	38	53.5	40	42.1	78	47.0		
	61-80	7	9.8	6	6.3	13	7.8		
Educational level	Illiterate	13	18.3	11	11.5	24	14.4	27.68	0.00
	Read & write	29	40.8	20	21.05	49	29.5		
	Primary	20	28.1	40	42.1	60	36.1		
	Junior school	6	8.4	15	16.0	21	12.6		
	High school	6	2.2	6	6.3	12	7.2		
	> high school	1	1.4	2	2.1	3	1.8		
Marital status	Married	68	95.7	93	97.9	161	96.9	1.37	0.19
	Unmarried	3	4.3	2	2.1	5	3.1		
Farming system	Livestock production	3	4.3	4	4.2	7	4.2	1.64	0.17
	Crop production	-		-		-	-		
	Mixed production	68	95.7	91	95.8	159	95.8		

Table 2 Demographic characteristics of HHs in the study area

Variables		Agro ecology					
		Highland(n=71)		Midland(n=95)		Overall(N=166)	
		N	%	N	%	N	%
<5year	Male	93	8.6	104	7.25	197	7.79
	Female	120	11	97	6.76	217	8.58
	Total	213	9.8	201	14.02	414	16.37
5-15 years	Male	88	8.9	130	9.06	218	8.6
	Female	129	12.7	159	11.08	288	11.39
	Total	217	10.7	289	20.15	506	20
16-40 years	Male	157	14.5	291	20.29	448	17.72
	Female	162	15.6	373	26.01	535	21.16
	Total	319	15.0	564	39.33	983	38.88
41-60 years	Male	163	12.4	125	8.7	288	11.39
	Female	162	13.4	124	8.6	286	11.35
	Total	325	12.8	249	17.36	576	22.78
>60years	Male	23	3.0	21	1.46	44	1.74
	Female	10	1.7	10	0.69	20	0.79
	Total	33	2.5	31	2.16	64	2.53
Total	Male	529	48.01	671	46.8	1200	47.47
	Female	565	51.99	763	53.2	1328	52.53
	Total	1094	43.27	1434	56.73	2528	100
	Mean	5.82±0.19	--	7.63±0.21	--	6.72±0.20	
	SE	0.190	--	0.215	--	0.202	

[a-b] = means in the same row with different letter of superscripts are significantly different ($P<0.05$), N= number of respondents, HH= household, %= percentage.

4.2. Landholding and Land Use System

The average landholding (ha) per HH and land use pattern in the study area is indicated in Table 3.

The overall landholding of the study area was 1.29±0.375 ha. However, the landholding in highland agro-ecological zone was 1.32±0.5a ha, out of which 0.9, 0.25, 0.1, 0.003, 0.002, 0.05ha of land were allocated for cropland, enset production, grazing land, forestland, fallow land and homestead, respectively. In the midland agro ecology the average land per house hold was 1.26±0.25 ha, of which 1.15, 0.065, 0.004, 0.004, 0.02, and 0.02ha were allotted for cropland, enset, grazingland, forest, fallow land an home stead land , respectively. The total landholding per household in highland agro ecology was significantly($P< 0.05$) higher than that of the mid land and the largest part of the land was allocated for annual crop production followed by grazing land in both agro-ecologies.

Table 3 Average landholding/HH and land use pattern in the study area of sodo district(Mean±SD)

