Assessment of Feed Resource Availability and Quality in Kedida Gamela District, Southern Ethiopia

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Abstract— *Availability of major livestock feed resources, their chemical composition and balance between available feed resources and requirements of existing tropical livestock units (TLU) in Kedida Gamela district (Southern Ethiopia) were assessed. A survey was conducted on 100 sample households (HH) and data collected using group discussions, structured questionnaire and personal observations. Furthermore, chemical composition and in vitro dry matter (DM) digestibility (IVDMD) of major feed resources identified (natural pasture and crop residues) were also determined. A total of 28,675 tonnes of DM were produced annually for a total of 40,080 TLU which satisfies only 31.4% of their maintenance requirement. Maize stover and wheat straw contain lowest ash and from agro-industrial by-products noug cake and wheat bran the highest ash content. The highest ($p<0.05$) crude protein (CP) content among roughages was recorded from natural pasture and the lowest from maize stover, but the rest of feed resources come in between, with no significant differences among them. The highest neutral detergent fiber and acid detergent fiber contents for roughage feeds recorded were from teff straw and maize stover, while no differences were noted ($P>0.05$) between the agro-industrial by-products. The highest acid detergent lignin content for roughage feed was recorded from maize stover to natural pasture and the highest from agro-industrial by-products was recorded from wheat bran to noug cake. Differences in IVDMD for major feed resources were not significant ($P>0.05$). The differences in nutrient composition and IVDMD of the feed resources in midland and highland followed similar trend, although there were slight differences in nutrient content and IVDMD of similar feedstuffs from the two altitudinal zones. In conclusion, the main feed resource is crop residues which are of low quality with high fiber content, low digestibility which may result in reduced livestock productivity and disease resistance. Chopping followed by soaking or ammonaition or urea treatment could be suggested to improve quality of the roughages.*

Keywords— Feed resources, Chemical composition and In vitro studies, Feed balance.

I. INTRODUCTION

Naturally endowed with different agro-ecological zones and suitable environmental conditions, Ethiopia is a home for many livestock species, suitable for livestock production and have the largest livestock population in Africa (CSA, 2013).An estimate indicates that Ethiopia is a home for about 55.03 million cattle, 27.35 million sheep, 28.16 million goats, 1.96 million horses, 6.95 million donkeys, 0.36 million mules, 1.1 million camels and 51.35million poultry (CSA, 2014).

The livestock subsector has an enormous contribution to Ethiopia's national economy and livelihoods of many Ethiopians. The subsector contributes about 16.5% of the national GDP and 35.6% of the agricultural GDP (Metaferia et al., 2011). It also contributes 15% of export earnings and 30% of agricultural employment (Behnke, 2010).

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 (Alemayehu and Sisay, 2003). Animal feeding systems in this country are mainly based on grazed native pastures, which are deteriorating in quantity and quality, which vary seasonally resulting in poor animal performance. Inadequate livestock nutrition is a common problem in the developing world, and a major factor affecting the development of viable livestock industries in low income countries (Sere et al., 2008).

This study was thus designed to assess the available feed resources, estimate the amount of feed that can be produced per-annum and relate with the annual requirement for the existing livestock population in Kedida Gamela district,

Kembata zone, Southern Nations, Nationalities and People Regional State of Ethiopia.

II. MATERIALS AND METHODS

Description of the study area

The study was conducted in Kedida Gamela district Southern Nations, Nationalities, and Peoples' Region (SNNPRS) which is located 296 km south of Addis Ababa and 125 km southwest of Hawassa, the regional capital. It is one of the districts in the SNNPRSof Ethiopia. The district consists of 17 rural and 1 urban Kebele. The altitude of this district ranges from 1700 to 3028 meters above sea level. Its area is divided into 7% highland (*Dega*) and 93% *Weyna Dega* (sub-tropical climate). The annual rainfall varies from 1000 to 1450 mm, while the annual mean temperatures also vary from 14^{o}C to 24^{0}C with a mean value of 19^{0}C.

There are two farming systems in the district that are classified based on the crop commodities they produce and species of livestock they rear. Accordingly maize, teff and wheat are abundantly produced and cattle are the predominant livestock species.

Sampling procedure

The study had two parts; a survey and laboratory analyses. The district was stratified into highland and midland; 2 kebeles from each of the midland and highland, and twenty five households from each kebele (100 HHs) were selected for the survey.

