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Original Research

Assessment of Cattle Feed Resources; Chemical Composition and Digestibility of Major Feeds in Essera District, Southern Ethiopia

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Abstract

The aim of this study was to identify major feed resources and analyzing chemical composition and Digestibility of major feeds. A total of 6 feed samples (1 indigenous grass, 2 crop residues, 2 indigenous legumes and 1 indigenous browse) were collected using a total of 90 household participants and key informants for vernacular name identification. A semi-structured questionnaire was prepared and used to collect data on available feed resources. Collected data were analyzed using descriptive statistics, indices, one-way ANOVA and Pearson correlation coefficient using SPSS version 20 software. The first three major feed resources were natural pasture (54.4 and 90%), crop residues (63.3 and 100%), and crop aftermath (65.5 and 90%) during dry and wet season, respectively. The results of laboratory analysis of chemical composition showed that the DM content of maize stover, teff straw, *Lamuxxa*, *Cayshiyaa*, *Dawuro daama* and *Gasaa* were 92.11, 92.09, 69.63, 57.08, 43.38 and 18.73%, respectively. The crude protein contents of *Dawuro daama*, *Cayshiyaa*, *Gasaa*, *Lamuxxa*, *teff* straw and maize stover were 14.23, 13.39, 12.35, 10.30, 4.26 and 3.67%, respectively, while the corresponding values of IVDMD were 85.18, 77.22, 95.29, 76.19, 50.68 and 40.90%. The NDF contents of maize stover, *teff* straw, *Lamuxxa*, *Cayshiyaa*, *Dawuro daama* and *Gasaa* were 78.23, 76.10, 41.92, 25.37, 16.5 and 9.43%, respectively, whereas the corresponding values of ADF were 53.94, 46.25, 23.43, 15.55, 10.53 and 5.34%. The results revealed that CP was positively correlated ($r = 0.92$, $P<0.01$) to IVDMD and negatively ($r= 0.84$, $P<0.05$) to NDF and ADF and ($r=0.92$, $P<0.01$). The results indicated that indigenous legumes and browse have considerable potential for strategic supplementation of poor quality roughages. Further studies in animal trials have to be warranted to substantiate their supplementary value and level of inclusion in animal diet.

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INTRODUCTION

Ethiopia has an immense potential for increasing livestock production, both for local use and for export purposes. However, limited feed supply and poor quality of the available feeds are the major constraints for optimal livestock productivity in tropical and sub-tropical countries Boufennara *et al*. (2012). These regions are characterized by irregular rainfall and thus livestock have to survive on persistent shortage of feed resources of low nutritional value for most part of the year (Solomon and Teferi, 2010. During the dry periods, poor quality feeds and inadequate nutrition has been reported to be one of the most important constraints for livestock production Ethiopia across all ecological zones. In addition, degradation of lands due to uncontrolled and excessive use of communal grazing lands of undulated topography in the highlands and erratic rainfall in semi-arid areas has further reduced the availability of feed resources (Solomon and Teferi, 2010).

The use of improved forages by smallholder farmers is not common and utilization of agro-industrial by-products is limited to urban and peri-urban areas (EARO, 2001). Currently, with increasing human population and demand for crop production, grazing lands are shrinking and livestock are kept in low potential lands that are not suitable for crop production and other purposes (Alemayehu, 2005). This condition is evident in the mixed farming systems of the highlands and mid altitude zones of Ethiopia.

To improve ruminant nutrition, efforts have been made in Ethiopia through exploration of the indigenous feed resources and introduction of improved genotypes (Getnet, 2003). However, the introduction of exotic species has been less successful mainly due to adaptability, agronomic problems and land shortages. Thus, indigenous plant species are contributing the largest proportion of the livestock feed across all agro-ecological zones of Ethiopia (Getnet, 2003).

Even though, cattle play a very significant role in the livelihood of smallholder farmers in the *Essera* District, cattle feed resources, feeding practices and nutritional values of feeds have not yet been studied and their feeding value is unknown. Therefore, this study was conducted to identify major cattle feed resources and feeding systems and to analyze the chemical composition and dry matter digestibility of the major cattle feed resources in the District for efficient utilization of indigenous and locally available feed resources.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in *Essera* District of *Dawuro* Zone, Southern Nation Nationalities and People Region (SNNPR). The district covers a total area of 1043.1 km^2 and lies between 6.7-7.02^0 latitude and 36.7 to 37.1^0 longitudes, with an elevation ranging from 501 to 2500 m.a.s.l. The District lies in three agro-ecological regions: *Kolla* region, which is within 500-1500 m.a.s.l; *Woyna-dega* within 1501-2500 m.a.s.l; and *Dega* at above 2500 m.a.s.l. The annual mean temperature varies from 17.6 to 27.5^{o}C. The rainfall is a bimodal type: the short rainy season is between February and March and the long between May and September. The average annual rainfall varies between 1401-1800 mm (EWARDO, 2008). The area is characterized by crop-livestock mixed farming system. According to the land use plan of the area, 38.4% is cultivated land, 13.39% grazing land 16.81% forest bushes and shrub land, 17.09% cultivable, and 14.31% is covered by others (EWARDO, 2013).

