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Full Length Research Paper

Assessment of productive and reproductive performance of dairy cattle nexus with feed availability in selected peri-urban areas of Ethiopia

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The study was conducted to assess the performance of dairy cattle in relation with feed availability and quality in selected peri-urban of Debre Birhan, Jimma and Sebeta areas of Ethiopia. Structured questionnaire, secondary data sources, field observations and laboratory analysis were employed to generate data. A total of 60 farmers (Debre Birhan=20, Jimma=20 and Sebeta=20) were randomly selected for the study. The overall estimated mean lactation length of cows was 296.5±8.7 days and was not different (*P>0.05*) among sites. The overall estimated mean age of heifers at first service was 27.5±1.0 months and age at first calving was 36.8±1.0 months and differed (*P<0.001*) considerably among the study sites. The result of the study indicated that grass hay was the main basal diet in all study areas. Laboratory analysis of major feed resources indicated that hay had Crude Protein (CP) content of 6.1% and crop residues varied from 3.1 to 6.7%. In addition, crop residues had lower digestibility (48%), its energy value ranged from 6.5 to 7.9 MJ/kg dry matter (DM). Wheat bran, and molasses had Metabolizable Energy (ME) content of 13.2 and 12.5 MJ/kg DM, respectively. Brewery wet grains had lower CP (27%) than cottonseed cake (42%) and enough seedcake (35%). Annual feed balance estimation revealed that the total estimated available feed supply met 83% of the maintenance DM requirement of livestock per farm per year while, the total estimated CP and ME were in accordance with the livestock requirement merely for maintenance. Therefore, from the current study it was concluded that the quality of available basal roughage feeds is generally low and strategic supplementation of protein and energy rich feeds should be required. Furthermore, optional feeds like brewery wet grains and other non-conventional feed resources should be further considered.

Key words: Age at first service, calving interval, crude protein, daily milk yield, days open, feed supply, feed quality, lactation length, metabolizable energy.

INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa (CSA, 2010). The livestock population census showed that Ethiopia has about 50.8 million heads of cattle, 25.9 million sheep, 21.9 million goats, 1.9 million horses, 5 million donkeys, 0.3 million mules, 0.8 million camels and 42 million poultry (CSA, 2010). This does not include livestock population of three zones of Afar and six zones of Somali regions. However, despite the large number of livestock resources in the country, its productivity is extremely low. In Ethiopia, annual milk production per cow is generally low due to reduced lactation length, extended calving interval, late age at first calving and poor genetic makeup (Alberro, 1983; Mukasa-Megerwa, 1989; Demke et al., 2000). Another major problem to such low livestock production and reproduction is shortage of livestock feeds both in quantity and in quality, especially during the dry season (Ahmed et al., 2010). Furthermore, quality of native pasture is very low especially in dry season due to their

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low content of digestible energy and protein and high amount of fiber content (Zinash et al., 1995).

This is much worse for crop residues owing to their lower content of essential nutrients (protein, energy, minerals and vitamins) and lower digestibilities and intake. Despite, these problems, however, ruminants will continue to depend primarily on forages from natural pastures and crop residues (Zinash and Seyoum, 1989). Peri-urban dairy production systems have emerged around cities and towns, which heavily rely on purchased fodder (Vernooij, 2007). Commercialization of dairy production takes place around cities and towns where the demand for milk and milk products is high (medium and large towns) (Azage, 2004). However, the production system has been constrained by shortage of feed supply in dry season (quantity and quality) (Yoseph et al., 2003a). Few research works have been carried out with regard to feed availability in relation with dairy animals in urban and peri-urban dairy farms (Yitaye et al., 2009). Current and up-to-date baseline information is lacking in peri-urban areas on productive and reproductive performance of crossbred dairy cows in association with feed availability and quality under the prevailing situations. This study was therefore, aimed to look into the performance of cattle with respect to feed resources availability in selected areas of Ethiopia.

MATERIALS AND METHODS

In Jimma and Sebeta, there was no grazing land available and dairy cattle did not have access to grazing while in Debre Birhan dairy cattle are managed under indoor feeding system and have free access to graze for some hours a day. Milk supplied to Peri-urban and urban areas are only obtained from crossbred cows and hence crossbred cows with any exotic blood level inheritance were used for the study. Variables under productive and reproductive performance of cattle were estimated based on the farmer's estimation.