The survey was conducted by interviewing HHs using pretested questionnaire and group discussions to generate data on feed resource availability and use system in the wet and dry seasons.

Feed sample preparation procedures

In the beginning the feed samples from grazing sites were taken from quadrats placed and demarked across diagonal line transects in the grazed area, and dividing with systematically sampling procedures into 5 sub samples (top, bottom, middle, right and left positions) and 5 quadrats (0.5m x 0.5m) was harvested from each of the 5 sub samples. The grass in the quadrats was completely cut at ground level by sickle (manually). Finally, the harvested samples were mixed thoroughly and 1/3 of it taken; then, air dried. The air-dried samples were oven-dried at 60^{0}C for 48 h and ground to pass through 1 mm sieve and kept in air-tight containers awaiting chemical analysis.

Estimation of the quantity of available feed resources

The quantity of feed resource in the study area was estimated using the information collected from the respondents on crop production/yield and area coverage. Besides, secondary data on the area of the land used for cultivating annual and perennial crops and the amount of grain produced was collected from the district Agricultural Bureau and Kebeles annual report to augment primary data. The amount of crop residues and by-products that are used as source of animal feed was estimated using established conversion factors/multipliers developed by different researchers. The multiplier used for wheat, barley and teff straw was 1.5 per unit weight of grain yield, while the factors for maize and haricot bean were 2.0 and 1.2, respectively (FAO, 1987). The dry matter (DM) output of grazing pasture was estimated based on FAO (1987) multiplier factor, which is 2.0 tons/ha. Crop aftermath grazing potential was estimated by using a mean of 0.5 tons per hectare (Lamm and Ward, 1981; Kossila, 1984; Rasby et al., 2008).

Estimation of balance between feed supply and requirement

Total annual DM produced from natural pasture, crop residues, crop aftermath, tree legumes and concentrates were compared to the annual DM requirements of the livestock population in the sampled households. The number of livestock was converted into tropical livestock units (TLU) using the conversion factors of Varviko et al. (1993). The DM requirements of the livestock population were calculated according to Kearl (1982) where the daily DM requirement for maintenance of 1 TLU (250 kg livestock) which consumes 2.5% of its body weight is 6.25 kg DM/d.

Chemical Analyses

The dry matter (DM), organic matter (OM) and total nitrogen (N) contents of feed samples were determined following standard methods of AOAC (2002) and crude protein was calculated as N x 6.25. The NDF, ADF and ADL were determined by the method of Van Soest, et al. (1991), using ANKOM Fiber Analyzer220 (ANKOM Technology 05/03, Macedon, NY USA).

Statistical Analysis

The statistical analysis was carried out using a Statistical Package for Social Science (SPSS, version 16). Data analyses involved the use of appropriate descriptive statistics, frequencies, and one ways independent mean comparison parameters between the two study sites.

III. RESULTS AND DISCUSSION

Land holdings and land use systems in the study area

The average land holding per household and use pattern are shown in Table 1. The average land holding per household in the high and medium altitude zone was 0.66 and 0.71, respectively.

Table 1. Average land use patterns and holding size (ha, Mean ±SD) per house hold in highland and mid land.

	Location		
Land use type	Highland (N=50)	Midland (N=50)	Average
Homestead	0.027 ± 0.002	0.033 ± 0.003	0.03 ± 0.0025
Cultivated land	0.33 ± 0.015	0.37 ± 0.1	0.35 ± 0.05
Private grazing land	0.12 ± 0.12[b]	0.14 ± 0.1[a]	0.13 ± 0.11
Wood land	0.16 ± 0.18	0.19 ± 0.14	0.2 ± 0.16
Total land holding	0.66 ± 0.02[b]	0.71 ± 0.024[a]	0.69 ± 0.02

Different superscript denote significant difference at P < 0.05 between mean within a row

The average land holding in the study area(0.69±0.02 ha) is lower than those reported for neighboring districts of Damot Gale (Fikre, 2009) and Dale districts (1.77ha) of Sidama zone (Endashaw,2007) possibly due to differences in population density of the areas.

Livestock Holding

Cattle and sheep were the dominant species of livestock kept in the study area followed by goats and the least were equines (Table 2).

