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Assessment of Feed Resources, Determination of the Feed Balance and Analysis of Chemical Compositions of the Most Commonly Used Feeds in Sankura District, Silte Zone, Southern Ethiopia

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Abstract: This study was conducted to assess feed resource availability, feed balance, chemical composition and dry matter digestibility of major feedstuffs in Sankura district, Siltie Zone of Southern Nation Nationalities and Peoples Regional State. One hundred thirty two, (94 from lowland and 38 from midland agro ecologies) were selected for the study purposively based on their livestock rearing experience, number and types of livestock holding in consultation with districts' livestock experts. A structured questionnaire was prepared and an interview of each household was carried out to collect data on demographic and socio-economic characteristics of households, livestock holding and composition, available feed resources and feeding practices, livestock feeding management practices and constraints of livestock production. The common feed samples that were used in lowland and midland agro ecologies available in one season (July to August) were randomly collected and analysed for chemical composition. Descriptive statistics was used to analyze the data using SPSS. The average family size of the households was 7.74±0.298 for lowland and 5.92±0.305 for midland agro ecologies. Average farm size of households in the lowland and midland agro ecologies was 2.38±0.08 ha, respectively. The total land holding per household was 1.32 ha for lowland and 1.01 ha for midland agro-ecology. There was a significant difference ($p<0.05$) in livestock holding between lowland and midland agro ecology. The major feed resources available were natural pastures, crop residues and improved forages and pasture. About 136,569.867 tons total dry matters (tDM) per year were produced in the study district, whereas about 202,834.8 t DM was the total annual requirement. Hence, there was a deficit of about 32.6% DM in the district. The major constraints hindering livestock feeding were land shortage, lack of irrigation system and inaccessibility of concentrate feeds. In the study, area with the exception of natural pasture roughages evaluated as higher CP contents than the minimum level of 7% CP required for optimum rumen microbial function. The NDF content for all feedstuffs in the current study is higher than the critical level of 45% and also the IVDMD value in the current were lower than 65%. In conclusion, unless efforts are made to meet the nutrient requirements of livestock through proper feed management and supplementation. It is necessary to supply adequate amount of feed all year round through treatment of crop residues, which are the dominant feedstuff and supplementation with tree legumes.

Key words: Feed Resource · Livestock · Feed Balance · Chemical Composition · Feed Management

INTRODUCTION

Livestock is an important segment of the agriculture sector in Ethiopia. The contribution of livestock to the agriculture economy accounts for 47 % [1]. Livestock production is among the most important agricultural enterprises in the developing countries of the world. It contributes significantly to the livelihood of smallholder farmers and pastoralist societies. The importance of livestock in the provisioning of food, incomes, employment, nutrients and provision of insurance during times of crises and uncertainty to millions of rural households is widely appreciated. In developing countries including Ethiopia, livestock provide the majority of the livestock domestic products for households. Keeping livestock have served the poor as

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a social safety net, providing insurance for times of need. Livestock are also important providers of nutrients and draught power for crop production in smallholder crop-livestock production systems. Livestock also serve as food security, human nutrition and economic growth for developing countries including Ethiopia. In response to a variety of drivers including human population growth, rising income and urbanization, livestock production systems in developing countries such as Ethiopia are changing rapidly which could be seen as an opportunity to benefit from the livestock sector [2].

Livestock feed resources are classified as natural pasture, crop residue, improved pasture and forage, agro industrial by products, other by-products like food and vegetable refusal, of which the first two contribute the largest feed type [3, 4]. The contribution to these feed resources, however, depends up on the agro-ecology, the type of crop produced, accessibility and production system [5]. In the mixed farming systems of mid altitude areas of the country, the main permanent natural pasturelands are found on upper slopes of hills, farm margins and seasonally water logged areas. Due to poor management and overstocking, natural pastures are highly overgrazed resulting in sever land degradation, loss of valuable species and dominance by unpalatable species [6].

Feed scarcity of both quantitative and qualitative dimensions is the major bottleneck for the promotion of the livestock sub-sector in the country. Much of the available feed resources is utilized to support maintenance requirement of the animals with little surplus left for production. There are marked seasonality in quantity and quality of available feed resources due to various environmental determinants (drought, frost etc.) [7].

Ethiopia has a large livestock population and diverse agro-ecological zones suitable for livestock production and for growing of diverse types of food and forage crops. However, livestock production has mostly been subsistence oriented and characterized by low production and productivity, which is reflected by low output of meat, milk, drought power and other animal products. Feed constraint both interns of quantity and quality, is among the main challenges to improve livestock production in Ethiopia. Natural pasture and crop residues are the major sources of feed for livestock in most parts of the country, which for most part are inadequate to supply maintenance level of feeding for the existing livestock population [8, 9]. Furthermore, at present, grazing areas have been shrinking and declining due to rapid expansion of cultivated land at expense of grazing land for crop production to provide food for the ever-increasing human population. Limited extension services of forage production and utilization; inadequate availability of forage seeds and planting material of desired species and a lack of suitable forage options that are well adapted to local biotic (pests and diseases) and a biotic (edaphic and climatic) stresses contribute to low productivity. Furthermore, improper management (e.g., no fertilizer or manure application and overgrazing) of natural pastures has also lead to soil nutrient depletion and pasture degradation and limit livestock production. As a result, there is always likely to be limited feed resources for the existing livestock population in the country. This condition calls for improving the supply and availability of feed. Improving pasture quality and productivity is especially important if we are to address feed constraints and sustainably increase feed and food production. In this regard, intensive utilization of the available feed resources through improved management, production and utilization is highly recommended as one of the major strategies for feasible livestock productivity in Ethiopia [9, 10]. The objective of current study is to assess feed resource availability, feed balance, chemical composition and dry matter digestibility of major feedstuffs in the study area.

MATERIALS AND METHODS

Description of Sankura District

Area Coverage and Location: The study was carried out in six kebeles of Sankura district of Siltie Zone Southern Nations, Nationalities and Peoples Regional State (SNNPRS), Ethiopia. The district is located 215 km south of Addis Ababa and about 127 km south west of the Regional capital, Hawassa in the Great Rift Valley; it is bordered on the west by Hadiya Zone, on the north by Wulbareg district, on the northeast by Dalocha and Lanfuro district and on the southeast by Alaba zone. The district is geographically located 7°29' 14.68" north latitude and 38°6' 20.415'' east longitudes and it is found at altitudinal range of 1799 to 2001 m a.s.l, most of it being 1800 m a.s.l.

The total land area is 33723.47 hectar; out of these 77.25% is suitable for agriculture. Land use data of district showed 75.35% arable, 9.6% grazing land, 2.08% forest, 1.9% potentially cultivable, 0.94% uncultivable land (hills) and 10.11% others like rivers, inaccessible lands and gorges.

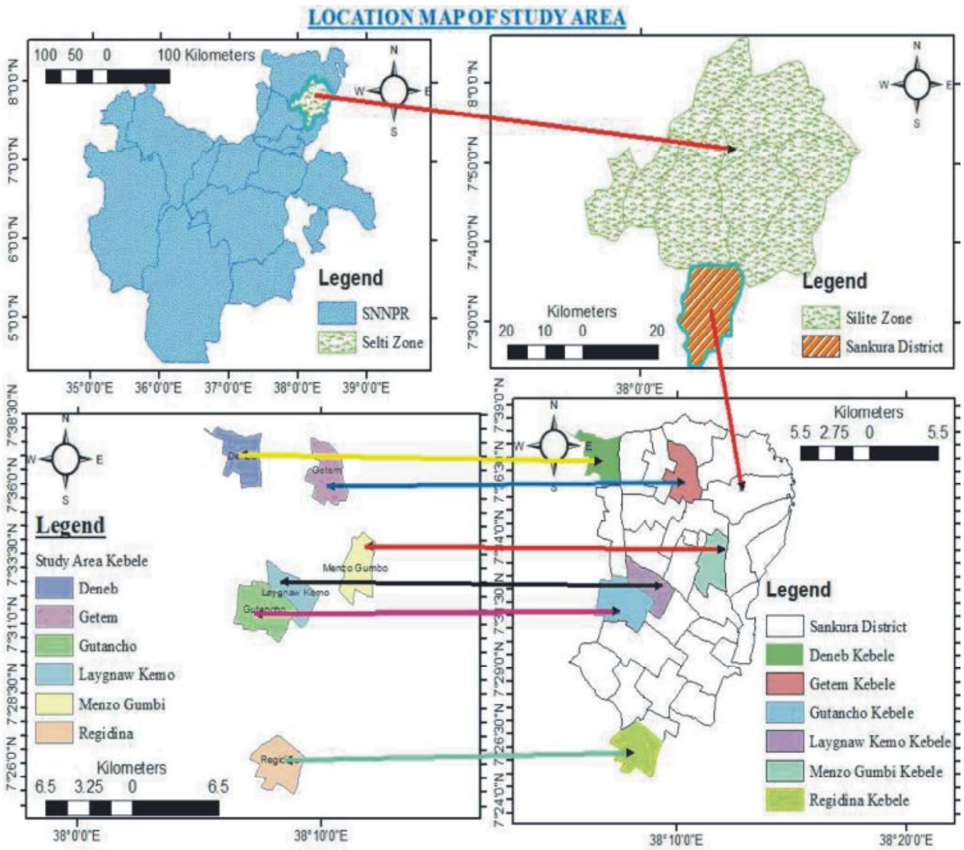

Fig. 1: Satellite map of study area

Table 1: Major Crop production and Livestock population

District	Major Crop	Production(QT)	Land in Hector	Major Livestock	Pop.
Sankura	Maize	306,344.5	5621.5	Cattle	106,926
	Wheat	172,188.45	4315.5	Sheep	31,076
	Teff	23,220.1	1304.5	Goat	24,273
	Sorghum	10,147.5	521.5	Poultry	204,400
	Barley	4,655.6	306	Donkey	16,010
	Haricot bean	28,810	1473.5	horses	553
				Mule	125
Total		545,366.15	14428.75		106,926

Source: - Agriculture and natural resource and livestock and fishery offices, 2021 [12].