Variables	Agro ecology			P-value
	Highland(n=71)	Midland(n=95)	Overall(N=166)	
Total land(ha)	1.32±0.05 [a]	1.26±0.25[b]	1.29±0.38	0.04
Crop land	0.9±0.50	1.15±0.25	1.03±0.38	0.02
Enset	0.25±0.01	0.065±0.01	0.17±0.01	0.01
Grazing land	0.10±0.03 [b]	0.004±0.02 [a]	0.052±0.02	0.000
Forest land	0.003±0.14 [b]	0.004±0.02 [a]	0.003±0.08	0.002
Fallow land	0.02±0.0	0.02±0.01	0.02±0.01	0.003
Home stead land	0.05±0.02	0.02±0.17	0.035±0.06	0.001
Land allocated for annual crops(ha)				
Wheat	0.25±0.13	0.15±0.05	0.20±0.04	0.000
Barley	0.125±0.05	**	0.065±0.02	
Teff	0.25±0.05 [a]	0.25±0.04 [b]	0.25±0.04	0.000
Maize	0.25±0.00 [a]	0.625±0.03 [b]	0.44±0.02	0.000
Bean	0.01±0.01 [b]	0.025±0.00 [a]	0.02±0.00	0.000
Pea	0.02±0.01 [b]	0.01±0.00 [a]	0.01±0.00	0.000
Sorghum	**	0.01±0.00 [b]	0.005±0.00	0.000

[b-a] = means in the same row with different letter of superscripts are significantly different ($P<0.05$), **= not grown in the area,HH=household, ha = hectare.

Table 4. Annual field crops yield and crop residues in tons per HHs in the study area of Soddo District in East Gurage zone(Mean±SD).

Type of crops	Agro ecology						P-valu
	High land(n=71)		Mid land(n=95)		Over all(N=166)		
	Grain yield	Straw	Grain yield	Straw	Grain yield	Straw	
Wheat	2.42±0.25 [b]	3.63±0.38	3.85±0.23[a]	5.77±0.38	3.14±0.24	4.71±0.3	0.01
Barley	1.54±0.24	2.31±0.36	**	**	0.77±0.12	1.16±0.1	
Teff	0.26±0.25[b]	0.39±0.38	1.74±0.11[a]	2.61±0.17	1.00±0.18	1.5±0.27	0.00
Maize	3.8±0.16 [b]	5.7±0.24	5.7±0.14[a]	8.55±0.21	4.75±0.15	7.13±0.2	0.01
Bean	0.37±0.19 [a]	0.44±0.28	0.05±0.8[b]	0.06±0.12	0.21±0.11	0.30±0.1	0.00
Pea	0.2±0.26[a]	0.25±0.39	0.01±0.7[b]	0.02±0.11	0.11±0.13	0.16±0.19	0.003

[b-a] = means in the same row with different letter of superscripts are significantly different ($P<0.05$), ** = not grown in the area, HHs = household

4.3. Crop Yield and Crop Residue Estimation

Crop yield and crop residues production in study area is indicated in Table 4. From the result of current study, it is clear that the types of annual crops grown were limited in number.. The major annual crops grown in highland agro-ecology of the study areas of Soddo district in East Gurage zone were wheat, barley, bean, pea and partially teff. Whereas wheat, teff and maize took the highest rank of production in midland agro ecology of the study area. Consequently, the biomass of wheat and barley straw were the largest among other crop residues produced in highland. The crop residues of wheat , teff and maize r encompass the largest portion of crop residues produced in midland agro ecology.

Table 5. Livestock size in Number and TLU in the study area of soddo district in East Gurage zone

Livestock Species	Agro ecology								
	High land				Mid land				
	Indigenous		Cross		Indigenous		Cross		
	N	TLU	N	TLU	N	TLU	N	TLU	
Cow	454	363.2	116	208.8	428	342.4	274	493.2	
Heifer	198	99	36	25.2	66	33	53	37.1	
Oxen	234	257.4	28	53.2	257	282.7	67	127.3	
Bull	48	52.8	6	11.4	59	64.9	13	14.3	
Calves	142	28.4	46	18.4	126	25.2	89	35.6	
Sheep	276	27.6	**	**	179	17.9	**	**	
Goat	117	11.7	**	**	212	21.2	**	**	
Donkey	54	27	**	**	93	74.4	**	**	
Horse	46	36.8	**	**	**	**	**	**	
Total	1569	903.9	232	317	1420	861.7	496	707.5	