Livestock per HH in the current study area is lower compared to other areas of the country (Abdinasir 2000; Solomon 2004) mainly due to limited feed resources and grazing land because the available land is mainly utilized for crop production.

Table 2. Cattle herd composition (TLU) per household in Kedida Gamela district (Mean ±SE)

	Location		Overall mean	Total
Classes of livestock	Highland (N=50)	Midland (N=50)	(TLU)	(TLU)
Cattle	3.21 ± 0.16	2.89 ± 0.14	3.05 ± 0.15	35,618
Sheep	0.05 ± 0.012	0.04 ± 0.011	0.045 ± 0.012	1,345
Goats	0.029 ±0.011	0.036 ± 0.1	0.032 ± 0.010	1,093
Equine	0.034 ± 0.1	0.027 ± 0.14	0.031 ± 0.012	2,025

Source: CSA, 2003; TLU conversion factors: - Cattle (0.7), sheep and goat (0.1), donkey (0.5), mule (0.7), horse (0.8) (Janke, 1982); SE=Standard Error, N=No of respondent, TLU=Tropical livestock unit

Most of the farmers in the study areas kept more than one species of domestic animals. Owning more livestock species, especially sheep and goats is the means of risk aversion in case of natural disaster or any incidence of disease outbreak. Some farmers prefer to keep sheep and goats because it is easier to manage and accommodate them on a smaller area than large ruminants.

Equines (donkeys and horses) were the most valuable pack animals for transportation of people and other goods in many parts of the study area especially where other means of transportation are limited. Equines were also used for threshing and transporting agricultural inputs and products, drinking water for animals and human beings, wood, crop residues and charcoal which is consistent with the report of Lemma (2002).

Land used for crop production

The results of the present study (Table 3) have shown that the dominant crops in the area were maize, teff, wheat, barley and haricot bean. Land allocated for maize was higher (P< 0.05) in midland, but that allocated for teff it was higher in highland. However, there is no difference in land allocation for the remaining crops between the two agro-ecologies.

Land allocations for maize, teff and haricot bean were comparable with the report of Netsanet (2006) in both Sodo Zuria and Badewacho district.

Table 3. Allocation of land (ha, mean ±SE) for production of different types of crops

Crop produced	Location		Overall mean N=100
	Midland(N=50)	Highland(N=50)	
Wheat	0.05 ± 0.004	0.162 ± 0.01	0.105 ± 0.05
Barley	0.03 ± 0.003	0.062 ± 0.16	0.045 ± 0.1
Maize	0.22 ± 0.02[a]	0.06 ±0 .002[b]	0.14 ± 0.01
Tef	0.19 ± 0.01[b]	0.25 ± 0.02[a]	0.22 ± 0.02
Haricot bean	0.08 ±0.002	0.07 ± 0.02	0.07 ± 0.011

ha= *hectare, SE= standard error, t=tones, N=No of respondent; Different superscript letters denote significant difference at P < 0.05 between mean within rows*

Available feed resources

According to the respondents, feed shortage occurs in April and May (Table 4). During this period natural pasture becomes extremely poor and farmers provide livestock with any available dry crop residues and tree leaves.

Table 4. Availability of major feed resources over months of the year in the study area

Type of feed	Months of the year											
	J	F	M	A	M	J	J	A	S	O	N	D
Pasture	-	-	-	-	-	√√	√√	√√	√√	√	√	-
Maize thinning (green)	-	-	-	_	-	-	√√	√√	√√	-	-	-
Maize stover	√	√	-	-	-	-	-	-	-	√√	√√	√
Tef + other crop residues	√	√	√	-	-	-	-	-	-	√√	√√	√
Weeds from cultivated fields	-	-	-	-	-	√√	√√	√√	√√	-	-	-
Aftermath	-	-	-	-	-	-	-	-	-	√√	√√	-

√= *fair availability of feed,* √√= *good availability of feed and–poor availability of feed.*

The estimated yields of grain and dry matter from crop residues

The estimated amount of crop residues produced and the contribution of other feeds (grazing lands, forest areas, stubbles and fallow lands) are presented in Tables 5 and 6.