Climate: Agro ecologically, the district has two agro ecological conditions those are lowland and midland. The annual rainfall varies from 1000 to 1490 mm, while the average Annual temperature is 23 degree centigrade. The area receives the reliability of rainfall for crop production and duration of growing periods, the three seasonal patterns of rainfall in this district experienced Summer (Dec., Jan. and Feb.) Provide rain for limited part of the region, Belg (little rain season) (March, April) the amount of rainfall received is relatively lower than the winter Rainfall that occurred in June, July, August. September However, in each of the seasons the rain may Begin earlier/later and lasts before the usual time. This has an impact on growing period and reliability of rainfall.

Population: There is no recent human population census of the district, but according to 1999 E.C National population and Housing census results, the total population of Sankura district was 112,710, of which 56,556 were Males and 56,154 were females. Of the total population in the district, 94.8% resides in rural areas while only 5.2% are located in urban areas. The data indicated further that there were 21,997 households in the district with an average of 5.0 persons per household with 1,560 households in urban areas and 20,462 households in rural areas.

Livestock Population and Major Crops Growing in the District: Farmers in the district has an estimated total 74,848 head of cattle, 31,076 sheep, 24,273 goats, 553 horses, 125 mules, 16,010 asses, 204,400 poultry of all species and 5535 beehives for the district [11].

Design and Sampling Procedures: A cross sectional survey (non-experimental) study design was employed with households using semi structured questionnaires, focus group discussion (FGDs), key informant interview (KIs), field observation to assess livestock feed resources and for analysis of chemical compositions of the most commonly used feeds and Multi stage sampling design was employed to collected the data.

Sampling Technique and Sample Size Determination: Sankura district was selected purposively because of its livestock production potential. Then after it was stratified into two, based on agro-ecology (as per the conventional classification method used) namely; mid land and lowland agro ecologies. The district consists of 29 rural kebeles with 25 of them located in the lowland and 4 in the mid land. Four out of the 25 in the lowland and 2 of the four in the mid land were used for the survey assuming that they would represent the kebeles in each agro ecology. Accordingly, the six representative kebeles namely, Menzo Gumbi, Regdina, Gutancho and Layi Kemo) from the lowland (4 kebeles) and Getem and Deneb from midland (2 kebeles) were selected randomly. List of the target households in each kebele were selected purposively based on their livestock rearing experience, number and types of livestock holding in consultation with districts livestock experts. Hence, a total of 132 respondents were selected from six kebeles according to Solomon *et al.* [13], sample size determination formula.

$$n = \frac{Z^2.p.q.N}{e^2(N-1) + Z^2.p.q}$$

where; n = sample size, Z = 95% confidence limit (interval) that is 1.96 given or constant, P = 0.1 (population proportion to be included in the sample that is 10%) =it depends, q = None occurrence of event = 1-p= 1- 0.1 that is (0.9), N = total number of (household) found in the study area and e = level of accuracy or sampling error (Where, $\alpha = 0.05$).

To get the sample size;

Table 2: Selected household unity of the study area

No	Kebele	Total HH	Sample HH
1	Menzo- Gumbi	472	23
2	Layi- Kemo	450	22
3	Getem	452	22
4	Deneb	330	16
5	Gutancho	620	30
6	Regdina	400	19
	Total	2724	132

Selected household unity of the study area

$$n = 1.96^2*0.1*0.9*2724/0.05^2\ (2724-1) +1.96^2*0.1*.09 = 131.6 \text{ rounded to } 132$$

Finally, from a total of 2724 households 23, 22, 22, 16, 30 and 19 from Menzo-gunbi, Layi-kemo, Getem, Deneb, Gutancho and Regdina kebeles respectively, were purposively selected for the study.

To determine representative samples from each kebeles, sampling proportion to population was used.

$$Pi = n_i /N$$

where:

Pi = proportion of population included in the study area.

n_i = the number of sample

N = the total number of the population

Based on this, proportion from each kebele was Pi = 132/2724 = 0.048

Data Collection

Types and Sources of Data: Both primary and secondary sources were used to collect the data. Secondary information was obtained from Sankura district livestock and fishery office (SDLFO) and Agriculture and natural resource office (SDANRO) by holding discussions and interviews with experts of district office agriculture, livestock and fishery office. Primary data sources were household survey, focus group discussions (FGD) and key informants interviews (KII) in which the data were collected using questionnaires. Moreover, laboratory chemical analysis was conducted to estimate the nutrient composition of the most commonly used feed stuffs..

Household Survey: The actual household survey was conducted from May 2021 to October 2021 with a pre-tested questionnaire along with focus group discussion and key informants interviews. Household level data and feed resource were collected from the sampled households employing semi-structured questionnaires. The questionnaires was pre-tested and rearranged before the actual data collection started. Primary data on household education level, household size, household herd size and composition, land holding and utilization pattern, major feed resources, production of grain and crop residues, seasonality of feed availability, constraints in feed production, conservation and supply were the major ones among others. The contents of the questionnaires focused primarily on livestock feed resource and feed related constraints of livestock production in the study areas.

Focus Groups: One focus group discussions which comprises of 8 participants (4 male and 2 female farmers ranging between 30-42 years of age; 2 development agents (DA), who have better experience in livestock and feed production, was held at each study kebele to clarify and check issues not well indicated by interviewed households. The discussions focused on the livestock feed resources, feed resource availability, feed conservation practice, feed conservation method, livestock feed resource utilization, major livestock feed constraints and opportunities existing in the study area and feed shortage alleviation strategies.

Key Informant Interview: Fifteen key informant's three livestock production experts from the district and 12 livestock developmental agents from interviewed kebeles were identified and interviewed. Livestock feed resources, feed resource availability, major livestock feed constraints and opportunities for livestock feed production existing in the area, feed shortage improvement strategies, alternative livestock feed and extension services on livestock feed production to societies were also key issues that had been discussed during the discussions with key informants in the study area.

Secondary Data Collection: Secondary data sources, namely, research reports, official reports and plans, information pack/basic information records and stakeholders' meeting were used to support and triangulate data from primary sources. Most of these were obtained from government officials and experts by holding discussions and interviews with experts of district office agriculture, livestock and fishery office.

Secondary sources of information employed in this study were included published and unpublished materials such as reports, plans, official records, project proposals and reports, research papers and websites and these sources were used carefully by counter checking for their accuracy/validity.

Determination of the Feed Balance in the Study Area

Estimation of Annual Feed Availability in the District: The quantity of feed DM obtained annually from different land use type was determined by multiplying the hectare under each land use type by conversion factor of each crop [14]. Conversion factors of 2.0, 0.5, 2.0, 2.0, 1.8 and 0.7 t DM/ha/year was used for natural pasture, crop aftermath grazing, private grazing land, communal grazing land, fallow land and forest/wood land respectively. The quantity of available crop residues produced by farmers was estimated by converting crop yield to straw yield [14- 17]. Accordingly, for a ton of wheat, barley and teff straws a multiplier of 1.5 was used, for haricot bean a multiplier of 1.2 was used [14], for noug seed and linseed a multiplier of 4.0 was used [14, 15], for maize a multiplier of 2.0 [17] and sorghum a multiplier of 2.5 was used [16]. According to Adugna *et al*. [18], 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 feed mostly occurs during feeding and/or used for other purposes shown in appendix.

Estimation of Dry Matter Requirement of the Animals in the District: Data of livestock population in the selected households was obtained from the interview of household heads during the survey. Total annual DM produced from natural pasture, crop residues and improved forages and concentrate was compared with annual DM requirements of the livestock population in the sampled households. The number of livestock population was converted into tropical livestock unit (TLU) for local and crossbred animals using the recommended conversion factors of Funte *et al.*[19], Gryseels and Goe [20] and Seyoum and Zinash [21]. Therefore, livestock Species-specific TLU conversion factors of 0.7 for cattle, 0.1 for sheep and goats, 0.5 for donkeys 0.8 for horses and 0.7 for mule were used. The DM requirement of livestock population was calculated according to Kearl [22] where the daily DM requirement for maintenance of 1 TLU (equivalent to 250 kg livestock) which consumes 2.5% of its body weight is 6.25 kg DM/day or 2281 kg DM/ year/animal or 2.28tones/year/TLU [19].

Chemical Composition and in Vitro Dry Matter Digestibility

Sampling of Feeds for Chemical Analysis: Representative samples of feed resources commonly used by farmers, which are available, were collected randomly from both agro ecologies in one season (July to August). Then representative samples of roughage feeds like natural pasture, elephant grass, desho grass were thoroughly mixed and divided into quarters by its type and representative of each sample was taken. For crop residues samples like wheat straw, maize stover and teff straw were randomly taken by ten (10) farmers thoroughly mixed and divided in to quarters by its type and representative of each sample were taken to determine chemical composition of feedstuffs.

Chemical Analysis and *In vitro* Dry Matter Digestibility: The feed samples were oven-dried at 60 0C for 48h and ground to pass through 1 mm sieve size for chemical analysis and in vitro dry matter digestibility (IVDMD). The ground samples were kept in air-tight containers until used for analysis. The determination of dry matter (DM), ash and ether extract (EE) was conducted according to AOAC [23]. Nitrogen (N) content was determined by AOAC [23] method and crude protein (CP) was calculated as N*6.25. The neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed following the procedure of Van Soest *et al.*[24]. In vitro dry matter digestibility (IVDMD) was estimated using a Daisy II Incubator based on the modified two stages in vitro Tilley and Terry procedure [25], as modified by Van Soest and Robertson [26]. Analyses were carried out at Hawassa University, College of Agriculture and animal Nutrition laboratory.

Statistical Analysis: The survey data were analyzed by using SPSS (version 20). Descriptive statistics such as mean, standard error (SE), frequency, percentage, were used to summarize different qualitative and quantitative variable. The means of quantitative data between agro ecologies and seasons were compared by employing two-way analysis of variance. Spearman correlation coefficient was used to realize the relationship between factors of importance. Level of significance was considered at P<0.05. The statistical differences between qualitative variables that were analyzed followed cross tabulation (chi-square procedure) was also proclaimed significant at P<0.05. The statistical model used for analyzing data on feed resource was:

$$\text{The model: } Yijk = \mu + \alpha i + eijk$$

Yijk = Response variable/Dependent variable
μ = Overall mean
αi = the effect of location (agro-ecology)
eijk = The error term

For parameters, which required ranking, indices were calculated to provide ranking of major feed types and feeding practices for dairy cattle production in the study area and coping strategies to feed scarcity. The indices were calculated as follows:

Index = (5×number of responses for the first rank+4 ×number of responses for the second rank+3×numberof responses for the third rank + 2 × number of responses for fourth + 1 × number of responses for the fifth) / (5 × total responses for the first rank + 4 × total responses for the second rank + 3 × total responses for the third rank + 2 × total responses for the fourth rank + 1 × number of responses for the fifth) n number of respondents.