N= number of cattle, TLU= tropical livestock unit

4.4. Trends of Cattle Population in the Past One Decade in the District

Respondent's perception about the trends of cattle population in the past one decade was indicated in figure 2 . Accordingly, about 31%, 44% and 25% of the respondents in the highland and about 16.5%, 66% and 17.5% in the midland areas of the study indicated that the cattle population in the last one decade (10 years) was in decreasing, increasing and no changing order, respectively. Trends of cattle population declining were higher in high altitude areas than midland agro ecology. The Major reasons reported by the respondent households for decreasing cattle population in the district were shortage of feed, manpower to manage cattle and reduction in production and reproductive performance of cattle owned by the households. (SWADO)

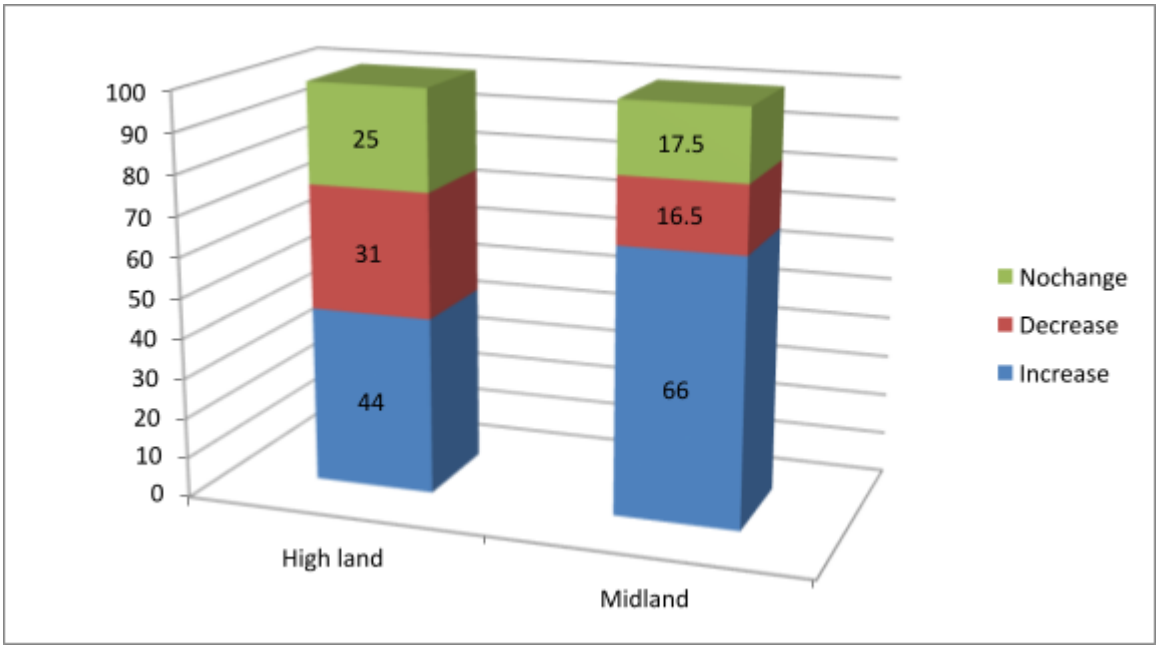

Figure 2 Trends of Cattle population in the past one decade in the study area of soddo district East Gurage zone

4.5. Livestock Management

4.5.1. Types of Livestock Feeds and Feeding System

Major feed resources available in the soddo district were indicated in Table 7. In highland and midland agro ecologies of soddo district cattle production system is characterized by extensive system of production. Households in the study areas largely depend on feeding of crop residue and natural pasture. According to the results obtained from current study, the common crop residues available in the district were maize Stover, wheat straw, teff straw, and barley straw.. Enset leaf and leaf midribs was also used as animal feed in highland agro ecology during long dry season to supplement the inadequate feed supplies from natural pasture and crop residue. In both highland and midland agro ecologies of the study areas households largely depend on grazing lands and crop residues to feed their livestock. Based on the responses of interviewed HHs (Table 7) about 43% and 57% from high land and 72% and 28% from midland agro ecology had a practice of individual and group feeding system, respectively.

Table 7. Major livestock feed resource and feeding system in the study area.