Household Sampling and Feed Sampling and Preparation

Multi-stage random and purposive sampling techniques were used to select study *kebeles* and households. The study sites were selected purposively by the agro-ecological conditions, proximity to main road and cattle population. Based on the available information, E*ssera* District has a total of 29 *kebeles* distributed into *dega* (high altitude), *woyna-dega* (medium altitude) and *kolla* (low altitude). Then the *kebeles* in each agro-ecology were ranked according to their cattle population and the first two kebeles with highest cattle numbers from each agro-ecological zone making totally six *kebeles* were selected purposively to represent the District. The sample size for surveying was determined using the formula recommended by Arsham (2007).

N=0.25/ (SE) 2

Where: N= sample size and
E= standard error of the proportion

Assuming the standard error of 5.27% at a precision level of 5%, and the confidence interval of 95%, 90 households having cattle were selected by a simple random sampling technique for interview. Thirty from *dega*, thirty from *woyna-dega* and another thirty from *kolla* were selected randomly. The selection of feeds or plant species for laboratory analysis was done based on information provided during group discussion regarding their relative abundance in the area and their consumption by cattle. Samples of feeds were taken during the dry season because this is the period of the year when these feeds may be more important for cattle due to feed shortage. Representative samples of the feeds, which are dominantly grown and used for feeding cattle in the district, were collected from different areas, where available with the help of trained and recruited enumerators. Feed samples were collected on the same day from the shoreline of river and swampy areas and then the collected samples were bulked per feed type. Then samples were dried under shade, and the amount sufficient for lab analysis was sub-sampled & transported to Hawassa University Animal Nutrition Laboratory.

Determination of Chemical Composition and *In vitro* Dry Matter Digestibility

The various feeds evaluated in this study were grouped into different major classes. Then samples were oven dried at 65^{o}C for 72 hours and ground in Willey Mill to pass through 1 mm sieve. Feed samples were analyzed for DM, nitrogen (N) and ash contents according to AOAC (2000). Nitrogen was determined using the micro-Kjeldahl method (AOAC, 2000). The CP content was calculated by multiplying nitrogen content by a factor 6.25 (N x 6.25). Neutral detergent fiber (NDF), acid detergent fiber (ADF) was determined using Ankom^{200} Fiber Analyzer and acid detergent lignin (ADL) was determined using Ankom Daisy^{II} incubator according to Van Soest *et al*. (1991). The Ankom^{200} Fiber analyzer and Ankom Daisy^{II} incubator were used to determine *in vitro* DM digestibility (IVDMD).

Data Analysis

The data were analyzed using the SPSS software version 20 (SPSS, 2013). The descriptive statistical analysis was also employed for descriptive data, which included frequencies, percentages, means and standard errors in the process of describing feed resources and feeding system. Indices were calculated for major sources of crop residues in the study area. The means of quantitative data between study sites were compared by employing one-way analysis of variance (One-way ANOVA) in SPSS. Pearson correlation coefficient was used to understand the relationship among nutrient contents such as ash, DM, CP, ADF, NDF, ADL and IVDMD. The differences between means were declared significant at P<0.05, whereas statistical differences between qualitative variables were also proclaimed significant at P<0.05 and P<0.01.

RESULTS AND DISCUSSION

Feed Resources and Feeding System

Natural pasture, crop residue, crop aftermath and others were ranked 1st, 2nd, 3rd and 4th by 54.4, 63.3, 66.5 and 95.6% of HH during dry season in overall agro-ecology, respectively (Table1). In contrast, during wet season natural pasture, crop aftermath/stubble grazing, crop residues and others were the first, second, third and fourth ranked sources of cattle feed by 90, 90, 100 and 93.3% of HHs, respectively, which was in line with the report of Belay *et al*. (2012) in *Dandi* district. All respondents remembered that free grazing on natural pastureland is the most dominating feeding system for their cattle in the study area. HHs mentioned that there was feed shortage during dry season and cropping season in the area, which was similar with the finding of Kechero *et al*. (2013), feed shortage is prevalent throughout the year both in dry and wet seasons. Results showed that there were no effects of the agro-ecology on cattle feeds, but season had effect on cattle feeds in the study area. Inadequate supply of feed in both quantity and quality was reported to be the single most important problem responsible for low productivity of livestock (Ulfina *et al*., 2005).