RESULTS AND DISCUSSION

Socio-demographic Characteristics of the Respondents: The socio demographic characteristics of the households included in the survey are presented in Table 3 below.

Gender equality makes good sense. This study shows no significant difference in the sex of HH heads between agro ecologies. The proportions of male headed households were 74.5% in lowland and 81.6% in midland with the overall male headed households being 78%,while 24.5% and 18.4% were female headed in lowland and midland agro-ecologies, respectively. The overall female-headed households were 22%. The higher number of male headed respondents compared with female headed in lowland and midland agro ecologies is in agreement with that of Azage [27] who reported the majority (67%) of the respondents were male household heads in Addis Ababa. Assefa *et al*. [9] also reported higher proportion (85%) of male household heads in Adami Tullu Jiddo Kombolicha district.

Overall mean age of the household heads was found to be 38.09±0.406 with the minimum value of 28 and the maximum value of 48 years. This result is lower than the findings of [27] (42.82±1.37) for Alaba district and there was no significant difference (P>0.05) between the agro ecologies.

Educational background of sampled household heads is believed to be an important feature that determines the readiness of the household head to accept new ideas and innovations.

As educational status of a household head increases, it is assumed to increase the transfer of relevant information and as a result increase farmers' knowledge about the use of feed for livestock to increase the productivity of livestock. Out of the households included in the current study, about 31.9% and 29% were illiterate

Table 3: Household characteristics of the respondents

Variables	Location Lowland N= 94	 Midland N= 38	 Overall N=132	P value
Sex of the household head (%)				
Males	74.5	81.6	78	0.383
Females	25.5	18.4	22	
Educational status (%)				0.150
Illiterate	31.9	29	31.8	
Primary	54.3	60.5	55.3	
Secondary	3.2	2.6	3.03	
College and above	3.2	2.6	3.03	
Can read and write	7.4	5.3	6.8	
Income (%)				
Low	24.5	34.2	29.3	
Medium	72.5	61.1	67.8	
High	3	2.7	2.9	
Age of the household head ((Mean±SE)	37.91±0.47	38.53±0.805	38.09±0.406	0.639
Average family size per household (Mean±SE)	7.74±0.298	5.92±0.305	7.22±0.240	0.157

N=Number of respondents, SE=Standard error, % = percentage

in lowland and midland areas, respectively, while 54.3 % in lowland and 60.5% in midland attended primary education. The rest of them, which accounted for the smaller proportions, have attended either high school or college education; or can read and write. There were no significant differences among household heads of the agro ecologies in the level of education (P > 0.05). This was attributed to better chances of education and establishment of schools uniformly both agro ecology. Majority of the respondents (61.4%) in the present study had formal education and is important to understand extension messages and to realize the importance of new technologies within a short time. According to Ofukou *et al*. [28], farmers with high educational levels usually adopt new technologies more rapidly than lower educated farmers. In general, the proportion of educated farmers (61.4%) in the study area was in agreement with the finding of Mergia [29] and higher than the finding of Bedasa [30], who reported 50% for highlands of the Blue Nile Basin, Ethiopia.

The overall average family size of the households was 7.22±0.240 (ranging from 2-14). This value was greater than both the regional and National values report of 5.2 (SNNPR) and 5.1 CACC, 2003 [31], respectively. This is highly attributed to the polygamous marriage of the society in the district and low awareness of family planning. The values of family size between the two study sites are comparable; being 7.74±0.298 in lowland and 6.61±0.367 in midland; declaring non-significant difference (P>0.05).

Landholding and Land Use Pattern of the Households: Land is the most important limiting production factor in the study area and the quality and quantity of land available greatly determines the amount of production. However, as opposed to family size, the land holding per household is decreasing from time to time affecting the production of crop and rearing livestock. The landholding and land use pattern of the study area are shown in Table 4. The study revealed that the total land holding per household was 1.32 ha for lowland and 1.01 ha for midland agro-ecology. The overall land holding per household was 1.175 ha. The total land holding of the household was significantly (P<0.05) different between the two study sites. The main reason for the higher land holding in the lowlands is that the land is flat and most of the land is used for agriculture and the midland area is relatively small due to the low terrain and high mountains and valleys. The land holding obtained in the current study is agreement with the land holdings of 1.1 ha/HH in Shashemene-Dilla area [32] and the national average land holdings of 1.22ha/HH [4].

The average cropland holding per household was 1.02±0.04 ha for lowland and 0.85±0.096 ha for midland agro ecologies and there was a significant (P<0.05) difference between both sites. The overall average cropland holding per household was 0.93±0.48 ha/HH. The average land allocated for private grazing land was 0.12±0.017 ha and 0.06±0.23 ha/HH in lowland and midland agro ecologies, respectively. The overall average private grazing land was 0.09±0.14 ha and the

Table 4: Land holding (ha) and land use pattern of the sampled households in study area

	Agro Ecology mean,±SEM			
Variables	Lowland N= 94	Midland N= 38	Overall N=132	P value
Total land (ha)	1.32±0.09	1.03±0.15	1.175±0.08	0.004
Crop land (ha	1.02±0.04	0.85±0.96	0.93±0.035	
Private grazing (ha)	0.12±0.017	0.06±0.23	0.09±0.14	0.000
Forage and pasture (ha)	0.03±0.012	0.02±0.023	0.025±0.011	
Others (ha)	0.15±0.07	0.1±0.11	0.125±063	
Land allocation for field crop (ha)				
Maize	0.48±0.018	0.27±0.026	0.375±0.016	
Teff	0.1±0.006	0.15±0.013	0.125±0.005	
Wheat	0.35±0.014	0.26±0.029	0.305±0.013	
Barley	0.010±0.0004	0.037±0.016	0.015±0.094	
Haricot bean	0.07±0.005	0.063±0.007	0.066±0.004	
Sorghum	0.08±0.006	0.07±0.010	0.08±0.005	

N=Number of respondents, SE=Standard error, ha = hectare

two agro-ecologies were significantly (P<0.05) different in this regard. However, areas of private and communal grazing lands were very small and decreasing from time to time in the two agro-ecologies compared to TLU per household due to population pressure and redistribution of land for investments. Improved forage and pasture landholding per HH was 0.03±0.012 ha and 0.02±0.023 ha for lowland and midland agro-ecologies, respectively. The overall average improved forage and pasture landholding/HH was 0.025±0.011 ha and there was no significant difference (P>0.05) among the agro ecologies. According to 34.1% of the respondent forages could be grown as pure stand on the field, while 65.9% respondent reported that planting tree legumes as border and live fence was practiced which includes intercropping with cereals and alley cropping as a possible means of establishing improved forages.

In the study area, the large proportion (79%) of the land is used for annual crop production and perennial crop production, indicating the limitations of pasture supply from grazing land or fallow land implying the dependence of farmers on crop residues for livestock feeding. Overall, the mean landholding for maize was 0.375±0.016 ha per household but there was a significant difference (P<0.05) between the two agro ecologies in this regard. Land allocation for maize, *teff* and barley in midland was higher than a lowland. Overall, the mean landholdings for wheat were 0.305±0.013 ha per household and the land holding for these two crops was significantly different (P<0.05) between agro-ecologies. The annual crop production holding obtained in the current study is agreement with the annual crop production holdings of large proportion (70%) in Kedida Gamel district Fiseha [33] and the mean land holding for maize in the current study was larger than the average land holdings for maize is 0.13ha/HH in Kedida Gamel district, Southern Ethiopia [33].

Livestock Holding and Composition: Table 5 shows the livestock holding per household in the study area in tropical livestock units (TLU). The total livestock holding per household in lowland and midland agro ecologies was not significantly different (P>0.05). The overall mean TLU of livestock per household in the study area was 4.413, 0.409, 0.415, 0.698, 0.238 and 6.175 for cattle, sheep, goats, donkeys, poultry and total livestock, respectively. with some variations to the current study, an average TLU of 7.97, 0.74, 0.46, 0.78 and 0.07 for cattle, sheep, goats, donkeys and poultry, respectively in Meta Robi district was reported by [29]; and 5.35, sheep 0.49, goats 0.03, donkeys 0.22 and poultry 0.02 in Jeldu district were reported by Bedasa [30]. Cattle and sheep holding per household in lowland and midland agro-ecologies were significantly different (P<0.05), while sheep and goat holding of the household at wet season were significantly larger (P<0.05) than at dry season. This is due to the fact that during wet season there is better-feed availability than dry season.

The average livestock holding per household in midland agro ecology was 4.69, while it was 6.77 in lowland agro ecology. Cattle were the most important species in both study areas, which could be observed from total cattle holding per household. The cattle holding per household in highland and midland agro-ecology were not significantly different (P>0.05). This is due to that farmers in the study area buy more cattle at wet season because there is better- feed availability during wet season. The cattle holding of households in the study

Table 5: Livestock species holding and composition per household (TLU)

	Agro Ecology mean,±SEM			
	Lowland (N=94)	Midland (N= 38)	Overall (N=132)	
Livestock	mean,±SEM	mean,±SEM	mean,±SEM	P value
Total livestock	6.772±0.290	4.697±0.364	6.175±0.245	0.066
Cattle	4.856±0.245	3.315±0.300	4.413±0.203	0.035
Sheep	0.458±0.023	0.289±0.039	0.409±0.021	0.000
Goat	0.443±0.037	0.347±0.242	0.415±0.029	0.570
Donkey	0.744±0.035	0.585±0.234	0.698±0.014	0.130
Poultry	0.26±0.180	0.159±0.110	0.238±0.144	0.005

TLU=Total livestock unit,; N=Number; SE= standard error..