Feed resources	Agro ecology					
	Highland (71)		Midland (95)		Overall	
	n (index)	Rank	n (index)	Rank	N (index)	Rank
Natural pasture only (NP)	2(0.01)	5	1 (0.005)	4	3 (0.007)	5
Crop residue only (CR)	**	**	12(0.064)	3	12(0.031)	4
Industria by product(IBP)	**	**	**		**	
Enset only	2 (0.01)	4	**	**	2 (0.005)	6
NP &CR	24(0.127)	2	43(0.228)	2	67 (0.178)	3
NP, CR & IBP	19(0.10)	3	132(0.702)	1	151 (0.402)	1
NP, CR, IBP & Enset	141(0.75)	1	**	**	141(0.375)	2
Feeding system in %	%		%		%	
Individual feeding	43		72		57.5	
Group feeding	57		28		42.5	

IBP=Industrial byproduct, NP=Natural pasture, CR= Crop residue n = number of households per agro ecology, N = total number of households in the study

4.6. Chemical Composition and Nutritive Value of Feed

Table 8 shows the nutritional value (DCP (g/kg), IVDMD% ME (MJ/kg DM%), and chemical composition (DM%, ASH%, CP%, EE%, NDF%, ADF%, and ADL%) of the primary feed stuffs (maize stover, wheat straw, enset, teff straw, natural pasture, and barley straw) in the research region utilized for cow feeding. In the highland, the dry matter (DM) content of all feeds that were accessible for feeding cattle varied from 90.43% wheat straw to 92.53% enset, whereas in the midland agroecology, it varied from 91.12% wheat straw to 92.87% maize stoven and natural pasture. Barley straw had a dry matter (DM) content of 92%, whereas natural pasture on the highlands had a DM content of 91.23%.

The crude protein (CP) content of crop residues varied from 3.56 % in wheat straw to 9.07% in barley straw for high land and 3.09% in wheat straw to 5.87% in teff straw for midland agro-ecology. The CP value (9.92%) in high land and (8.19%) in midland was obtained from natural pasture. The CP content of natural pasture was higher in high land agro-ecology than in midland agro-ecology. The CP value (8.51%) obtained from enset leaf and leaf midribs was higher than the minimum CP value (7%) required for optimum rumen microbial function. The ash content of crop residues in the study area ranged from 9.11% barley straw to 9.22% wheat straw in the highlands and 9.09% teff straw to 9.37% wheat straw in the midlands The fat content (EE) of feed stuffs ranged from 0.27% wheat straw to 6.84% enset in highland, where enset had the highest EE content (6.84%). The (EE) contents of crop residues in midlan are maize stover (O.47%), wheat straw (0.76%), and teff straw (2.75%). The EE content of natural pasture in midland (1.9%) and high land (1.56%)

4.7. Estimated Annual Feed balance

Estimated annual nutrient supply of feed stuffs in highland and mid altitude agro ecology in the study area used for cattle feeding was indicated in Table 9. The annual nutrient supply of DCP of wheat straw, barley straw men's and natural pasture (6.9 kg,17.59 kg,16.5kg and 19.24kg) respectively in high land agro-ecology and the annual nutrient supply of DCP of wheat straw weight strap, maize Stover and natural pasture ; 8.97kg, 17.04kg, 12.19kg and 23.76kg respectively in midland land agro ecology.

Table 9. Estimated annual nutrient supply of feed stuffs in highland and midaltitude agro ecology in the study area of soddo district in East Gurage zone.