Description of the study areas

Debre Birhan is found in North Shoa administrative zone of the Amhara National Regional State and is located at 130 km north of the capital Addis Ababa, at 39°30' E longitude and 09°36' N latitude. It is a typical highland area with an elevation of 3360 masl. It receives an annual average rainfall of 731 to 1068 mm and has an annual temperature range of 6 to 20°C.

Sebeta is located 25 km Southwest of Addis Ababa and situated at a latitude and longitude of 8°55′N and 38°37′E, respectively. It has an elevation of 2356 m above sea level and has annual rainfall of about 1650 mm. The mean annual minimum and maximum temperature is 8ºC and 19°C, respectively.

Jimma is located at 350 km away from the capital Addis Ababa. It is the largest city in the South Western Ethiopia. It lies between 36º10´ E longitude and 7º40´ N latitude. Its altitude is 2060 masl. Its climate is humid tropical with bimodal heavy annual rainfall, ranging from 1200 to 2800 mm. The mean annual minimum and maximum temperature of the area is 11.3 and 26.2°C, respectively.

Sampling procedures

A reconnaissance survey was conducted in order to select specific dairy farmers and to get general picture of the study sites. Based on the record available from the respective district of the agricultural offices, there were about 200, 200 and 205 dairy farmers keeping crossbred cows in Debre Birhan, Jimma and Sebeta peri-urban areas, respectively. Based on the sample size to proportion technique 10% of the farms from each site were considered. Accordingly, a total of 60 dairy farms (20 from each site) were randomly selected from the peri-urban area of each study site. A structured questionnaire was prepared and pre-tested for its applicability before its administration. Interviews were carried out at the farmer's home to enable counterchecking of the farmer's response with respect to the availability of feed resources, livestock population, productive and reproductive performance of cows and the overall management system of the farm.

Feed quantity assessment

The quantity of feed dry matter obtainable from natural pastures were determined by multiplying the hectare with their respective estimated annual DM yield per hectare that is, 2.0 t/ha (FAO, 1987). The amount of purchased dry forages such as hay and straw was determined by estimating a single donkey load or lorry load and for baled hay by asking how many bales of hay would be purchased for a year. Whenever record was available, the quantity of purchased feeds was considered from the record. The quantity of available crop residues produced by farmers was estimated by applying grain to straw ratio as suggested by FAO (1987) and assuming 10% utilization wastage. The quantity of concentrates and non-conventional feed resources were estimated by interviewing the farm owners with regard to the frequency and quantity purchased per month. The grazing potential of crop stubbles was estimated using a mean of 0.5 ton per ha as reported by FAO (1987).

Chemical analysis of feed samples

Chemical analysis of feedstuffs was performed at Holetta Agricultural Research Center nutrition laboratory. DM and ash contents of feed samples were determined by oven drying at 105°C overnight and by igniting in a muffle furnace at 600°C for 6 h, respectively. Nitrogen (N) content was determined by Kjeldahl method and CP was calculated as N*6.25 (AOAC, 1995). Calcium (Ca) and phosphorous (P) contents were determined by atomic absorption spectrophotometry (Perkin, 1982). Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL), Neutral Detergent Fiber (NDF), were analyzed by the method of Van Soest et al. (1991). *In vitro* Organic Matter Digestibility (IVOMD) was determined by the modified Tilley and Terry method (Van Soest and Robertson, 1985). ME and Digestible Crude Protein (DCP) content of a particular feed were estimated from IVOMD and CP contents, respectively, as per the following equations.

ME (MJ/kg DM) =0.015*IVOMD (g/kg) (MAFF, 1984).

DCP (g) = 0.929*CP (g) -3.48 (Church and Pond, 1982).

Assessment of livestock feed requirement

Livestock populations were converted into Tropical Livestock Unit (TLU) as suggested by Gryseels (1988) for indigenous zebu cattle and Bekele (1991) for crossbreds. The DM requirements for maintenance were calculated based on daily DM requirements of 250 kg dual-purpose tropical cattle (an equivalent of one TLU). Nutrients supplied by each feed types were estimated from the total DM output and nutrients content of that feed on DM basis. The total nutrient requirements (DM, CP and ME) per day per livestock species were estimated based on the recommendations of Kearl (1982) and McCarthy (1986) for tropical livestock.