Table 6: Major Feed resources available in the study area

	Availability level						
Feed resources	First	Second	Third	Fourth	Fives	Index	Rank
Natural pasture	63	10	34	30	0	0.260	2th
Crop residues	64	24	15	43	29	0.289	1st
Hay	6	51	18	6	0	0.151	4nd
Forage and pasture	0	40	42	27	13	0.178	3th
Fodder trees	0	7	21	7	17	0.060	5th
Aftermath	0	0	3	8	0	0.011	7th
AIBP	0	0	0	13	74	0.050	6rd
Others	0	0	0	0	0	0.000	
Total	132	132	132	132	132		

*Index = [(5 * rank 1)+(4 * rank 2)+(3 * rank 3)+ (2 * rank 4)+ (1 * rank 5)] divided by sum of all feed resources mentioned by respondents, AIBP = Agro-Industrial By Products

area was higher than the finding of Mergia *et al*. [29], who reported 3.3 TLU/HH in Baresa watershed and Mengistu *et al.* [34] which was 3.05±0.15 TLU per household in Kedida Gamela district. It is, however, lower than the finding of Sisay [35] in Debark (5.1±0.35TLU/HH), Layarmachiho (5.6±0.38TLU/HH) and (9.4±1.03TLU/HH) in Metema district of North Gonder and Yishitile [36] for Alaba district which was 7.38TLU/HH.

Major Livestock Feeds in the Study Area: Table 6 indicates major feed resources available to livestock in the study area. Crop residues, Natural pasture, improved forages and pasture; and hay are ranked as 1st, 2nd, 3rd and 4th, respectively. There is limited improved forage production to supplement livestock feeds in the study area. Conventional and non- conventional feed sources are not used to feed livestock in both agro-ecologies of the study area.

During the group discussion, it was pointed out that crop residues, natural pasture, improved forages and hay are major available feed resources. This finding is in agreement with the report of Zinash *et al.* [37] and Terefe [38] for the Ethiopian central highlands. In general, natural pasture and crop residues are the major feed resources. Crop residues from cereals like maize, wheat, teff and barley were the major feed resource in the area. The importance of natural pasture and crop residue in this study is in agreement with report of Ahmed *et al.* [5], Adugna *et al.* [39] and Belay *et al.* [40] in the central zones of Ethiopia, in the central highlands of Ethiopia and in Dandi district, respectively.

Feed Resources during Dry and Wet Seasons: Table 7 depicts the seasonal feed availability. During the dry season, 90.9% of the respondents in the study district use crop residues as number one feed resource followed by hay (73.5%) and 56% of them use agro-industrial by product. In wet seasons, all the respondents (100%) in both agro ecologies use natural pasture followed by improved forage, pasture and fodder tree to feed their animals.

During dry season feeds that grouped under crop residues, hay and natural pasture were ranked 1st, 2nd and 3rd in the study area with index values of 0.327, 0.229 and 0.145, respectively. In contrast, during wet season natural pasture was ranked 1st both in the study area with index values of 0.494 which was in line with the report of Jimma *et al*. [7]; Andualem *et al*. [41] for Essera District, Southern Ethiopia; Belay *et al*. [40] in Dandi district and Shitahun [42] for Bure district, Ethiopia. It was

Table 7: Feed resources during dry and wet seasons in the study area

Season	Feed types	Availability level						
		First	Second	Third	Fourth	Fives	Index	Rank
Dry season	Natural pasture	0	0	61	52	0	0.145	3rd
	Crop residues	120	12	0	0	0	0.327	1st
	Hay	12	87	15	0	0	0.229	2nd
	Forage and pasture	0	23	32	30	25	0.138	4th
	Fodder trees	0	0	0	6	33	0.023	8th
	Aftermath	0	0	8	15	0	0.029	7th
	AIBP	0	0	10	29	74	0.082	5rd
	Others	0	10	6	0	0	0.027	6th
	Total	132	132	132	132	132		
Wet season	Natural pasture	132	41	30	32	0	0.494	1st
	Crop residues	0	0	0	7	58	0.036	5rd
	Hay	0	0	13	11	0	0.031	6th
	Forage and pasture	0	68	47	50	0	0.259	2nd
	Fodder trees	0	23	42	12	0	0.122	3rd
	Aftermath	0	0	0	0	0	0.000	7th
	AIBP	0	0	0	20	74	0.058	4th
	Others	0	0	0	0	0	0.000	7th
		132	132	132	132	132		

*Index= [(5 * rank 1)+(4 * rank 2)+(3 * rank 3)+ (2 * rank 4)+ (1 * rank 5)] divided by sum of all feed resources mentioned by respondents, AIBP=Agro Industrial By-Product

generally accepted by all respondents that there is seasonal shortage of feed resources in the study areas. The availability of feed resources varied in seasons with respect to quality, quantity and type of feed. During the wet season, the feed resources available to livestock in the study area were mainly natural pasture. Whereas, during the dry season feed resources available to livestock include, crop-residue, hay and natural pasture in their descending order.

Natural Pasture Availability: Natural pasture is the major feed resource of the study area during wet season, which was in agreement with the report of Alemayehu and Sisay [43] who reported that natural pasture and crop residue are the major feed resources in most areas of Ethiopia. These feed resources are generally poor in quality and their productivity and supply is seasonal, particularly a critical problem during the dry season. During the group discussion, Households mentioned that there was feed shortage during dry season in the area, which was similar with the finding of Kechero *et al*. [44] for Jimma zone and Andualem *et al*. [8] for Essera district, southern Ethiopia. Results from the current study showed that there were less effects of the agro-ecology on livestock feeds availability, but season had great effect on livestock feed availability.

The status of communal grazing land differs in the study agro-ecologies. Overall, 50% of HHs used communal grazing land to graze their livestock. About 47% and 3% of the respondent used tree covered grassland and open grass land in the study area, respectively. All of the respondents (100%), in the study areas replied that the size of communal grazing land was decreasing over the years. They believed population growth and settlement (37.5%) and the consequent explanation of farming land (62.5%) were the major reasons.

The mean private grazing land owned by the respondents in the study area was 0.2±0.017 and 0.12±0.23 hectares per household for lowland and midland agro ecology, respectively (Table 4). As shown in the table, the mean private grazing land of natural pasture was significantly different ($P<0.05$) in the study area. This was probably due to the larger area of private grazing land holding per household in lowland than midland area. The availability of natural pasture during wet season was significantly larger ($P<0.05$) than dry season. This is due to the adequate availability of rainfall during wet season. Traditional livestock production in the study area is predominantly based on crop residue followed by natural pasture which was in line with the report of Mergia *et al*. [29] andualem *et al*. [41] and Zewdie and Yoseph [45].

Table 8: Utilization of agro industrial by product in the study area

Variables	Lowland (N=94)	Midland (N=38)	Overall (N=132)	P value
Practice of AIBP (%)				0.235
Yes	86.4	92.3	90.6	
No	15.6	7.7	9.4	
Types of AIBP (%)				0.625
Wheat bran	79.7	83.6	82.5	
Molasses	12.1	10	10	
Concentrate mix	8.2	6.4	7.5	

AIBP= Agro industrial by-product, N = number of respondent

Crop Residues Availability: In the study area, crop residues such as maize stover, wheat, *teff*, barley and haricot bean straws, become major livestock feed resources during dry season which was in agreement with the report of Alemayehu and Sisay [43] who reported that natural pasture and crop residue are the major feed resources in most areas of Ethiopia. Moreover, crop residue is known as dominant feed resource in all livestock production systems in Ethiopia [43]. However, their contributions to the total feed resource base varies from place to place based on cropping intensity [46] and the nature of crop residues produced depends on the amount and type of crops grown in the area [35]. The available crop residues in the study area are excess from November to February and adequate available from March to June. This shows that the production of crop residues is high due to land allocated for crop production being large and cropping is twice per year for most of the crops. Moreover, less attention has been given to feed storage generally across the agro-ecologies

Crop Aftermath Availability: Crop aftermath/stubble grazing was an important feed resource of livestock feed during dry season in the study area. After harvesting the crops, livestock were allowed to graze on the aftermath, which was available after the harvest of cereal crops from late November to late March, being accessible to all livestock classes without any restriction for in the locality.. Farmers used aftermath grazing as one means to sustain their livestock before they started feeding of collected crop residues. The landowners only allowed their livestock to graze on the stubbles for first two months. Then other neighboring community could graze their livestock after two months. In agreement, stubbles are accessible to livestock owned by individual farmers for the first two months in central highlands of Ethiopia and later it becomes accessible to all animals in the community [35]. Crop aftermaths are the major feed source in dry season in South Western Ethiopia [47, 48].

Agro-Industrial by Products: During severe feed shortage the Concentrates mix and molasses used for milked cows, fattening beef, sheep and goat and also wheat bran supplements are also used for equines by majority (90.6%) of farmers in the study area. Concentrates mix and wheat bran is normally purchased from the nearby town, Worabe Melik farmers union and wheat flour industry. And molasses purchased from Sugar industry by district livestock and fishery office. The use of AIBP in the two ecologies was not significantly different ($P>0.05$). In agreement with the report of Belay and Geert [48] concentrates mix and wheat bran are purchased from the nearby market of Durame town. In contrast, Mergia *et al*. [29] for Baresa watershed reported that only about (21.7%) of respondents were using agro industrial by products as supplement. Moreover, out of the total respondent farmers, 12%, 18% and 4% of the farmers use supplement feed during severe feed shortages in Debark, Layarmachiho and Metema districts, respectively [35]. Overall, about 82.5% of respondents use wheat bran as supplement with average amount of 50 kg/month per household in the study area (Table 8). However, the amount varied depending up on season and production levels of the animals. Only about 10% and 7.5% of respondents used Molasses and concentrate mix as supplements with average amount of 25 and 20 kg/month per household, respectively (Table 8). This is due to the price of concentrate mix per kilogram being too high and the limited availability of molasses in the town as compared to wheat bran that majority of farmers use wheat bran.