Feed stuffs	Agro ecology						P-value
	High land			Mid land			
	DCP(kg)	DM(t)	TME (MJ)	DCP(kg)	DM(t)	TME (MJ)	
Wheat	6.90 (11.45%)	483.80 [a] (36.28%)	3,348,218.85 (36.28%)	8.97 (14.48%)	494.21 [b] (27.52%)	3,632585.94 (27.52%)	0.04
Barley	17.59 (29.2%)	400.49 (30%)	2,771,658.06 (30%)	**	**		0.00
Teff	**	**		17.04 (27.5%)	454.22 (25.3%)	3,338,647.92 (25.3%)	0.00
Maize	**	**		12.19 (19.67%)	836.60 (52.16%)	6,149,251.13 (46.59%)	0.00
Enset	16.50 (27.39%)	436.47 (32.75%)	3,020,663.66 (32.74%)	**	**		0.00
Natural pasture	19.24 (31.94%)	12.54 a (0.92%)	86,785.17 (0.94%)	23.76 (38.35%)	10.45 b (0.58%)	76810.51 (0.58%)	0.03
TOTAL	60.23(kg)	1333.30(t)	9,227,325.74(MJ)	61.96(kg)	1795.48(t)	13197295.5(MJ)	

[b-a] = means in the same row with different letter of superscripts are significantly different ($P<0.05$), ** = not grown in the area, HHs = households, TME=total metabolism energy ,DCP=Digest able crude protein,DM=Dray matte

Table 10. Estimated annual nutrient supply, requirement and balance of animals in the study area of sodo district East Gurage zone

Livestock in TLU in Agroecology	Annual nutrient supply			Annual nutrient demand			Annual nutrient supply and demand balance		
	TDM(t)	TDCP(t)	TME (MJ)	TDM(t)	TDCP(t)	TME (MJ)	TDM(t)	TCP(t)	TME (MJ)
Highland = 1220.9	1333.3	60.23	9,227,325.74	1935.13	134.35	13,284,373.4	-601.83	-74.12	-4057047.6
Amawute = 640.4	734.57	33.17	5,058,563.45	1015.03	70.47	6968066.76	-280.46	-37.3	-1909503.31
Esheged=580.5	598.73	27.06	4,168,762.29	920.1	63.88	6316306.61	-321.37	-36.82	-2147544.32
Midland = 1569.2	1795.48	61.96	13197295.5	2252.8	157.42	15,852607.2	-457.32	-95.46	-2655311.72
Dugeda =432.2	517.29	17.82	3802117.44	620.48	43.38	4366235	-103.19	-25.56	-564117.56
Adlesilasie=362	422	14.56	3101910.32	519.7	36.32	3657050.6	-97.7	-21.76	-555140.29
Soloke =393	440	15.18	3189507	564.2	39.43	3970223.5	-124.2	-24.25	-780716.45
S	416.19	14.35	3103759.93	548.41	38.32	3859097.6	-132.22	-23.97	-755337.67

TDM = total dry matter, TDCP = total digestible crude protein, TME = total metabolizable energy, MJ = mega joule, (t) = ton

5. Discussion

5.1. Demographic Characteristics of Households

According to the results obtained from this study, the proportion of male to female households in the highland areas were 95.75% male, 4.25% female. Whereas the percentage of households in the midland areas of the study were about 97.87% male and 2.13% female with the overall average of about 96.81 % male and 3.19% female households in the current study. This result was relatively comparable with the results of 84.62% male and 15.38% female headed household reported by Gatwech (2012) in Gambella, south west Ethiopia, and 83.6% male and 16.4% of female headed households reported by Dirsha (2019) in Gurage zone southern Ethiopia.

The results of the current study indicated that the majority 96.81% of the household respondents were married and about 3.19% single. The result obtained in the current study was relatively comparable with the values of 97.4% married, 1.3% single and 1.3% divorced reported by (Bernabas *et al*., 2018) for Quara Districts in Northern Ethiopia. The average age of the HHs within the age interval of 21-80 years was 43.5±0.9 which is similar with the average age of 43.4±1.0 reported by Seid and Berhan (2014) in Burji Woreda, Segen Zuria Zone of SNNPRS, Ethiopia. This result has indicated that majority of the household were at the productive age groups and can manage their cattle.