Statistical analysis

Data collected were analyzed using Statistical Analysis System software (SAS, 2002). Descriptive statistics were employed to describe qualitative variables. General Linear Model (GLM) procedure of SAS was employed to analyze the effect of classification variables. A completely randomized design was employed as per the following model.

$$y_{ij} = \mu + S_i + e_{ij},$$

Where, y_{ij}, Productive and reproductive performance of dairy cows, μ = overall mean, S_i = the effect of i^{th} study sites, e_{ij} = random error

RESULTS AND DISCUSSION

Household characteristics

In the study areas (Debre Birhan, Sebta and Jimma), about 86.7% of the respondents were male dairy farmers while 13.3% were females (Table 1). Less number of female-headed households involved in livestock keeping in the current study could probably be due to cultural issues that force females to get married and/or for economic reason. The results of the current work differ from the report of Azage (2004) who reported 33% female-headed households and 67% male headed household livestock keepers in Addis Ababa Table 1.

Livestock herd structure

The average livestock holding per household in all study areas was (15.6±0.2 TLU) (Table 2). The number of sheep per household was higher (*P<0.05*) at Debre Birhan than the rest of study sites. This is because of suitable weather conditions and better grazing lands. The average number of horses per household was much larger in Debre Birhan (*P<0.05*) than in Jimma and Sebeta, which might be related to better adaptation to the environment and suitability of these animals for people to overcome transport problems associated with rugged terrains. At Jimma and Sebeta, horses were rarely kept, but purchased from other areas for pulling carts. The average number of donkeys per household in Debre Birhan was higher (*P<0.05*) than in Sebeta. Donkeys are mainly used as pack animals in these areas Table 2.

Productive and reproductive performance of cows

Least squares means for daily milk yield, lactation length, age at first service, calving interval and days open are shown in Table 3. The estimated mean daily milk yield based on the farmers response varied significantly (*P<0.001*) among the study sites. In Sebeta area, the estimated daily milk yield (9.7±0.5 kg) was higher (*P<0.001*) than the rest of the study areas. The highest estimated daily milk yield observed for Sebeta area could possibly be the result of better access to brewery by-products, agro-industrial by-products and hay. The whole range of estimated daily milk yields (6.1 to 9.7 kg) reported in this study corresponds well with values reported earlier (Demeke et al., 2000). The current report also agreed with that reported by Mesfin et al. (2009) for crossbred dairy cows. Yoseph et al. (2003b) reported an average daily milk yield of (8.9 kg/day) for crossbred dairy cows in urban and peri-urban area of Addis Ababa, which is closer to the current finding. However, Moges and Baars (1998) reported higher average milk yields (9 to 12 kg/day). The difference could be attributed to differences in management conditions and the level of exotic gene inheritance in the crossbred animals. The overall estimated mean lactation length of cows in all study sites was 296 days and varied from 273 to 327 days and was not different (*P>0.05*) among sites.

The estimated lactation length was comparable to the ideal lactation length of 305 days as defined by Foley et al. (1972). However, farmers have the attitude that extended length of lactation favors growth of calves despite low milk yields. The overall estimated mean age of heifers at first service was 27.5 months and age at first calving was 36.8 months that differed (*P<0.001*) considerably among the study sites. Estimated mean ages of heifers at first service and calving were shortest at Sebeta (24.3 and 33.6 months) compared to other sites. The results are in accordance with the mean value of 25.6 months reported for age at first service and 36.2 months reported for age at first calving for dairy heifers under urban production systems (Emebet, 2006). Heifers maturing at younger ages are better milk producers and have lower rearing costs (Ruiz-Sanchez et al., 2007). Neither the age at first service nor the age at first calving in the present work meet the optimum age at first service (14.6 months) and calving (24 months) for milk yield under intensive management for exotic breeds as

Table 1. Demographic characteristic of the respondents in selected peri-urban dairy production system of Ethiopia.

Household variable	Study sites			
	Debre Birhan	Jimma	Sebeta	Total
Sex of household head	n=20	n=20	n=20	n=60
Male (%)	100.0	80.0	80.0	86.7
Female (%)	0.0	20.0	20.0	13.3
Overall (%)	100	100	100	100

n = number of respondents.

Table 2. Herd size and herd structure (Mean ± SE) per household in selected peri-urban dairy production system of Ethiopia.