Improved Forages and Pastures: There were relatively good adoption and availability of improved forage crops grown in the study area, which was introduced by the Safety net program in collaboration with the district agriculture office. According to the respondents report, the majority (91.3%) of households planted improved forage crops; the remaining 8.7% of the households did not cultivate improved forage crops

Table 9: Forage type and production practice in the study area

Variables	Lowland (N=94)	Midland (N=38)	Overall (N=132)	P value
	% of responses			
Production practice				0.062
Yes	89.1	92.7	91.3	
No	10.9	7.3	8.7	
Forage types				0.223
Desho grass	68.1	78.9	71.2	
Elephant grass	31.9	21.1	28.8	

N = number of respondent

Table 10: Seasonal supply of available feeds in study area

Feed resources	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural pasture	*	-	-	-	-	X	X	X	X	X	*	*
Improved forage	*	-	-	-	-	X	X	X	X	X	*	*
Hay	*	*	*	*	*	-	-	-	-	-	-	*
Crop residue	X	X	*	*	*	*	-	-	-	-	X	X
Aftermath	*	*	-	-	-	-	-	-	-	-	-	*
AIBP	*	*	*	*	*	-	-	-	-	-	*	*
Others	*	*	*	*	*	*	*	*	*	*	*	*

r=period of excess availability; *= period of limited availability; - = period of shortage

(Table 9). In agreement with the results of this research, 58% and 67 % of dairy farmers in Nekemte and Bako towns of the western Oromia have been reported to have practiced improved forage production [49]. Contrary to the current findings, all households (100%) in Dandi district of Oromia do not cultivate improved forages to feed their livestock [40]. It was also reported that only 13.3% households cultivate and use improved forages in Daro Labu district, Western Hararghe Zone [50]. Majority of the respondents (68.4%) in South Western Ethiopia do not practice forage cultivation [47].

However, the proportion of land allocated for improved forage and pastureland was 0.02±0.012 ha and 0.02±0.023 ha in lowland and midland agro-ecology, respectively. The overall average improved forage and pastureland was 0.02±0.011 ha and there was no significant difference (P>0.05) among the agro ecologies. Furthermore, 34.1% of the respondents practiced planting improved forages as pure stand, 65.9% of them do plant tree legumes as a border and live fence, intercropped with cereals as well as alley cropping was a possible practice. Overall, the major available improved forages in the study area as reported by respondents were Desho grass (71.2%) and Elephant grass (28.8%). This forage species have been tested and were found to be well adapted, productive and accepted by the farmers. In addition to the forage the farmers have practiced species various forage technologies such as backyard, soil band particularly associated with the natural resource conservation.

Moreover, all FGD and key informant explained that the adoption rate of the forage technologies in the study area were found to be relatively better due to strong extension support and currently with rapid improved forage development, the district was recognized and awarded at zonal level (information from livestock and fishery expert). Forage development strategies such as planting in pure stand, intercropped with the cereals and alley cropping have a chance of better acceptance by the community. According to my personal observations livestock owners in the surveyed area practice growing of multipurpose legume trees, such as Sesbania and others as a live fence. These feeds are good sources of protein and minerals for dry season feeding.

Feed Resources Calendar: Respondents in the current study classified months of the year according to feed availability (Table 10). Excess availability of feed resources vis-à-vis months of the year were associated with rainy season and crop harvesting season. Grazing on private grazing lands and using improved forage was a common practice from June to October. In the rest of the seasons, grazing lands did not provide feed for livestock. Crop residues were the major sources of feed from November to February. During the dry season, livestock largely depend on crop residues in the study area. This is line with the reports of Belay and Geert [48] that stated crop residues and stubble grazing are the major feed resources during the dry season in Burie Zuria District, North Western Ethiopia.. The maximum shortage of feed

Table 11: Crop residues utilization in the study area

	% of respondents (N = 132)				
Variables	Feed	Fuel	Selling	Plastering	Other
Maize stover	76.5	18.2	5.3	0	0
Wheat straw	94.7	0	0	3.8	1.5
Teff straw	61.4	0	25	18	0
Barley straw	81.1	0	7.6	11.4	0
Haricot bean straw	87.1	0	8.3	0	4.5

n = number of respondents

in the study area was observed from March to May. In these months, the availability of natural pasture, improved forage, hay, crop residues and aftermath grazing is reduced. The type and quantity of available feeds in the study area appeared to be strongly influenced by seasons. The type of feeds available in each month varies according to the season. The current results were in agreement with that of Husen *et al*. [51] who reported that feed resources availability has shown seasonal variations in Jimma Zone, Southwest Ethiopia. As a result serious livestock body weight loss and production reduction was a common phenomenon in the study area. Seasonal variations in feed quality and quantity are the main limitation to animal production and cause fluctuation in productivity throughout the year in Belesa district of Amhara Region [52].

As it was revealed by the majority (97.5%) of respondents in the current study, most severe feed shortage was occurring from March to May, which was comparable with the study of Andualem *et al*. [41] for Essera District who reported that according to 51.1% of respondents feed shortage existed between February to April. Similarly, Mengistu *et al*. [29] has also reported that severe feed shortage occurred in April to May for the current study area. Mergia *et al*. [29] for Baresa watershed reported that 100% of the respondents replied feed shortage is very critical during the month of April to May.

In general, relatively feed is in good supply during the months of June to October, as a result of better growth of pasture, improved forage and weeds grown as annual and perennial crops are available during this time which also confers with the report of Mergia *et al*. [29]. Thus, effective collection, conservation and proper utilization of crop residues and hay making might increase the quantity of available feeds while looking for other alternatives options such as use of urea treatments and scale-up of improved forage species with participatory approach to improve the nutritional quality of available feeds for dry season in the study area.

Crop Residue Utilization and Feed Preservation Practice

Crop Residues Utilization: Table 11 presents the utilization of crop residues in the study area. The important share of crop residues as feed resource in the study area, as illustrated earlier in this study revealed that crop residues are under competitive uses. About 77.5% of households stated that the residues from wheat straw, *teff* straw and maize stover are used primarily for feed. In addition, 21.8% of the respondents indicated that *teff* straw and wheat straw are used for construction of local houses by mixing it with mud, which is then used to plaster the wall. A good proportion of households (18.2%) stated that the residues from maize crop are used as a source of firewood. The only crop residues sold in the study area are wheat straw and *teff* straw. It was reported by the HHs that no crop residue is completely consumed by animals without leaving some for other purposes. They are used as a fuel, roof shatter, fences and any of their combinations as the need arises besides their use as livestock feeds. Crop residues use as fuel source and plaster of walls are highly competing with feeding of livestock and hence an alternative means should be assessed to minimize this competition through awareness creation of the farmers. The result of this study agrees with the report of Bedasa [53] in the highlands of the Blue Nile Basin, Ethiopia, which illustrated crop residues are under competitive uses.

Furthermore, utilization efficiency has great problems when it comes to crop residues because of less attention is given to proper collection of crop residue, storage and crop residues are excessively dumped during harvest period in addition to competition of alternative uses of crop residues. Indeed, majority of farmers had no a great concern to store the crop residues in a separate cottage constructed merely for storages of crop residues or on the roof in their cottages. On the other hand, some farmers efficiently utilize these feed resources which they give to their animals group by group or some even soak with water to improve palatability and digestibility, still few others chop browses like Acacia and *wanza* to give to their animals with these crop residues and this is what is called efficient utilization of locally available feed resources and is worth appreciation to be favored to be practiced by farmers. Farmers have to even develop not only proper collection, storage and minor quality improvements but also have to reach a level where they can formulate their own ration from mixes of crop residues, indigenous browse and a salty rift valley soil (local name of bolet) abundantly available in the nearby since crop residues and stubble constitute the major feed for the area.

The value of crop residues as animal feed becomes more important because of the long dry season of about 6 months with no green fodder. There is, however, an abundant supply of crop residues; particularly cereal straw during this period because the dry season normally coincides with the harvesting time of cereal crops in addition to the 69% dry matter production being from crop residues at *district* overall.

Feed Storage Practice: The feeding value of crop residues could be greatly improved if they were stored soon after harvest. Cutting and storing will minimize wastage from grazing and if done soon after maturity, will retain relatively good quality feed for livestock. One of the utilization efficiency of feed resources is providing storage house. Moreover, less attention has been given to feed storage generally across the agro-ecologies; thus, 51.5% of the respondent reported that crop residues are stored stacked outside, while 48.5% of the respondent said crop residues are stored stacked under shade in the study area. Not storing properly the feed during ample production for use during dry period, especially crop residue was major factor that related with utilization efficiency. Both crop residues and hay were stored outside which are exposed to solar radiation and rain. This implies there is a need of awareness creation for farmer.

Preservation of pasture during ample production for use during dry period in the form of hay was practiced by about 22.2% and 13.5% of the respondents for lowland and midland agro ecology, respectively. This reveals that haymaking is not widely practiced in the study area due to scarcity of grazing land, despite that, available grasses are used for roof cover which was in line with the report of Mergia *et al*. [29].

The rest of them (77.8%) and (86.5%) of the respondents for lowland and midland, respectively were not practicing haymaking. In contrast, Jimma *et al*. [7] for Kindokoisha and Humbo district, Southern Ethiopia reported that about 57.1% of respondents conserved feeds for dry season in form of hay. The result of this study is comparable with the report of Andualem *et al*. [41]. They mainly used a cut and carry system to feed their livestock as fresh due to inadequacy of natural pasture. Silage preparation for their livestock was not practiced by farmers in the study area due to mainly lack of knowledge for how to prepare it and inadequacy of forage. In a similar research, Jimma *et al*. [7] in Angetcha district, Southern Ethiopia reported that there were no respondents that conserved feed resource in form of silage.

Feed Quality Improvement Practice in the Study Area: There are different techniques by which the quality of a feed could be improved. To mention some of these techniques; physical treatment from a simple soaking with water, chopping, grinding and pelleting up to the highest technique of chemical treatment, especially the latter improves the nutritive value of crop residues by 30% there by removing the hard cover of plant cellulose. In this case, crop residues are not exposed to such treatments in the survey areas. There is no doubt that the effect of sodium hydroxide on digestibility and intake of roughages is one of the techniques used to improve quality of roughages. In general, digestibility increases between 10-20% and can be expected to improve the intake by 30-50% [54]. The overall feed quality improvement practices in the study area as reported by 30.4% of respondents was soaking with water, 63.65% chopping, 3.45% urea treatment and 4.5% grinding (Table 13). The current study identified that chopping of leaf and crop residue (mainly maize Stover) were major feed quality improvements strategies that are practiced commonly in the study area, which was followed by about 30.4% of respondents who use socking feeds (such as wheat bran and crop residues) into water to improve palatability and digestibility.