5.2. Landholding and Land Use System

The average land holding per household was 1.32±0.5 ha in highland and 1.25±0.25ha in midland agro ecology. The overall average land holding in the study area, was 1.29±0.375ha which was lowest when compared with 2.91±0.18ha reported by (Andualem *et al*., 2015) in Essera Woreda, Dawuro Zone, Southern Ethiopia and 2.7ha was reported by Asaminew and Eyassu (2009) in North western highlands of Ethiopia. However, the reports of current study on the land holdings per HH was similar with 1.015ha reported by Ayalew (2017) in south Wollo Zone Amhara region Ethiopia, 0.9ha reported by (Abebe *et al* .,2014) in Ezha districts of the Gurage zone southern Ethiopia and lower than 2.5ha reported for the Dendi District in Oromia Region by (Belay *et al.,* 2012).

5.3. Livestock Population and Herd Structure

The holding size of local cattle was higher than the size of cross breed animal particularly in highland agro- ecology of the study areas due to lack of breed improvement practices. In highland areas, about 82.04% of households participated in the study kept local cattle breed that could be due to lack of awareness to use artificial insemination and improved bull service. However, the percentage of local breed ownership reported in this study was lower than 98.5% of local cattle ownership reported by Minale and Yilkal (2015) in Kucha Districts Southern Ethiopia. of the study. Similarly, the average household's ownership of 3.38±0.28 cows was higher than 1.4 cows per HH reported by (Abebe *et al*., 2014) in Ezha Districts of Gurage Zone, Southern Ethiopia and 1.22 cow per HH reported by Ayantu, (2006) in Wolaita Zone Ethiopia.

5.4. Livestock feed Management

5.4.1. Types of Livestock Feed Resources and Feeding System

The availability of feed resources in the study area depends on the season. However, crop residues,and natural pasture in most cases in mid-altitude were commonly used as cattle feed resources in the study areas. In addition to the other mentioned feed resources, feed from enset leaves and leaf midribs has been another opportunity to feed animals in the study area of highland agro ecology. The result of the current study is comparable to the result of Getu (2019).who reported that roughages including natural pasture ,grass hays, crop residues, and non-conventional feed resources are feed resources for dairy animals in Sebeta, Bedele, and Debre-Berhanareas.

5.5. Chemical Composition and Nutritive Value of Feeds

The chemical composition and nutritive value of the major feedstuffs utilized for cattle feeding in the study areas were indicated in Table 8 Dry matter (DM) content of the feeds available for livestock feeding in both highland and mid altitude agro-ecologies was above 90%, which corresponds with the reported results of different scholars in different parts of the country Ahmed (20060)and Sisay (2006).

The ash content of the major cereal crop residues in the study area ranged from 9.09% teff straw to 9.97% maize Stover midland, in which the maize Stover had the highest ash content 9.97% in midland, followed by wheat straw 9.37% in highland agro-ecology Table 8. The ash content reported for barely straw in this study was lower than the value 14.6% reported by Yitaye (1999) and Solomon (2004), but similar to the value 9.11% reported by Mekuanint and Girma (2017). On the other hand, the value of ash content for wheat straw 9.37% was similar to 9.34% reported by Mekuanint and Girma (2017), but higher than 8.94% reported by (Alemu *et al*., 1989) and 8.22% reported by Solomon (2004). The ash content of the maize Stover recorded in this work 9.97% is far greater than the result reported by Yitaye (1999), which was 7%. The variations observed in the ash contents of crop residues of cereal crops could be associated with environmental factors such as rainfall, soil character, temperature, and contamination of the residues by other external factors.

In general, except for barly straw, the percentage of CP obtained from crop residues that are considered available feed resources for livestock feeding in the study areas is much lower than that set as a minimum level of nitrogen 7% to limit intake Milford and Minson, (1966) Van Soest, (1982). The CP content reported in the current study from the same residues of crops (Table 8), however, is at a lower level to fulfill the optimum CP requirement of livestock, which agreed with the general statement made by Preston and Leng (1984), which indicated that some cereal crop residues have a low nitrogen content and are composed of cell wall components with little soluble cell contents. Grasses from the highland and midland agro-ecologies of the study areas, respectively, had CP contents of 9.92% and 8.19%. The value for CP content of grasses from highland agro-ecology was higher than that of midland areas. Such differences may be associated with the reduction in the proportion of legumes in the pasture with a decrease in altitude, and this is in line with the findings of Alemayehu (1985) and Mekuanint and Girma (2016).