Table 1: Respondents ranking using different feed resources based on season in the study area

Agro-Ecology	TFR	Dry season				Wet season			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th
Dega	NP	66.7	20	13.3	0	100	0	0	0
	CR	6.7	66.7	26.7	0	0	0	100	0
	CAm	26.7	13.3	60	0	0	100	0	0
	Others	0	0	0	100	0	0	0	100
W. Dega	NP	46.7	20	33.3	0	80	20	0	0
	CR	40	60	0	0	0	0	100	0
	CAm	6.7	13.3	66.7	13.3	0	80	0	20
	Others	6.7	6.7	0	86.7	20	0	0	80
Kolla	NP	50	23.3	26.7	0	90	10	0	0
	CR	33.3	63.3	3.3	0	0	0	100	0
	CAm		13.3	16.7	70	10	90	0	0
	Others	0	0	0	100	0	0	0	100
Overall	NP	54.4	21.1	24.4	0	90	10	0	0
	CR	26.7	63.3	10	0	0	0	100	0
	CAm	15.6	14.4	65.6	4.4	3.3	90	0	6.7
	Others	2.2	2.2	0	95.6	6.7	0	0	93.3

TFR= Type of Feed Resource NP= Natural Pasture CR= Crop Residue CAm= Crop Aftermath

Natural Pastures

Farmers in the study area indicated that natural pasture was first most important source of feed for their cattle in both dry and wet season in the study area. Grazing on natural pasture was the most dominant feeding practice for cattle. Cattle are reared on natural pasture under continues grazing systems. Natural pasture in the high altitudes was rich in pasture species, particularly indigenous legumes (Kechero *et al*., 2010). According to field observation and survey results, there was grazing of cattle on communal and private pastureland, roadside, swampy area and around homestead either free or tethered in the study area.

Leaves from multipurpose trees (Aynalem *et al*., 2008), bushes and shrubs were provided during the end of the dry season. Due to continuous stocking and over grazing of pastures and roadsides, soil erosion has developed into major phenomenon. Encroachment of the less palatable and preferred plants like *Asracantha longifolia* locally known as *okaa* in the major grazing areas become a major problem of cattle production. Tethering and cut-and carry were mainly practiced in major cropping seasons.

Crop Residues Sources and Utilization

Maize stover, *teff* straw and bean and pea haulms were the major sources of residue in the study area with indices of 0.407, 0.245 and 0.126, respectively. Barley straw, sorghum stover, and others such as *Enset*, banana, coffee and root crops were other important sources of crop residue for their animals with indices of 0.111, 0.052 and 0.037, respectively (Table 2). The results were in agreement with the study of Azage *et al*. (2011), for *Mieso* woreda. Crop residues are abundantly produced throughout the world.

As indicated in the Table 3, all of households stated that the residues from *teff* straw and maize stover are used primarily for feed. In addition, 93.3% of the respondents indicated that teff straw is used for construction of local houses by mixing it with mud, which is then used to plaster the wall. The highest proportion of households (88.9% for maize and 77.8% for sorghum) stated that the residues from these crops are used as a source of firewood. The only crop residue sold was *teff* straw in the study area. In this study, no crop residue is completely consumed by animals without leaving some behind. The major uses of crop residues in the District is of course as a feed but considerable households surveyed alternatively use crop residues for fuel, roof shatter, fences and any of their combinations as the need arises. Crop residue as fuel source is one, which highly competes more since the practice is a daily consumption and an alternative way has to be found to minimize this competition through awareness creation of the farmers.

Crop Aftermath

As the result revealed, during wet season, crop aftermath/stubble grazing was the second most important source of cattle feed followed by crop residues. After harvesting the crops, cattle are allowed to graze stubbles of maize, sorghum, teff, wheat, barley and pulses between October and December. The stubbles are not accessible to other neighbor cattle owners in the community for first two months as agreed to the report of Sisay (2006) where stubbles are accessible to livestock owned by individual farmers in central highlands of Ethiopia. For the first two months, the stubble is grazed by the animals of the farm owner and later it becomes accessible to all animals in the community. Farmers in the district use aftermath grazing as one means to sustain their cattle until almost the second short rains cultivation.

Hay

All HHs (100%) in the study area, were not practicing hay making. This was mainly due to letting cattle graze standing dried grass, lack of awareness and large number of cattle as indicated by 60, 33.3 and 6.7 % of respondents, respectively. The most common practice used in conservation of feed resources was grazing in the form of standing hay (Figure 1). However, during this study, the researcher observed that, model farmers from each *kebeles* of the district selected and trained on hay and silage-making using less sophisticated procedures and locally available materials by the Woreda Agriculture and Rural Development office in collaboration with Agricultural Growth Program, which was not applied at least up to the time of the survey work. This may indicates that there was a weak extension service.