The techniques by which the different households use in trying to efficiently utilize the feed resources for almost the available feed resources starting from collection, storage, preservation and improving the feed quality are depicted below in Table 13. As a result, worth to employ all the techniques by which efficient utilization of feed resources could be achieved. In addition to this proper storage of crop residues, upgrading the quality of the feed including chemical treatment maximizes the efficiency of utilization.

Table 12: Feed preservation practice in the study area

	Lowland (n=94) % of responses		Midland (n= 38) % of responses	
Variable	Yes	No	Yes	No
Crop residue	100	0	100	0
Hay	22.2	77.8	13.5	86.5
Silage	0	100	0	100

N = number of respondents

Table 13: Feed quality improvement attempts made by farmers in the study area

	%, Responses			
Variables	Lowland (n = 94)	Midland (n = 38)	Overall (n = 132)	p value
Socking with water	26.6	34.2	30.4	0.229
Chopping	62.8	64.5	63.65	
Urea treatment	4.3	2.6	3.45	
Grinding	6.4	2.6	4.5	
Pelleting	0	0	0	

n = number of respondents

Table 14: Livestock Feeding System in the Study Area

		% of response			
Season	Feeding system	Lowland (n=94)	Midland (n=38)	Overall (n=132)	P value
Dry season	Herded	12.8	13.1	12.8	0.798
	Stall feeding	60.6	65.8	62.2	
	Tethering	26.6	21.1	25	
Wet season	Herded	34	23.7	31	0.378
	Stall feeding	15.9	13.1	15	
	Tethering	50.1	63.2	54	

n = number of respondents

Livestock Feeding Systems in the Study Area: Table 14 depicts livestock feeding practices of the study area. Feeding systems of livestock in the study area were herded grazing on natural pastures, stall feeding and tethering at the backyard and roadside. The overall feeding systems during dry season in the study area were; 12.8% herded grazing, 62.2% stall-feeding (zero grazing) and 25% tethering Overall feeding systems during wet season in the study area were 31% herded grazing, 15% stall feeding and 54% tethering. Feeding systems of livestock both during wet and dry seasons for the two agro ecologies in the study were not significantly different (P>0.05). Grazing natural pasture was the major feeding practice but it is now shifting to zero grazing because of continuing shrinkage of grazing land. Animals are grazing around homestead and are supplemented with weed, chat leftover and crop residues. Herding depends on size of land per HH and season. Those HHs with large number of livestock allow their animals to graze around the homestead or nearby communal grazing land. Similarly Brandt *et al*. [54] stated that there was variation in livestock management according to wealth category; wealthier HHs possesses more livestock and requires greater access to additional labor and grazing land. Reduction of communal grazing lands was caused by using the grazing lands for crop production; enclosures of vast areas as result of severe overgrazing, land degradation and deforestation.

Tethering is also the common way of managing animals in the study area. Tolera [55] earlier reported the increasing practice of cut-and-carry system (feeding of grasses and weed from crop field and roadsides) in southern Ethiopia. Tethering or herding depends on size of herd and land per HH and season. Those HH with small herd size tether their animals in front of their houses. Stall-feeding is practical during the dry season in the study area when the availability of natural pasture decreased. This result was also in agreement with the findings of previous studies by Brandt *et al*. [54] reported that stall-feeding is practiced during the dry season in most *enset* growing areas of Ethiopia.

Table 15: Water source for livestock in the study area

		% of responses		
Season	Water source	Lowland (n=94)	Midland (n=38)	Overall (n=132)
Dry season	River	41.5	12.4	26.9
	Pond	58.5	81.4	69.9
	Spring and water pipe	0	6.2	3.1
	Rain water	0	0	0
Wet season	River	21.3	2.5	11.9
	Pond	0	0	0
	Spring and water pipe	0	0	0
	Rain water	78.7	97.5	88.1

n = number of respondents

Table 16: Feed and water scarcity in the study area

		% of responses			
Season	Variable	Lowland (n= 94)	Midland (n= 38)	Overall (n= 132)	P value
Dry season	Feed shortage				
	Yes	98.5	96.8	97.5	0.023
	No	1.5	3.2	2.5	
	Water shortage				
	Yes	98.4	88.5	92.7	0.020
	No	1.6	11.5	7.4	
Wet season	Feed shortage				
	Yes	7.5	1.2	3.4	0.017
	No	92.5	98.8	96.6	
	Water shortage				
	Yes	7.8	2	4.2	0.030
	No	92.2	98	95.8	

n = number of respondents

Livestock Watering Practice in the Study Area: There are about two rivers and many local ponds as water sources in the study area. The greatest source of water for *Sankura* is the *Bilate River* a dependable perennial river of the district where majority of the households rely on for livestock production. Other rivers like *dijo* are also main stay of for animals' as a source of water but because they are seasonal, farmers will be required to look for water during dry period. Apart from these, locally dug ponds are good sources of water for humans and livestock in Sankura district. Overall, the majority (92.7%) of respondents were experiencing water shortage during dry season (Table 15). The main sources of water for livestock during wet season are rainwater and river. The overall water source during wet season in the study area were; 11.9% river, 88.1% rainwater. Water sources at wet season for the two agro ecologies were not significantly different (P>0.05). The main sources of water for livestock during dry season are river and pond. The overall water sources during dry season in the study area were 69.9% pond water and 26.9% river (Table 15).

Shortage of water is a critical problem in the study area particularly during the dry season. Problems of water shortages are highly dictated by seasonality where it becomes more pronounced during dry period. During this period, farmers will be obliged to travel distances of a day and normally watering frequency decreases. Shortages of water supplemented with poor quality roughages undermine physiological performances of the animals, reduction in productions, anestrous and ultimately ends in emaciation. Therefore, both fertility and fecundity of the animals will be affected.

Constraints, Opportunities and Coping Strategies to Scarcity of Feed: Feed scarcity and major constraints of livestock feeding in the study area are depicted in Table 16. About 97.5% of all respondents in the study area experience feed shortage during dry season in the same extent in both agro-ecologies, while overall about 96.6% of respondents reported that they did not experience feed shortage during wet season. However, there was a significant (P<0.05) difference gin feed

Table 17: Major constraints of livestock feeding in the study area

	Lowland (n = 94)		Midland (n = 38)	
Variable	Index value	Rank	Index value	Rank
Land shortage	0.3766	1	0.3842	1
Lack of irrigation system	0.2489	2	0.2789	2
Inaccessibility of concentrate feeds	0.2181	3	0.2184	3
Occupation of communal grazing land	0.1564	4	0.1184	4

*Index= [(5 * rank 1)+(4 * rank 2)+(3 * rank 3)+ (2 * rank 4)+ (1 * rank 5)] divided by sum of all feed resources mentioned by respondents, n = number of respondents

Table 18: Major opportunities of livestock feeding in the study area

	Lowland (n = 94)		Midland (n = 38)	
Variable	Index value	Rank	Index value	Rank
Keeping limited stocks	0.3500	1	0.2184	3
Development of forage production	0.2606	2	0.3974	1
Cut and carry feeding system	0.1426	4	0.1474	4
Availability of concentrate mix and wheat bran	0.2468	3	0.2368	2

*Index value= [(5 * rank 1)+(4 * rank 2)+(3 * rank 3)+ (2 * rank 4)+ (1 * rank 5)] divided by sum of all feed resources mentioned by respondents, n = number of respondents

availability between both agro ecologies (higher in midland than the lowland during wet season. This is probably due to farmers in midland had better improved forage production and access to purchase green feed (grass, forage) and concentrates near from market.

Majority of the respondents (97.5%) in the study area reported that they experience feed shortages during the dry seasons (P>0.05), mainly because of, land shortage (1st), lack of irrigation system and water sources for irrigation (2nd), inaccessibility of concentrate feeds (3rd) and occupation of communal grazing land (4th) in both lowland and midland agro ecology (Table, 17). feed shortages during the dry seasons in the study area there is not significantly different (P? 0.05) in both agro ecologies. The respondents stated shortage of land as the most important cause of low feed availability because it affects the production of DM from natural pasture, crop residues and forages since landholding per household was positively associated with total DM matter production per household. This result is in agreement with the finding of Belay and Geert [48] for Jimma town Ethiopia, that lack of access to land was stated by the respondents as the most important cause of low feed availability.

Lack of irrigation system and water sources for irrigation is another important problem for improved forage production, thus forage production in the study area is entirely based on rain fed in wet season. As a result, during the dry seasons, there is shortage of green feeds, which were widely used as basal diet during the rainy season. The low availability and quality of feeds in the dry seasons tends to affect the productive and reproductive performance of livestock unless the animals are adequately supplemented. In the study area regardless to agro ecologies, the grazing land amount was decreasing from year to year, because of the communal and private grazing land was expanded by crop cultivation due to the increment of human population. This result was similar with Adugna and Aster [56] and Alemayehu [57], has also reported that grazing lands are steadily shrinking and being converted in to arable land in the mixed farming and mid altitudes of Ethiopia.

Woldeamlak [58] of Gojam and Wollo, northern Ethiopia has also reported similar trends of expansion of cultivated area. Moreover, the communal grazing lands were distributed to investors and occupied by investment activities particularly in midland agro ecology. The utilization rate and need of concentrate feeds were high in the study area. However, the availability and accessibility of concentrate feeds were very low except for wheat bran and concentrate mix [59].

Based on the output of focused group discussion and key informants feed shortage, water scarcity during the dry season, inaccessibility of concentrate feed, Occupation of communal grazing land and animal disease were the major challenges in a decreasing order for livestock production and productivity in the study area.