5.6. Estimated Annual Feed Balance

The annual available feed was compared with the annual requirements of the livestock population. The daily requirements of DM, DCP, and ME per TLU for maintenance were estimated based on the recommendations of Kearl (1982) and McCarthy (1986) for TLU. The overall estimated feed supply in the study area satisfies only 74.3%, 42.09%, and 76.37% of the maintenance requirements of DM, DCP, and ME in livestock, and it was 25.7%, 57.91, and 23.63 deficits per year, respectively, for DM, DCP, and ME (Table 10). Estimates on the amount of available feed supply and demand per year per agro-ecology were made, and there were differences in available feed demand and supply. In highland agro-ecology, the available feed supply met only about 68.9% DM, 44.83% DCP, and 69.49% ME of the maintenance requirement of livestock per farm per year. In mid land agro-ecology, on the other hand, the available feed supply satisfied about 79.7% DM, 39.36% DCP, and 83.25% ME of the maintenance requirements of livestock.

Within Highland agro-ecology, the available feed on a year-round basis in Amawute PA satisfied about 72.37% DM, 47.08% DCP, and 72.95 ME maintenance requirements, while in Eshegede PA of Highland agro-ecology, livestock feed balance and the available feeds could only satisfy the maintenance requirements of 65.07% DM, 42.35% DCP, and 66% ME, respectively. On the other hand, in PAs of Dugeda, Adelesilasie, Soloke, and Anati found in Mid-land agro-ecology, the available feed can only satisfy the

maintenance requirements of 83.37%, 81.25%, 77.99%, and 75.89% DM; 41.17%, 40.11%, 38.51%, and 37.47% DCP; and 87.08%, 84.82%, 81.46%, and 79.27% ME, respectively. It was indicated in Table 18 (contradictory with above) that the total estimated annual feed supply in the study area of Soddo a district in Gurage zone met only about 74.3% (DM), 42.09% (DCP), and 76.37% of the of the maintenance requirements of livestock

6. Conclusion and Recommendation

6.1. Conclusion

The study was conducted in the two agro ecologies of the district because the two areas are well known for its higher number of cattle population in the District. In the district no research has been conducted to gives information about major feed resources available at different agro ecologies of the study area of Livestock, so the study is justifiable to have recorded and realistic information for future development work. A total of 166 livestock owner respondents were Simple random selected and data were collected through a questionnaire and personal observation. The result of the study showed that the livestock production system in the district was a mixed crop-livestock production system. The overall family size per household of 6.72±0.20, the cattle population of 7.17±0.3 heads (6.84TLU), and the land holding of 1.29±0.325 hectares per household were obtained in this study. About 64.1% and 35.9% of households in the study areas indicated that the highland agro-ecology of the study areas, the major feed resources of cattle were crop residue, natural pasture, , Enset leaf, and leaf midribs, while it was natural pasture, crop residue, , and maize Stover in midland agro-ecology. Annual feed supply in the district satisfies 68.9%, 79.7% TDM, 44.83%, 39.36% TDCP, and 69.46%, 83.25%TME of the maintenance requirement of livestock in TLU per year in highland and midland agro-ecologies, respectively. Major Livestock constraints are shortage of feed, poor, high-cost feed, inadequate extension and training service, and shortage of manpower. It was concluded that, due to poor husbandry practices, the productive performance of livestock was low. Therefore, intervention in husbandry practices, mainly improvement of feed and breed, should be done to increase milk production and productivity. Cattles feed deficit was serious and needed strong intervention and attention.

6.2. Recommendation

Therefore, based on the above conclusions, the following recommendations are forward;-

- For more efficient utilization of crop residues, practical trainings that give understanding towards feed treatments and conservation should be introduced and practiced, and focus should be given on low-cost feed ration formulation.
- Provide extension and training services to alleviate the skill gap observed among farmers

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