Livestock species	Study sites				Study sites			
					TLU			
	DB	Jimma	Sebeta	Overall mean	DB	Jimma	Sebeta	Overall mean
Cattle	11.8±0.7	11.9±1.5	8.8±1.5	10.8±0.7	14.6±0.9	13.3±1.7	11.6±1.9	13.2±0.9
Cows	3.7±0.3	5.0±0.7	5.0±0.7	4.6±0.4	6.6±0.6	9.0±1.3	9.0±1.3	8.2±0.6
Oxen	2.8±0.3[a]	0.2±0.1[b]	0.6±0.3[b]	1.2±0.2	4.2±0.5	0.2±0.1	0.7±0.3	1.7±0.3
Heifers	1.5±0.3	3.1±0.6	1.7±0.4	2.1±0.3	1.0±0.2	2.1±0.4	1.2±0.3	1.4±0.2
Bulls	1.0±0.2[a]	0.7±0.2[a]	0.1±0.1[b]	0.6±0.1	1.6±0.4	0.8±0.2	0.2±0.1	0.9±0.2
Calves	3.0±0.3	3.0±0.5	1.4±0.3	2.4±0.2	1.2±0.1	1.2±0.2	0.6±0.1	1.0±0.1
Sheep	24.2±2.9[a]	0.7±0.6[c]	2.7±0.8[b]	9.2±1.7	2.4±0.3	0.1±0.0	0.3±0.1	0.9±0.2
Goats	0.7±0.5	-	0.4±0.3	0.3±0.2	0.1±0.0	-	0.1±0.0	0.1±0.0
Horses	1.9±0.3[a]	1.1±0.2[b]	0.1±0.0[c]	1.0±0.2	1.5±0.2	0.8±0.2	0.1±0.0	0.8±0.1
Donkeys	3.1±0.3[a]	-	1.0±0.26[b]	1.4±0.2	1.5±0.1	-	0.5±0.1	1.0±0.1
Total herd size					20.1±0.3	14.3±0.4	12.5±0.3	15.6±0.2

[a-b-c] means with different letters of superscripts in the same row differ significantly (*P<0.05*), TLU = tropical livestock unit. DB = Debre Birhan.

Table 3. Least square means (LSM ± SE) milk production and reproductive performance of crossbred dairy cows in selected peri-urban dairy production system of Ethiopia.

Variable	Study sites		
	DB	Jimma	Sebeta
MY (kg/day)	6.1±0.4[b]	7.1±0.5[b]	9.7±0.5[a]
LL (days)	309±18.2	280.8±14.7	297.0±10.6
AFS (months)	32.5±1.7[a]	25.7±1.4[b]	24.3±1.7[b]
AFC (months)	41.8±1.7[a]	35.0±1.5[b]	33.6±1.7[b]
CI (days)	477.0±32.5	463.5±39.6	474.0±31.5
DO (days)	197.0±32.5	183.5±39.6	194.0±31.5

[a-b] means with different superscript in the same row for the same trait do significantly differ (P<0.05, MY = Milk Yield, LL = Lactation Length, AFS = Age at First Service, AFC = age at first calving, CI = calving interval, DB = Debre Birhan, DO = days open.

reported by Nilforooshan and Edriss (2004). The overall estimated mean calving interval and days open in the study sites were about 472 and 192 days, respectively. There was no marked difference (*P>0.05*) in length of calving interval and days open among the study sites. The length of days open was a bit more than 6 months in all study sites, which might affect the profitability and lifetime productivity of dairy cows Table 3.

Chemical composition and nutritive value of feeds

Chemical composition and nutritive value of the major feedstuffs in the study areas are shown in Table 4. All crop residues evaluated had lower CP contents than the minimum level of 7% CP required for optimum rumen microbial function (Van Soest, 1982). The mean IVOMD for cereal crop residues was about 48%, which is lower

than the minimum level required for quality roughages (Seyoum and Fekede, 2008). The neutral detergent fiber (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 and stubbles in this study might be categorized as low quality roughages that may inflict limitations on animal performance. The ADF content of crop residues varied from 51.0% in field pea straw to 56.3% in wheat straw. The ADF content for both crop residues and stubbles was within the range reported by Ahmed (2006) and Solomon et al. (2008). However, Teklay (2008) reported a lower ADF values for barley and wheat straw, which could be attributed to differences in climate, crop management and soil fertility. Generally, Kellems and Church (1998) categorized roughages with less than 40% ADF as high quality and above 40% as low quality.