Major Opportunities of Livestock Feeding in the Study Area: Majority (87.9%) of the respondents reported that they were practicing improved forage production (Table 18). The result was comparable with the reports of Diriba *et al*. [49], which stated that 58% and 67% of dairy farmers in Nekemte and Bako towns in western Oromia

Table 19: Major coping strategies to scarcity of feed in the study area

		Lowland (n = 94)		Midland (n = 38)	
	Variable	Index value	Rank	Index value	Rank
Dry season	Feed preservation as straw and hay	0.342	1	0.301	1
	Using browse trees	0.174	3	0.135	4
	Use of improved forage production	0.096	5	0.142	3
	AIBP	0.212	2	0.195	2
	Destocking	0.100	4	0.134	5
	Forage purchase	0.076	6	0.093	6
Wet season	Feed preservation as straw and hay	0.425	1	0.434	1
	Using browse trees	0.185	3	0.109	3
	Use of improved forage production	0.231	2	0.246	2
	AIBP	0.078	4	0.077	5
	Destocking	0.032	6	0.039	6
	Forage purchase	0.049	5	0.095	4

*Index value= [(5 * rank 1)+(4 * rank 2)+(3 * rank 3)+ (2 * rank 4)+ (1 * rank 5)] divided by sum of all feed resources mentioned by respondents, n = number of respondents

practiced improved forage production. In my personal observations, focus group discussion and key informants interview it was visible that farmers in the surveyed area could grow forages such as Desho grass, Elephant grass and few of them also grow multipurpose legume tree such as, Sesbania as live fence. This feeds are good sources of protein and minerals for dry season feeding. However, farmers lack knowledge on the importance of this tree legume.

Farmers could keep limited number of livestock in the study area. The main feeding system in the study area was stall feeding (zero grazing) (Table 18); thus it allows farmers to utilize the existing feed resources especially natural pasture and forage efficiently and effectively through minimizing wastage. Availability of concentrate mix and wheat bran in the study area was also another opportunity of livestock feeding thus farmers obtain wheat bran and concentrate mix from local environment by reasonable cost.

Access to extension service and training; farmers are supported by extension workers and know well about the benefit of livestock keeping, the probability of using and maintaining the livestock production and productivity will increase, this is another opportunity in the study area.

Major Coping Strategies to Scarcity of Feed in the Study Area: 97.5% of respondents stated that farmers implemented coping strategies during the dry season of feed scarcity, which occurred in the study area. To mitigate the existing shortage of feed by increasing the use of conserved straw and hay, agro-industrial by-products and concentrate mix, production and purchased of improved forage and reducing herd size. The present study is similar to the finding of Belay and Geert [48] for Jimma town, Ethiopia. They reported that farmers' adopted coping strategies for dry season feed scarcity by increasing use of agro-industrial byproducts and concentrate mix, increasing use of conserved hay, increasing use of non-conventional feeds, purchasing green feeds when available and reducing herd size.

Consequence of Feed Shortage on the Performance of Livestock: The major consequences of feed shortage for livestock in the study areas include weight loss, production reduction, increased mortality and weakness (Figure 2). The overall consequences of feed shortage in the study area were 24% weight loss, 33% production reduction, 20% increased mortality and 23% weakness. The current study is line with the finding of Andualem *et al*. [41] and Zewdie [60] with the exception of absence of heat.

Estimation of Annual Feed Availability and Feed Balance Dry Matter Production from Different Land Types: According to agriculture and natural resource Office (2021) [11], report, there are different land use types; private (individual) grazing land (6,200 ha), protected land (1272 ha), forestland (1742.42 ha) and open/communal land (2934 ha) in the study area, which are feed resource for livestock. From this area of land, the highest tons of dry matter (18,600 ton) were produced from private (individual) grazing land, whereas approximately the lowest tons of dry matter (636 ton) feed was produced from protected land [12]. 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), protected land (0.5) and forest land (0.7) according to

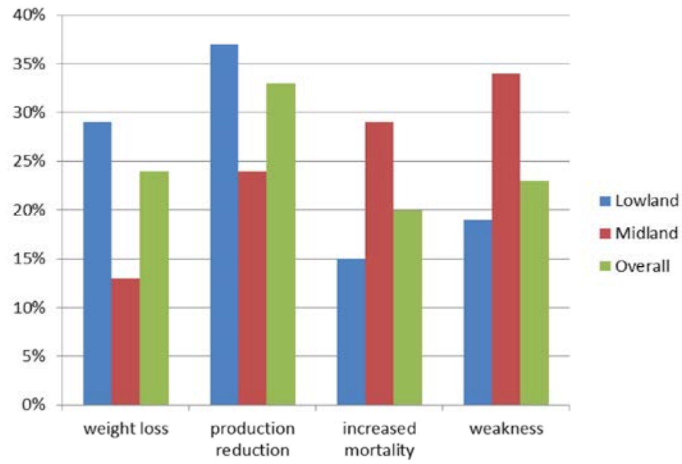

Fig. 2: Consequence of feed shortage on the performance of livestock

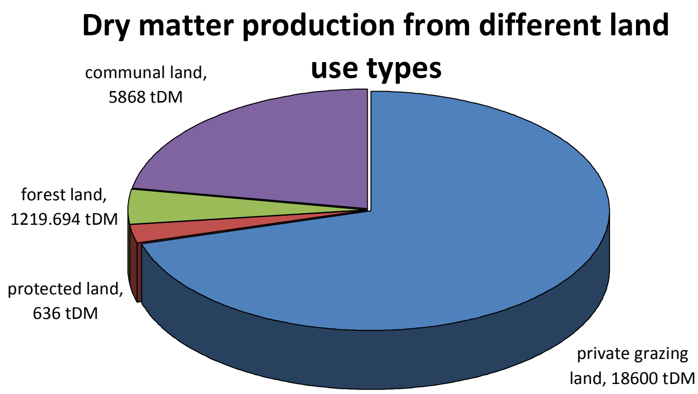

Fig. 3: Total DM productivity (tons) from different land use types in the study area

FAO [14]. The total DM (t/ha) from different land types in Sankura district was 26,323.694 tons. DM Productivity of different land use types is shown in Figure 3.

Crop Residues Dry Matter Production: The agriculture and natural resource office of Sankura district [11], report had demonstrated that 14428.75 ha of land are covered by cropping land. In the study area currently have been produced crop residues from maize, wheat, teff, barley and sorghum and haricot bean. The total area of different crop types grown is 5621.5, 4315.5, 1304.5, 306, 521.5 and 1473.5 ha, for maize, wheat, teff, barley, sorghum and haricot bean, respectively. The crop residues (94,418.4 tons of DM) are the first dominant feed resource in Sankura district as livestock feed. The dry matter production of crop residues in the study district is shown in Figure 4.

Crop Aftermath Dry Matter Production: Rendering to agriculture and natural resource office report of 2021 [11], it was demonstrated that 14,428.75 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 [14]. Accordingly, 7,214.375 tons of DM/ha/year was produced from crop aftermath.

Contribution of Improved Forage: According to livestock and fishery development office [11], currently improved forages such as desho grass, elephant grass, dismodium sesbania and Rodes grass are produced in the study area. The total area of different improved forage types grown is 543, 235, 11.5, 65 and 5.5 ha, for Desho grass, Elephant grass, Dismodium, Sesbania and Rodes grass respectively. Totally, 6,343 tons of DM was obtained from improved forage in the study area [14].

Contribution of Wheat Bran and Concentrate Mix Feed: The quantity (DM basis) of wheat bran and concentrates mix available for each household was obtained by interviewing the farmers during questionnaires survey.

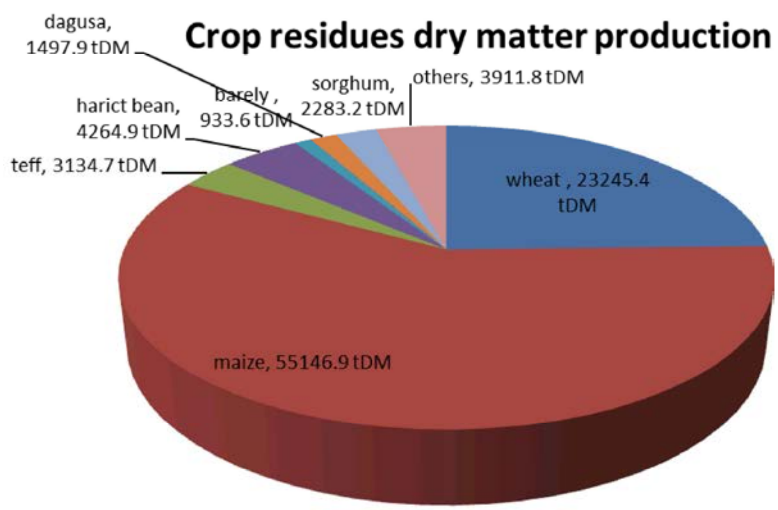

Fig. 4: Crop residues dry matter production in the study area

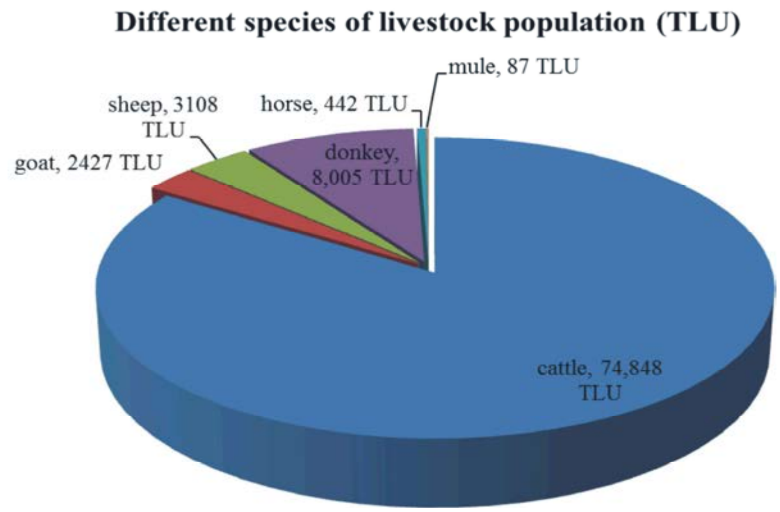

Fig. 5: Different species of livestock population (TLU) in the study area

Based on the annual report from livestock and fishery development office [11] was 11500 k/g wheat bran and 1598 k/g concentrate mix distributed in the district. Accordingly, 11.5 tons of DM was obtained from wheat bran and 1.598 tons of DM was obtained from concentrate mix in the study area; the contribution of wheat bran and concentrate mix was very little as compared to other feed resource.