Table 2: Sources of crop residues in the study area

Crop residues	Agro-ecology															
	Dega				***Woyna-dega***				***Kolla***				**Total**			
	R1	**R2**	**R3**	**Index**	**R1**	**R2**	**R3**	**Index**	**R1**	**R2**	**R3**	**Index**	**R1**	**R2**	**R3**	**Index**
Teff straw	0	0	6.7	0.011	0	66.7	33.3	0.278	53.3	46.7	13.4	0.444	17.8	37.8	17.8	0.245
Maize stover	33.3	33.3	26.7	0.322	80	20	0	0.467	46.7	53.3	13.3	0.433	53.3	35.6	13.3	0.407
Sorghum stover	6.7	6.7	6.7	0.067	0	0	0	0.000	0	0	53.3	0.089	2.2	2.2	20	0.052
Wheat straw	0	6.7	20	0.056	0	0	0	0.000	0	0	0	0.000	0	2.2	6.7	0.018
Barley straw	33.3	46.7	6.7	0.333	0	0	0	0.000	0	0	0	0.000	11.1	15.6	2.2	0.111
Bean and pea haulms	26.7	6.7	33.3	0.211	20	0	46.7	0.178	0	0	0	0.000	15.6	2.2	26.7	0.126
Others	0	0	0	0.000	0	13.3	20	0.078	0	0	20	0.033	0	4.4	13.3	0.037
Total	**100**	**100**	**100**	**1.00**	**100**	**100**	**100**	**1.00**	**100**	**100**	**100**	**1.00**	**100**	**100**	**100**	**1.00**

Index = [3 for rank 1) + (2 for rank 2) + (1 for rank 3)] for each of the factor divided by sum of all of the factor

Table 3: Utilization of crop residues in the study area

Type of crop residues	Percentage of responses					
	Feed	**Construction**	**Fuel**	**Compost**	**Sold**	**Other purpose**
Teff straw	100	93.3	53.3	55.6	33.3	22.2
Bean and pea haulms	68.8	0	61.1	0	0	0
Sorghum stover	93.3	88.9	77.8	62.2	0	64.4
Maize stover	100	10	88.9	82.2	0	53.3
Wheat straw	66.7	44.4	35.6	51.1	0	26.7
Barley straw	66.7	58.9	30	65.6	0	44.4

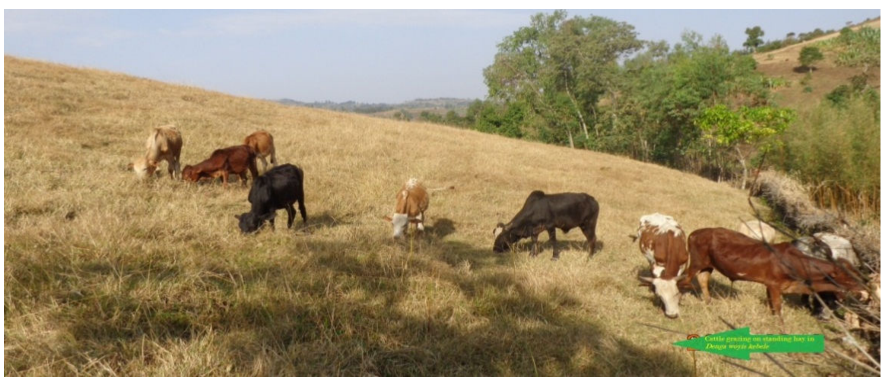

Figure 1: Cattle grazing on standing hay in one of the study kebele.

Indigenous Plant Feed Resources

To date, there has not been any scientific study of vegetation in the study area. Farmers climb up forage trees to lop down leaves and branches of various trees and shrubs and feed them to their cattle during the dry season except when they face critical problems. They also collect herbaceous wild plants, legumes and grasses as feed for cattle. Similarly, Adugna and Said (1992) reported in *wolaita Soddo*. *Cordia africana (Wanza) ,Bambusa vulgaris* (Bamboo tree), *Ficus sur (Shola), Zaagiya (Dawuregna), Ilala* and *washaa (Dawuregna), 'Dawuro daama'* (Figure 2a), *'Gasaa', 'Cayshiyaa' (*Figure 2b) and *'Lamuxxa'* (Figure 2c) were mostly used as cattle feed during dry season of the year/ feed shortage season in the district.

From the group discussion, it was heard that providing the leaf/fruit of *Ficus sur* for milking cow is locally not recommended due to it is considered that it cans the teat hole of milking cow and difficulty may face during milking. This is probably thought to be because of its sticky whitish colored fluid effect, which needs scientific investigation. '*Dawuro daama*' leaf and stem were chopped, grinded and mixed with salt and water and given to drink mainly for milking cows and fattening cattle. This disagreed with Adugna (2007) who reported that other feeds used for fattening include leaf of wild plant *Dambursa (Wolaytigna)* in Wolaita are. All farmers in the study area believed that it improves the quality of butter and they use it as mending medicine for broken cattle as well as human being.