Table 5. Area of major crops grown, their estimated yields of grain and crop residue

Parameter	Major crops					Total
	Maize	Teff	Wheat	Barely	Haricot bean	
Cultivated area (ha)	2029	3145	1572	714	1000	8462
Cultivated area (%)	23	37	18	8	11	
Grain yield (t/ha)	2.5	1.3	2.7	2.5	1.5	
Grain yield (t/year)	5074	4088	4245	1786	1501	
Residues yield (t DM/ha)	5	1.95	4.05	3	2.25	
Conversion factor	2.0	0.7	0.7	0.8	0.7	
Residues yield (t DM/year)	10148	6132	6368	2144	2251	27046

Chemical composition and nutritive value of feeds

Chemical composition and nutritive value of major feed stuffs are shown in Table 7 and 8.The CP content of the crop residues was lower than that set as a minimum level of nitrogen (7%) that limits intake (Milford and Minson, 1966; Van Soest, 1982). The CP reported for teff straw in the current study was similar to the values of 5.2% and 5.5% reported by Lulseged and Jemal (1989) and Tesfaye (1999). The results of this study in general agree with the general statement made by Preston and Leng (1984) that all cereal straws have low nitrogen content and are composed of cell wall components with little soluble cell contents.

Table 6. Area coverage and estimated productivity of grazing lands in the study area

Feed Sources	Area (ha)	Conversion factor	Yield(t DM /year)
Private natural pasture	126.36	2.0*	253
Communal natural pasture	651.24	2.0*	1303
Stubble grazing	145.8	0.5*	73
Total			1629

* Conversion factor FAO (1987)

The CP content of grass obtained from natural pasture from different altitudinal zones is slightly lower than that reported (9.6%) by Solomon (2004) for highlands of Bale. Feeds harvested from natural pasture can support maintenance CP requirement (7.2%) of ruminants (ARC, 1980).

The CP content of the wheat bran (WB) in this study falls in the range (18.80 to 19.47%) reported by Lonsdale (1989). Alemu (1998), Asnakew (2005), Simret (2005), and Fentie (2007) reported CP content of WB (19.99, 19.55, 20.10, and 23.08%, respectively) less than the value observed in the current study. In addition, it was a little bit more than earlier reports (16.31 and 16.50%) by Tesfay et al. (2001) and Solomon et al. (2004), respectively. The differences between the results might be due to the variation in the raw material, methods of milling and the extended storage of WB after milling.

The NDF content of all crop residues was above 65%. Roughage feeds with NDF content of less than 45% are categorized as high quality, 45 to 65% as medium quality and those with more than 65% as low quality roughages (Singh and Oosting, 1992). All crop residues in this study might be categorized as low quality roughages that may inflict limitations on animal performance. The NDF content of grass obtained from natural pasture from the different altitude zones was less than 65% and can be categorized as medium quality feeds (Singh and Oosting (1992). There was significant difference between the crop residues in their ADF content and in general all of them had a high ADF content which could possibly be associated with varietal differences, location and agronomic practices used when growing the crop. The results of this study were comparable to those reported by Yitaye (1999) and Solomon (2004). . The ADF of grass obtained from the different altitude zones is comparable to the reports of Zinash and Seyoum (1989) and Yihalem (2004). As the stage of harvesting increased the ADF content also increased which is in agreement with the findings of Kidane (1993) and Yihalem (2004).

Table 7. Chemical composition and IVDMD of the major feed resources in the two altitudinal zones of the district

Altitude	Feed category	Feed type	Ash	CP	NDF	ADF	ADL	IVDMD
Highland	Roughages	Wheat straw	10.01[a]	3.95	71.08[b]	35.64[b]	9.85[b]	51.2
		Teff straw	7.96[b]	5.16	78.21[a]	39.48[a]	7.78[b]	53.8
		Maize stover	6.5[d]	2.40	79.50[a]	41.40[a]	11.50[a]	50.1
		Natural pasture	7.67[c]	7.66	62.49[c]	31.95[c]	3.77[c]	57.2
	Agro-industrial Byproduct	Noug cake	9.61[a]	19.5	51.8	12.69	2.70[b]	57.1
		Wheat bran	2.85[b]	19.47	54.01	16.42	5.85[a]	51.0
Midland	Roughages	Wheat straw	11.81[a]	4.73	73.2[b]	36.01[b]	8.07[b]	52.2
		Teff straw	9.33[b]	5.34	77.88[a]	39.72[a]	7.49[b]	55.89
		Maize stover	6.2[d]	3.94	79.96[a]	40.55[a]	10.43[a]	51.1
		Natural pasture	9.02[c]	7.93	66.93[c]	35.09[c]	4.84[c]	56.5
	Agro-industrial byproduct	Noug cake	10.29[a]	26.87[a]	50.48	12.97	3.23[b]	56.75
		Wheat bran	3.9[b]	18.16[b]	53.78	15.38	5.16[a]	54.0