Total Tropical Livestock Unit (TLU) and Their Dry Matter Requirement: Based on the reported data of livestock and fishery development office [11] of Sankura district, the district had on average 88,917 tropical livestock unit (TLU); comprising 74,848 cattle, 2,427 goats, 3,108 sheep, 8,005 donkey, 442 horse and 87 mule (Figure 5).

Assuming that DM requirement for maintenance of one TLU is 6.25 kg/day (2.28 ton/year/TLU) [61], the estimated total annual requirements of DM for the dominant livestock species: cattle (170,653.4), goat (5,534.429), sheep (7,085.426), donkey (18,252.22), horse (1,007.7) and mule (198.3) will be about 202,731.475 tons of DM per year in the district. The population (TLU) of different species of livestock in the study area is shown in Table 20.

Feed Balance Analysis in the Study Area: The open grazing land, private grazing land, protected land and forest land, crop residues improved forage, concentrate mix feed and wheat bran were used to calculate feed supply for livestock in the study area. Accordingly, 94,418.4 tons of DM per year was produced from cropland

Table 20: TLU and annual feed requirement in the study area

Species	Livestock pop.	Conversion factors	TLU	DM requirement (tone)
Cattle	106,926	0.7	74,848	170,653.4
Goat	24,273	0.1	2,427	5,534.429
Sheep	31,076	0.1	3,108	7,085.426
Donkey	16,010	0.5	8,005	18,252.22
Horse	553	0.8	442	1,007.7
Mule	125	0.7	87	198.3
Total			88,917	202,731.475

TLU= Tropical Livestock Unit, DM= dry matter

Table 21: Feed balance analysis from different land, crop residue, crop aftermath and improved forage

Feed supply	Area (ha)	DM (tones)
Different land use	12,148.42	26,323.694
Crop land	14,428.75	94,418.4
Improved forage	860	6,343
Crop aftermath		7,214.375
Wheat bran		11.5
Concentrate mix		1.598
Total feed supply		134,312.57
Feed requirement		
Total no of TLU	88,917	
DM required/TLU/year	2.28 given	
Total annual DM required	202,731.475	
Feed balance	-68,418.905	
Proportion of feed gap (%)	33.7	

TLU= Tropical Livestock Unit, %= percentage

with exception of different land use types, improved forage, aftermath grazing, wheat bran and concentrate mix feed which produce 26,323.694, 6,343, 7,214.375, 11.5 and 1.598 tons of DM per year, respectively. Therefore, a total of 134,312.57 tons of DM per year was produced in the study district.

As it had been calculated the total DM produced in the study area from different feed resources was 134,313.367 tons and the demand for maintenance requirement of the livestock population in the district was 202,731.475 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 DM/ year) and this showed that a deficit off 68,418.905 (33.7 %) 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 [62]. This further recalls that there is need to introduce the feed improvement interventions in the study area in order to save the livestock.

Chemical Composition and Digestibility of Different Feedstuffs: The chemical composition of different roughages in midland agro-ecology is presented in Table 22. In midland agro-ecology the chemical analysis shows that desho and elephant grass had the lowest ash content and desho and natural pasture had highest NDF content when compared with elephant grass. The highest CP content was observed in desho grass and elephant grass and the lowest CP content in natural pasture. Natural pasture had the lowest ADF when compared with desho grass and elephant grass while elephant grass had highest ADL content when compared with desho and natural pasture. Natural pasture had the highest IVDMD when compared with desho grass and elephant grass. Among the crop residues in midland agro ecology, maize stover had the highest ash content compared with wheat straw and teff straw. The CP content of teff straw was the highest compared with wheat straw and maize stover. Wheat straw had the lowest IVDMD compared with maize stover and teff straw.

The chemical composition of different roughages in lowland agro-ecology is presented in Table 22. Among the roughage feeds, natural pasture had the lowest CP content as compared with desho and elephant grass. Also, natural pasture was highest in EE content when compared other feedstuffs. Natural pasture had the highest NDF and IVDMD content as compared with

Table 22: Chemical composition and in vitro dry matter digestibility of different feedstuffs in midland agro-ecology

Agro-ecology	Feed category	Feed type	Chemical composition (%DM) Ash	CP	EE	NDF	ADF	ADL	IVDMD (%)
		Natural pasture	10.31	6.61	13.21	73.21	40.21	6.86	62.54
	Roughages	Desho grass	8.89	13.35	8.11	74.05	45.25	7.51	36.23
Midland		Elephant grass	8.41	12.56	8.27	72.35	42.37	9.12	37.71
	Crop residue	Wheat straw	6.49	4.58	1.2	76.5	52.24	6.2	38.45
		Maize stover	10.62	4.22	1.01	67.15	34.41	10.31	56.46
		Teff straw	7.52	5.23	1.2	68.51	33.41	8.43	53.22
		Natural pasture	10.11	6.01	14.76	74.08	39.45	7.32	57.41
	Roughages	Desho grass	8.37	12.25	9.79	73.75	38.45	8.56	41.25
Lowland		Elephant grass	8.58	12.31	8.19	70.47	39.51	9.42	42.27
	Crop residue	Wheat straw	6.38	3.84	1.22	74.2	49.6	5.7	40.23
		Maize stover	9.77	3.97	1.14	70.25	37.28	11.22	60.52
		Teff straw	6.95	4.78	1.3	69.24	35.18	9.01	62.47

CP= crude protein; NDF= neutral detergent fiber; ADF=acid detergent fiber; ADL= acid detergent lignin; IVDMD=in vitro dry matter digestibility; DM= dry matter; %= percentage

desho and elephant grass. Among the crop residue in lowland agro ecology maize stover had the highest ash content compared with wheat straw and teff straw. The CP content of teff straw had the highest compared with wheat straw and maize stover. Wheat straw had the lowest IVDMD compared with maize stover and teff straw.

The ash content of roughages, natural pasture has highest value 10.31% and 10.11% from midland and lowland agro ecologies, respectively and from crop residue, maize stover has 10.62% and 9.77% from midland and lowland agro ecologies, respectively.

The ash content for roughage feeds in the current study was lower than the value reported by Tesfaye [63] and Wondatire *et al.* [64] for roughage feeds However, the ash value in the current study was higher than the values reported by Solomon *et al*. [65] and Fekede [66]

The CP value for roughage feeds in the current study areas was greater than the values reported by Wondatir [64] and Terefe [38]. Generally, with the exception of natural pasture roughages evaluated in the current study had higher CP contents than the minimum level of 7% CP required for optimum rumen microbial function [67]. Feeds with CP content less than 7% inhibits voluntary intake and microbial activity, resulting in poor digestibility [67]. The CP value in the present study for all crop residues is lower than the critical level 7% for optimum rumen microbial function.

The CP content of roughages desho grass and elephant grass 10.35% and 12.56% in midland and 12.5% and 12.31% in lowland agro ecologies, respectively. This indicates that desho grass and elephant grass had higher CP contents than the minimum level of 7% CP required for optimum rumen microbial function.

The NDF content for all feedstuffs (roughages and crop residue) in the current study in midland and lowland agro ecology is higher than the critical level of 45%, above which the voluntary feed intake and feed conversion efficiency will decrease due to longer rumination time [68]. Roughage feeds with NDF content of less than 45% are categorized as high quality Roughage feeds and with NDF content between 45% to 65% are categorized as medium quality.

The ADF content for all roughages in the present study is comparable with the reports by Terefe [38] and Kidane [69]. The ADF content for all roughages in lowland is lower than 40% and higher than 40% in midland agro ecology. The ADF contents for teff straw and maize stover in the current study was lower than the value recorded critical range. Roughages with ADF content less than 40% are high quality and above 40% as low quality [69].

The IVDMD values in the current study in midland and lowland agro ecologies, all roughages and crop residue were lower than 65%. According to Meissner *et al.* [70], feeds with *in vitro* digestibility of greater than 65% indicate good nutritive value and values below this level result in reduced intake due to lowered digestibility. The IVDMD in the current study was between the two agro ecologies was lower than the critical value of 65%, this indicates that all feed types poor nutritive value in the study area. It needs to treat the feed for upgrading the nutritive value of the feed.

CONCLUSION AND RECOMMENDATIONS

Generally, the major feed resources in the study areas regardless of agro-ecologies were natural pastures, crop residues, agro-industrial by products (wheat bran and concentrate mix),and improved forages. The commonly practiced feeding systems in the study areas were herded grazing on private grazing land and roadsides around the village, stall feeding (zero grazing) and tethering around homestead on natural pasture. Livestock feeding in the study area constrained by shortage of land, lack of grazing land, lack of irrigation system and water sources for irrigation and occupation of communal grazing land by investment activities. As it was disclosed by majority of respondents, feed availability and seasonality were the most commonly occurring problems and constraints that might affect the development of the livestock production in the study area; there were also opportunities to improve livestock feeding and production for the future times, such as, pseudo stem plants production, development of forage production, cut and carry feeding system and availability of wheat bran and concentrate mix. On the other hand, farmers adopted coping strategies with dry season feed scarcity are increased use of feed conserved as straw and hay, AIBP, improved forage production, transferring stocks to relatives and reducing herd sized. The total DM produced in the study area from different feed resources was 134,312.57 tons and the demand for maintenance requirement of the livestock population in the district was 202,731.475 tons DM/ year. The annual feed DM production in the district could not satisfy (33.7% less) the DM requirement of livestock kept in the area. 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. 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. The nutritive value of roughages and crop residue with the exception of desho rass and elephant grass the CP content was lower than the critical value 7% and the NDF and IVDMD content of all roughage and crop residue was poor nutritive quality. In order to solve, the shortage of feed availability and poor nutritive quality, farmers should practice feed conservation methods, particularly hay and silage making during excess of feed resources availability. Moreover, farmers should practice improved legume forage production widely on their own farmland and collect crop residues during crop harvesting times and store it under shed. In the study area, training should be given on effective utilization strategies of available feed resources such as use of urea treatment, nutrient block and silage making, in order to improve the quality of feed. Livestock feeding and watering practices were poor in the study area. To improve this management practices for the future, development agents and office experts of the district should provide intensive extension services and continuous follow-up of the management practices.

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