Gasaa and *Cayshiyaa (Dawuregna*) were the other indigenous legume and legume browse feed types, respectively. During group discussion with extension workers, local elders and locally experienced cattle owners in *Dega* and *Woyna dega* agro-ecology, it was mentioned that these two indigenous feed resources were used mainly during dry season for the sake of survival and milk production of cattle. These plants keep green through the year even during dry season.

'Lamuxxa' was one more feed resource in the study area. It was naturally cultivated grass species in *Kolla* agro-ecology particularly on the mounted area of the district and used as feed by cut- carry system for principally milking cow. These more promising wild plants should be further investigated for their voluntary intake and digestibility by animals, content of anti-nutritional factors, biomass production and ease of propagation.

(a). *Dawuro daama* **(b). *Cayshiyaa*** **(c). *Lamuxxa***

Figure 2: Indigenous legume (a), legume tree (b) and grass (c)

Non-conventional Feed Resources (NCFR) and Mineral Licks

Out of interviewed households, 95.6% practiced feeding of non-conventional feed resources. The most commonly used non-conventional supplementary feed is residues of local brewery (*atella*). Although the nutritional value this is feed is rated as good (Zewdie, 2010), the availability is very limited and therefore does not satisfy the demand owing to religious factor that totally forbid production of local alcoholic drinks (*tela* and *caticala*). Naturally obtained "*Axuriyaa*" (salty soil) (Figure 3) and "*Aduwaa*" (natural salty water) were abundantly available as cattle feed resources in the district and used by 55.3% of farmers. This figure was lower than the report of Yeshitila (2008) in *Alaba* district as the 72.3% of farmers using mineral or salt lick as animal feed resources. During the group discussion, it was mentioned that both mineral rich soil and natural salty water, locally known as *Axuriyaa* and *Aduwaa*, respectively, increase the quantity and quality of milk. This is probably due to high content of sodium in mineral soil.

Figure 3: "*Axuriyaa" (*salty soil) in one of study kebeles market

Nutritionally, study in *Soddo* previously showed that mineral-rich soil, locally known as *Bole,* which is synonym with *Axuriyaa,* is used as mineral supplement for ruminants. These soils are rich in sodium but low in phosphorous and hence attempts should be made to correct phosphrous levels of these feeds when they are used as dry-season supplements to diets based on crop residues and dry pastures (Adugna and Said, 1992). Mineral salt was commonly given for cattle in wet season. However, as suggested by the farmers, because of the hot climate and the scarcity of forage resources, animals were not given salts during the dry season. As gathered from key informants, salt is given to enhance feed consumption, initiate cows to be in heat and increase milk production. Tesfaye (2007) reported the same finding in *Metema* district of *Gonder* zone.

Very exceptionally sampled farms in the study, responded that they provide boiled grains like beans, maize grain to oxen, fattening and weak cattle. Although farmers selective feeding of productive animal is a good indication of their understanding of the role of supplementation in enhanced productivity, the question as to whether farmers supplement their cattle sufficiently or not is a question for further investigation. A residue from local drinks of coffee mainly from leaf was added with salt and water to be sprayed on standing hay grass and supplemented on crop residues of cattle feed. Papaya peels, banana (stem, leaf and peel) chopped and fed cattle, taro (*Colocasia esculenta*) stem and root, cassava, potato, sweet potato (vines and occasionally tubers), sugarcane tops, leaves and whole cane (chopped) and fed mostly to fattening animals, pumpkins and fruits and vegetables left over in the study area. This is in line with the report of Adugna (2007) in Soddo Zuria Woreda. Enset (*Ensete venticosum*) (stem, leaf and root), cabbage wastes, kitchen wastes and edible leaves of other plants such as '*Korch*' are also fed to animals in the study area and this is in agreement with Ayza *et al*. (2013) in *Boditti*.

Seasonality of Feed Availability, Feed Quality Improvement and Improved Forage Production

In the study area, all respondents have mentioned that they have come across cattle feed shortage. According to 48.9 and 51.1% of respondents, feed shortage existed in between January to March and February to April in the district, respectively. As the survey results revealed, 100, 97.8 and 53.3% of responses indicated that feed shortage resulted in weight loss, weakness and reduction in milk yield of cattle, respectively. Similar observation was reported by Zewdie (2010) in the Highlands and central rift valley of Ethiopia the consequences of feed shortage for livestock include weight loss, lower milk yield, mortality and absence of heat. However, this was alleviated by use of destocking, fodder bank and feed purchases as indicated by 24.4, 20 & 15.6% of HHs, respectively (Table 4). Of the total respondents, only 15.6% purchased green grass (9.3%) and crop residues (6.3%) from neighbored settlers. This agrees with Adugna (2007) in Damot Gale Woreda report as green grass and *teff* straw are sold depending upon the season and the size of the load.