DM= dry matter; NDF=neutral detergent fiber; CP= crude protein; ADF=acid detergent fiber; IVDMD = in vitro dry mater digestibility. Means within rows with different superscript letters denote significant difference at P < 0.05

Based on the lignin content, the different crop residues could be categorized as low quality roughages. In this study, the lignin content was high for all crop residues which is beyond the maximum level of lignin (7%, Reed et al, 1988) which limits DM intake. The ADL of grass obtained from the different altitude zones was lower than 7%. The NDF value of WB in the present study was comparable to earlier reported values (55.50, 44, 44.13, 44.97, 43.83, 44.94, and 39.16%) by Hirut (2008), Simret (2005), Mulat (2006), Fentie (2007), Abebe (2008) and Jemberu (2008), respectively. The mean NDF content of noug cake was 54.64%. Wheat bran contained higher ADL (5.5%) than noug cake (3.0%).

The ADF content of WB in this study was comparable to earlier reports (12.70, 12.47, 12.36% 12.39, and 12.45%) by Solomon et al. (2004), Simret (2005), Asnakew (2005), Fentie (2007), and Jemberu (2008), respectively, but lower than those obtained (15.50 and 14.6%) by Kaitho et al. (1998) and Hirut (2008) correspondingly and higher than those reported by Giri (2000) and Tesfay (2007) (9.49% and 9.46%, respectively).

The ADF content of noug cake observed in the present study is different from that reported earlier (28%) by Bediye et al. (1999). The differences between the results might be due to the variation in the raw material, methods of milling and the prolonged storage of noug cake after milling.

Table 8. Chemical Composition of individual feeds produced in the two altitudinal zones of the district

Feed category	Feed type	Altitude	Ash	CP	NDF	ADF	ADL	IVDMD
Roughage	Wheat straw	Highland	10.01	3.95	71.08	35.64	9.85	51.2
		Midland	11.81	4.73	73.2	36.01	8.07	52.2
	Teff straw	Highland	7.96	5.16	78.21	39.48	7.78	53.8
		Midland	9.33	5.34	77.88	39.72	7.49	55.89
	Maize stover	Highland	6.5	2.4	79.5	41.4	11.5	50.1
		Midland	6.2	3.94	79.96	40.55	10.43	51.1
	Natural grass	Highland	7.67	7.66	62.49	31.95	3.77	57.2
		Midland	9.02	7.93	66.93	35.09	4.84	56.5
Agro-industrial byproduct	Noug cake	Highland	9.61	29.5	51.8	12.69	2.7	57.1
		Midland	10.29	26.87	50.48	12.97	3.23	56.75
	Wheat bran	Highland	2.85	19.47	54.01	16.42	5.85	51.0
		Midland	3.9	18.16	53.78	15.38	5.16	54.0

DM= dry matter; NDF=neutral detergent fiber; CP= crude protein; ADF=acid detergent fiber; IVDMD = in vitro dry mater digestibility; Means with the same superscript letter for each feed type between altitudes in a column (for each feed type) are not significantly different (P>0.05).

Lower IVDMD values were observed in maize stover and this is likely to be associated with its higher lignin content compared to the other crop residues and the highest was from noug cake followed by wheat bran and this is in line with the explanation of Karue (1975) who stated that the higher the lignin contents the lower the IVDMD and the vice versa.

Difference in nutrient composition and IVDMD of the feed resources collected from the two altitudinal zones were not significant, although there were numerical differences.

IV. CONCLUSION AND RECOMMENDATION

From this study it can be concluded that the major feed resources available in Kedida Gamela district were natural pasture and crop residues with high fiber content and low digestibility which could decrease livestock productivity and disease resistance.

Moreover the annual feed DM production in the district could only satisfy 31.4 % of the DM requirement of livestock kept in the area; with very low crude protein and very high lignin contents, indicating the critical shortage of quality feed supply. Physical treatment such as soaking and chopping combined with treatments with ammonia or urea is suggested to improve the quality of the roughages.

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