All crop residues and stubbles could be categorized as low quality roughages. In this study, the lignin content was high for both crop residues and grass hay as compared to the maximum level of 7%, 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 reduces its availability to microbial enzymes (McDonald et al., 1995). The energy content of crop residues ranged from 6.5 MJ/kg DM (wheat) to 7.9 MJ/kg DM (barley) straw. The energy contents for crop residues in this study were within the range reported by Seyoum and Fekede (2008), but lower than the value of 10.3 MJ/kg DM reported by Teklay (2008). Differences might be due to differences in management practices, soil fertility and/or crop variety used (McDowell, 1988). Hay obtained from native grass had CP content of 6.1%. The value observed in the present study is lower than the minimum value required for optimum rumen microbial function reported by Van Soest (1982). It had also high NDF content. NDF content of hay reported in this study was within the range of the values reported by Dereje et al. (2010). 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). ME of commonly used energy supplements such as wheat bran, molasses and *Atela* varied from 12.5 to 13.2 MJ/kg DM.

Molasses had the lowest CP content as compared to wheat bran and *Atela*. The cell wall content of molasses was almost negligible, whereas wheat bran had relatively higher fiber contents. The nutritional values for the current feeds are compatible with that reported by Seyoum and Fekede (2008). Seyoum et al. (2007) proposed a standard for energy supplements as those feeds, which contain high CP (13.9%), IVOMD (82.2%) and ME (13.1 MJ/kg DM). With the exception of CP content of molasses, energy supplements (wheat bran, *Atela*) evaluated in the present work closely matched to this standard. Among the protein supplements, brewery wet grains had slightly lower CP (26.8%) than cotton seed cake (42.0%) and noug seedcake (34.5%). This might be due to differences in the chemical composition and type of grains used as a raw material to produce these by-products (Negesse et al., 2009). The ME contents of protein supplements were not much different. The energy content, protein content and IVOMD in protein supplements were high though slightly lower than the reported thresholds (Seyoum et al., 2007) for good quality protein supplements of (CP = 32.6%), (IVOMD = 65.5%) and (ME = 10.2 MJ/kg DM). Ca and P concentrations of the major feedstuffs in the study areas except for barley straw were low as compared to the normal range of 2.0 to 3.5 g/kg DM reported for livestock feeds by McDonald et al. (1995) Kellems and Church (1998) Table 4.

Estimated annual feed availability

The total estimated feed DM, DCP and ME production per farm in the study areas is shown in Table 5. The major feed resources include hay, agro-industrial by-products and crop residues. Feed dry matter was commonly obtained from hay in all study sites. However, farmers at Debre Birhan heavily rely on crop residues compared to Jimma and Sebeta. Agro-industrial by-products and non-conventional feeds were important feed resources next to hay in both Jimma and Sebeta. Use of improved fodder trees as animal feed in the study sites was rare and the DM calculation did not account for these feed resources Table 5.

Estimated annual feed balance

The total annual nutrient intake, nutrient requirement and feed balances in the study areas are shown in Table 6. In all the study areas, the estimated available feed supply met about 83% of the maintenance DM requirement of livestock per farm per year while the total estimated DCP and ME for maintenance were 40 and 10% surplus per year per farm, respectively. At Debre Birhan the existing feed supply on a year round basis satisfies only 64% of the maintenance DM requirement of the animals per farm. Similarly, the total available DCP and ME in the same area satisfy only 66% and 81% of the total livestock requirement per farm on a yearly basis. In Jimma, total annual DM requirement was 11.5% less than the annual DM requirement for maintenance. On the other hand, the total DCP and ME were 51 and 25% per farm, respectively, above the total annual maintenance requirement. In Sebeta, the total annual DM requirement for maintenance was 3% less than the requirement for maintenance while total DCP and ME were 102 and 26%

Table 4. Chemical composition and nutritive value of major feedstuffs in the study areas.