Table 4: Alleviating feed shortage, feed quality improvement and reasons of not practicing forage development in the study area

Agro-ecology				
Variables	**Dega**	**Woyna-dea**	**Kolla**	**Over all**
Ways of alleviating feed shortage				
Fodder bank	13.3	33.3	13.3	20
Destocking	20	0	53.3	24.4
Purchasing feed	20	20	6.7	15.6
None	6.7	0	0	2.2
Others	40	46.7	26.7	37.8
Means of feed quality improvement				
Soaking with water	60	6.7	36.7	34.4
Chopping	13.3	33.3	23.3	23.3
Grinding	26.7	20	0	15.6
Alkali treatment	0	26.7	13.3	13.3
Crashing	0	0	26.7	8.9
Others	0	13.3	0	4.4
Reasons why forage development is not practiced				
Scarcity of seed	26.7	60	80	55.6
Lack of awareness	53.3	13.3	20	28.9
Both	20	26.7	0	15.6

As the results revealed, only 17.8% of farmers used feed quality improvement techniques in the study area. Of these respondents, 34.4, 23.3, 15.6, 13.3, 8.9 and 4.4% treat crop residues by soaking with water, chopping, grinding, alkali (salt), crushing and others, respectively (Table 4).This result is slightly similar with the report of Yeshitila (2008) in *Alaba* crop residues are not exposed to such treatments in the survey areas. Most of the time a feed coping mechanism of like this is the interventions recommended in cereal based high crop residue areas like that of *Essera*.

All of interviewed respondents witnessed that there was no improved forages cultivation for their cattle at farmer's level in the study area. The study of Zewdie (2010) in central Highlands of Ethiopia also indicated that the proportion of farmers practicing improved forage production is only 13%. Most important constraints regarding improved forage cultivation were scarcity of seed/raw material (55.6%), lack of information (28.9%) and both scarcity of seed and awareness (15.6%) (Table 4). Farmer's reason for not practicing improved forage production varies across the study agro-ecologies. For example in *Kolla* the main reasons for not practicing improved forage production were lack of seeds followed by lack of awareness. For HHs in *dega* and *woyna-dega* agro-ecologies, the main reason for not practicing improved forage production was lack of awareness. Although lack of awareness is a common denominator for whole of the study area. Problems identified in this study agree with report of Zewdie (2010).

According to Alemayehu (2005), for last two decades, forage adaptability and production trials were made across the different agro ecosystems in the country and some promising forages were selected. It was observed that around homesteads of some HHs, there was *sesbania* tree as life fence, but farmers did not feed their animals because of lack of awareness. To date adoptions of technologies are generally limited to per-urban and urban area. Relevant question here is probably as to why policy measures that enhances improved forage production could not be implemented and as to whether policy recommendations, if it exists, are system specific or generalized.

Chemical Composition and IVDMD of Major Feed Resources

Regardless of the effect of season and agro-ecology, chemical composition of major feeds in the study district is shown in Table 5. The results of laboratory analysis of chemical compositions showed that the DM content of maize stover, *teff* straw, *Lamuxxa*, *Cayshiyaa*, *Dawuro daama* and *Gasaa* were 92.11, 92.09, 69.63, 57.08, 43.38 and 18.73%, respectively. The dry matter (DM) content of crop residues was above 90%, which corresponds with Sisay (2006). The CP contents of *Dawuro daama, Cayshiyaa, Gasaa* and *Lamuxxa* were 14.23, 13.39, 12.35 and 10.30%, respectively. Crop residues had CP content of 4.26 and 3.67% in *teff* straw and maize stover, respectively. This result is lower than the range of FAO's (1984) recommendation, that the threshold value of feedstuffs for CP is between 7% and 8%, which is adequate for maintenance of livestock and above the minimum requirement for optimum rumen function (7.5%) suggested by Van Soest (1982). The results of the current work agree with the report of Seyoum and Fekede (2008) that cereal crop residues are normally characterized by low digestibility and energy value, which are both inherent in their chemical composition. The former contained lower CP compared to the later. The lower content of CP for crop residues may be compensated with strategic supplementation of protein feeds to improve cattle performance.

Table 5: Chemical composition of major cattle feeds in the study district

Types of feed	Chemical composition (% DM)						
	DM %	Ash	CP	NDF	ADF	ADL	IVDMD
Crop resides							
Teff straw	92.09	7.89	4.26	76.10	46.25	5.24	50.68
Maize stover	92.11	6.56	3.67	78.23	53.94	5.66	40.90
Indigenous grass sp.							
'*Lamuxxaa*'	69.63	7.95	10.30	41.92	23.43	2.53	76.19
Indigenous legume sp.							
'Dawuro daama'	43.38	3.71	14.23	16.57	10.53	5.63	85.18
'Gasaa'	18.73	2.75	12.35	9.43	5.34	1.02	95.29
Indigenous browse							
'Cayshiyaa'	57.08	5.00	13.39	25.37	15.55	4.69	77.22

Indigenous legume browse has higher CP content compared to indigenous grass and crop residues sampled in this study. This confirms previous reports that indicated higher CP contents of indigenous browses in Ethiopia (Getnet, 2003; Solomon *et al*., 2004; Mekonnen *et al*., 2009 and Solomon and Teferi, 2010) and other tropical countries (Njidda and Akhimioya, 2010 and Boufennara *et al*., 2012). The CP content of indigenous legumes and grass species in the current study is higher than the minimum threshold level of between 7% and 8 % CP required for optimum rumen function and feed intake in ruminant livestock (FAO, 1984).

The NDF and ADF contents of all available major feed resources were in the range of 9.43% to 78.23% and 5.34% to 53.94%, respectively. Maize stover, teff straw and *Lamuxxa* had higher values of ADF and NDF. Sisay (2006) reported higher (>70%) NDF contents for cereal crop residues. NDF above 55% can limit the DM intake (Van Soest, 1967). The NDF contents of crop residues in this study are beyond the limit of 55% and hence could hinder DM intake (Van Soest, 1967). Roughage feeds with NDF content of less than 45% are categorized as high quality, 45-65% as medium quality and those with more than 65% as low quality roughages (Singh and Oosting, 1992). Therefore, crop residues in this study might be categorized as low quality roughages that may inflict limitations on animal performance. The higher NDF content could be a limiting factor on feed intake, since voluntary feed intake and NDF content are negatively correlated (Ensminger *et al*., 1990). Opposite to crop residues, indigenous grass, legumes and browse could be classified as high quality feeds, which could not impose limitations on feed intake and animal production. ADF is widely used for measuring the fiber in feeds, often substituting for crude fiber, which is used in the proximate analysis of feeds. The acid soluble fraction included primarily hemicelluloses and cell wall proteins, while the residue recovers cellulose and the list digestible non-carbohydrate fractions. Acid detergent has the advantage of removing substances that interfere with the estimation of refractory components so that ADF residue is useful for the sequential estimation of lignin, cut in, cellulose, indigestible Nitrogen and Silica (Van Soest, 1982). The ADF content of crop residues varied from 46.25% in *teff* straw to 53.94% in maize stover (Table 5). High ADF content in crop residues might be associated with lower digestibility since digestibility of feed and its ADF are negatively correlated (McDonald *et al*., 2002). Generally, Kellems and Church (1998) categorized roughages with less than 40% ADF as high quality and above 40% as low quality. So, crop residues could be categorized as low quality roughages.

The ADL content of crop residue, *Dawuro daama* and *Cayshiyaa* were comparable and in the range of 4.66 - 5.66%. The lowest value of ADL was found in *Gasaa* (1.02%) followed by *Lamuxxa* (2.53%). The ADL content was high for both crop residues and indigenous grass (Table 5), which limits DM intake. Lignin is completely indigestible and forms lignin-cellulose/hemicelluloses complexes (Kellems and Church, 1998) due to physical encrustation of the plant fiber and making it unavailable to microbial enzymes (McDonald *et al*., 1995). However, the lignin contents of feeds in this study were lower than the maximum level of 7% that limits DM intake and livestock production (Reed *et al*., 1986).

The IVDMD contents of indigenous legume types and browse type were higher than the grass type and crop residues. The highest content of IVDMD was found in *Gasaa* (95.29%) followed by *Dawuro daama* and

Cayshiyaa. Lowest level of IVDMD was found in maize stover (40.90%). The mean *in vitro* digestible dry matter in the dry matter (IVDMD) for crop residues was about 45.79%, which is lower than the minimum level required for quality roughages (Seyoum and Fekede, 2008). Due to long lag times and slow fermentation, straws and stovers limit intake and utilization (Van Soest, 1982). The IVDMD values of major feeds concur with reports of Solomon and Teferi (2010).

Correlations between Nutritive Value and Major Feed Classes

The correlation between the different parameters of the nutritive value of the major feeds is given in Table 6. The results indicated that CP was positively correlated (r = 0.92, *P*<0.01) with IVDMD, while negatively correlated (r= 0.84, *P*<0.05) with DM, (r=0.96, *P*<0.01) with NDF and ADF. This indicates feeds with higher CP could supply an adequate protein base for microbial growth and improves digestibility. It means that in the availability CP, better digestibility could be obtained. This concurs with other findings by Solomon and Teferi (2010) for northern Ethiopia and (Njidda and Akhimioya, 2010) for indigenous feeds and browses in Nigeria. There is a strong positive correlation (r= 0.99, *P*<0.01) between NDF and ADF. The findings are in agreement with other reports (Aynalem *et al*., 2004; Seyoum *et al*., 2007; Mekonnen *et al*., 2009 and Boufennara *et al*., 2012).