Feedstuff	DM (%)	Chemical composition (% DM)					Nutritive values				
		Ash	NDF	ADF	Lignin	CP	DCP (g/kg DM)	IVOMD%	ME (MJ/kg DM)	Ca (g/kg)	P (g/kg)
Crop residue											
Wheat straw	93.4	9.5	80.3	56.3	13.1	3.1	25.7	43.2	6.5	0.2	0.9
Barley straw	91.6	8.5	76.8	52.8	12.1	3.6	29.5	52.6	7.9	3.3	0.8
Oats straw	92.4	7.1	75.3	54.5	15.0	3.1	24.9	48.8	7.3	0.4	1.0
Faba bean straw	92.6	6.6	73.4	51.0	9.9	6.1	53.5	47.1	7.1	1.5	0.8
Field pea straw	91.8	6.5	72.7	52.3	11.1	6.7	59.1	48.4	7.3	1.4	1.0
Grass											
Hay	92.4	13.7	76.0	49.2	10.6	6.1	53.5	48.7	7.3	0.4	1.3
Non-conventional feeds											
Coffee pulp	90.3	9.0	55.5	48.6	6.7	11.1	99.9	49.0	7.4	0.5	1.1
Bean hull	90.9	3.1	72.7	61.4	8.2	6.5	57.3	55.9	8.4	0.6	3.0
Pea hull	91.0	3.6	58.6	40.8	7.5	16.4	148.7	63.7	9.6	0.4	2.0
Atela	21.8	5.8	60.2	22.5	11.0	21.0	167.3	87.8	13.2	0.2	0.6
AIBP											
Brewery wet grain	22.2	4.7	78.6	29.9	10.7	26.8	245.7	60.3	9.1	0.3	1.7
Wheat bran	86.5	4.4	52.8	8.1	-	16.9	153.2	83.0	12.5	0.2	0.8
Cotton seedcake	92.3	7.6	47.2	20.8	6.3	42.0	386.7	60.2	9.0	0.2	1.1
Noug seedcake	93.4	10.9	33.1	27.2	7.1	34.5	317.0	68.1	10.2	1.1	0.2
Molasses	72.4	18.5	-	-	-	4.0	29.0	99.6	14.9	0.8	0.2
Crop stubbles											
Barley stubble	92.5	6.2	80.3	68.5	7.5	2.2	17.0	53.5	8.0	0.9	0.3
Wheat stubble	93.0	6.4	81.7	69.7	8.1	2.1	15.9	48.3	7.2	0.4	0.7
Faba bean stubble	92.7	4.2	76.0	62.4	10.2	3.1	24.9	44.3	6.6	0.8	0.3
Field pea stubble	92.5	3.8	77.8	58.7	12.9	3.8	31.4	41.4	6.2	0.5	0.4
Oats stubble	93.2	7.3	79.8	71.5	7.7	1.9	14.6	50.2	7.5	0.3	0.2

AIBP = Agro-Industrial By-products, Atela = a by-product of local beverage.

above the total annual requirement per farm. Surplus DCP and ME above the maintenance requirement in Jimma and Sebeta could probably be attributed to the use of better energy and protein supplements. The larger deficit observed mostly under Debre Birhan area may be associated

Table 5. Estimated available dry matter production, DCP and ME supply per annum per farm in selected peri-urban dairy production system of Ethiopia.

Feedstuff	Study sites								
	Debre Birhan			Jimma			Sebeta		
	DM (t)	DCP (kg)	ME (MJ)	DM (t)	DCP (kg)	ME (MJ)	DM (t)	DCP (kg)	ME (MJ)
Crop residues	11.2	330	86100	-	-	-	4.6	120	30000
Hay	10.9	600	81600	14.4	770	105200	10.2	540	74000
AIBP	4.2	770	50400	8.8	1300	110200	10.2	2100	108700
Non-conventional feeds	-	-	-	4.4	500	43100	0.2	20	1600
Total	26.3	1700	218100	27.6	2570	258500	25.2	2780	214300

- Not available, Atela = a by-product of local beverage, AIBP = Agro-industrial by-products.

Table 6. Estimated annual feed dry matter and nutrient balance of livestock per farm per annum in selected peri-urban dairy production system of Ethiopia.

Study site	Annual nutrient supply			Estimated annual nutrient requirement (for maintenance)			Balance of supply and requirements		
	TDM (t)	TDCP (kg)	TME (MJ)	TDM (t)	TDCP (kg)	TME (MJ)	TDM	TDCP	TME
DB									
TLU=20.1	26.3	1700	218100	41.4	2600	270900	-15.1	-900	-52800
Jimma									
TLU=14.3	27.6	2570	258500	31.2	1700	206900	-3.6	+870	+51600
Sebeta									
TLU=12.5	25.2	2780	214300	26.0	1400	174100	-0.8	+1380	+40200
Average	26.3	2350	230300	32.9	1900	217300	-6.5	+450	+13000

DB = Debre Birhan, TDM = total dry matter, TDCP = total digestible crude protein, TME = total metabolizable energy.

with poor quality of roughages and absence of supplements.

CONCLUSION AND RECOMMENDATIONS

The quality of available basal roughage feeds for dairy cattle in peri-urban areas of Ethiopia is generally low. Better milk yield and reproductive performance observed at Sebeta area could be a point of interest to further study on the biological and economic efficiency of feeding agro-industrial by-products such as brewery wet grain for dairy cattle kept close to brewery factories. Alternative means of feed production and supply particularly in dry season should be in place with the involvement of all stakeholders and development actors Table 6.

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