Table 61: Correlation coefficients of chemical composition and in vitro dry matter digestibility of major feeds in the study area

	DM	Ash	CP	NDF	ADF	ADL	IVDMD
DM	1						
Ash	0.887**	1					
CP	-0.839*	-0.696	1				
NDF	0.953**	0.811*	-0.964**	1			
ADF	0.935**	0.747*	-0.963**	0.992**	1		
ADL	0.623	0.284	-0.352	0.515	0.549	1	
IVDMD	-0.944**	-0.717	0.924**	-0.976**	-0.991**	-0.639	1

* Level of significance at *P*< 0.05 levels, ** *P*< 0.01 level

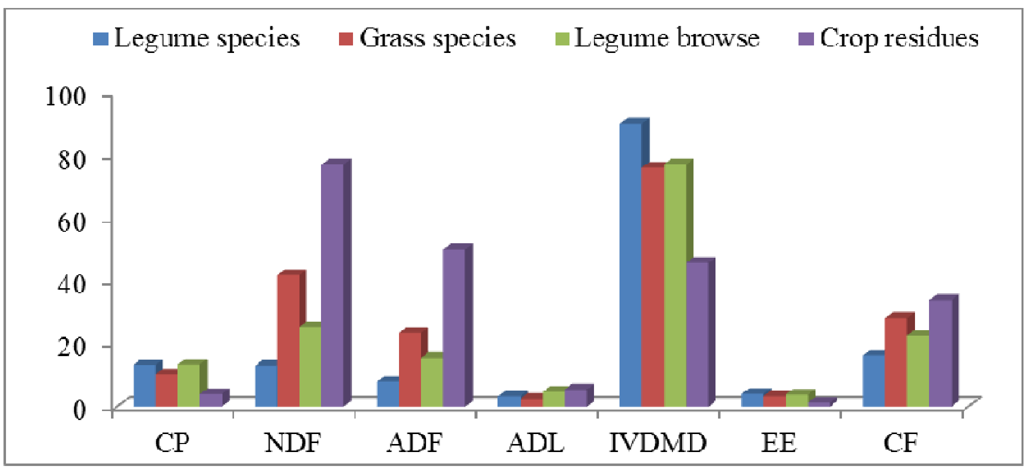

Figure 4: Proportion nutritive values of major feed classes in the study area

As illustrated in Figure 4, the chemical composition and dry matter digestibility of the major feed showed minute variations. Indigenous grass species and crop residues possessed higher amount of NDF and ADF and with lower IVDMD and CP. The CP and IVDMD values of indigenous legumes and browse were higher than the values obtained from indigenous grass and crop residues, which was in consonance with the report of Adugna (1990). On the other hand, indigenous grass contained higher CP and IVDMD compared to crop residues, which contradicts with the report of Deribe *et al*. (2013) in mixed farming system of Southern Ethiopia, reported as grasses from natural pasture contain lower CP and IVDMD. Similarly, indigenous grass had higher NDF and ADF compared to indigenous legumes and browse. Crop residues possessed higher NDF, ADF and ADL compared to indigenous grass, legumes and browse. The results were in agreement with other reports by Solomon *et al*. (2004)

CONCLUSIONS

Natural pasture and crop residues were the main sources of feed for cattle. In the study area, the higher proportion of feed was derived from natural pasture and crop-residues, and natural pasture and stubble grazing during dry and wet season, respectively. Although there was cattle feed shortage in the study area, the farmers did not conserve feed as hay and silage and also did not plant improved forages due to lack of awareness, lack of forage seed and combinations of other related factors.

CP content in feed samples from crop residues was below the critical level for optimum rumen function and feed intake. On the other hand, indigenous grasses, legumes and browses contain higher CP values with higher digestibility, indicating their suitability and potential for strategic supplementation, particularly during the dry season. Based on the results and conclusions of this study, the following recommendations are forwarded for improving cattle development in the study area. Provision of strong extension services and training on improved forage cultivation, sustainable conservation, proper storage and utilization of hay and crop residues and proper supplementations with forage legumes, interventions in the improvements of pastures and fodders, over-sowing pastures with forage legumes and using multi-purpose forages can also be potential alternatives in order to tackle the serious feed shortage in the area. Further studies aimed at animal's responses and anti-nutritional factors that might be associated with the use of indigenous feeds like *Dawuro daama*, *gasaa*, *cayshiyaa* and *lamuxxa* in future and efficient utilization of these indigenous and adaptable feed resources for optimal cattle production. Studies should be conducted on identification and contribution of important local tree browse species for cattle feeding during different seasons in the area

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Conflict of Interest

Authors have no conflict of interest

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