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Dairy Feed Quality and Feeding Practices in Selected Urban and Peri-Urban Areas of Nekemte and Nedjo, Western Oromia, Ethiopia

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Abstract: Dairy feed quality and feeding practice was studied in urban and peri-urban selected areas of Nekemte and Nedjo in Western Oromia, Ethiopia. This study was conducted with the objectives of investigating feed resources, assessing feeding practice and determining nutritional qualities of major dairy feeds. Purposive sampling technique was employed to select target dairy farms. A total of 60 dairy farms were selected from Nekemte (30) and Nedjo (30) to gather data through semi-structure questionnaire and field observation. Farmers were stratified into medium holders and small holders based on herd size. Samples of major feeds from both study sites were collected and analysis for chemical composition and *in vitro*- dry matter digestibility (IVDMD). The results of the study showed that natural pasture hay and crop residue were the major feed resources in both study sites. Stall feeding and semi-grazing feeding systems were practiced by 78.4 % and 21.6% of respondents respectively. Major feed samples were analyzed for ash, neutral detergent fiber (NDF), acid detergent fiber (ADF), crude protein (CP) and IVDMD. The ash contents of feeds samples varied significantly ($P<0.05$) from 44±1.8 g/kg DM (Teff straw) to 105±0.5 g/kg DM (Noug cake). The CP contents of feeds significantly ($P<0.05$) varied from 357±0.8 g/kg DM (Noug cake) to 50.3±0.32 g/kg DM (Teff straw). The NDF contents of feeds range from 184±0.17g/kg DM (Maize flour) to 774±0.17 g/kg DM (Teff straw). The IVDMD of sample feeds significantly varied ($P < 0.05$) with a range of 43.9±3.8 to 83.4±0.4 for hay and maize flour respectively. Teff straw had highest IVDMD value among roughage feeds. Therefore, the present study concluded that the quality of feeds were low in quality hence supplementation of energy and protein feeds is essential. Strategic energy and protein rich feed for supplementation, sensitizing farmers to use of other optional available feeds resources like hulls of pea, fruit wastes and technical intervention of pre-harvest and post-managements are paramount to increase dairy cattle milk productivity.

Key words: Dairy Production · Feed Quality · Feeding Practice · Urban · Peri-Urban

INTRODUCTION

Dairy production is biologically efficient system that converts large quantities of roughage to milk, the most nutritious food known to man [1]. Dairy cattle production in peri-urban and urban dairy systems of Ethiopia is characterized by low productivity due to mainly nutritional constraints, management practices and low genetic potential of the indigenous cows [2, 3].

The types of dairy feed resources mainly in Ethiopia are natural pasture, crop residue, forage crop, concentrates and non-conventional feeds [4]. The bases of feed resources in urban and peri-urban dairy production system are natural pasture grazing, hay and crop residues [5].

In spite of the presence of large and diverse animal genetic resources, the production and productivities of dairy cattle is low [6]. This productivity of milk in the

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country is low due to inadequate nutrition, age of delayed puberty, reduced conception rate, increased pregnancy losses, long calving interval and low milk production [7]. Availability of feeds resources is not the only challenge to the development of the dairy in particular, but also quality of the feeds is equally important [8]. The forage quality and quantity have seasonal variations especially during the dry season is a major concern. Lower nutritive value mainly crude protein (CP) content of pastures is 7% lower than the forage crude protein content which would cover the maintenance requirements of ruminants [9]. Lack of protein therefore adversely affects milk production, weight loss in lactating cows, reduced growth rate in heifers and result in underweight calves being born. Feeding is one of the problem and these animals may be limited to express fully their genetic potentials. It is fundamental approach to provide good quality diets to dairy cattle in sufficient amounts to maximize production [10]. In Nekemte and Nedjo studied areas, the dairy sub-sector is used for a provision of high-value food and it is a way of poverty reduction to better livelihoods for households in the areas. However, quality of native pasture is very low especially in dry season due to their low content of digestible energy and protein and high amount of fiber content [11]. Dairy feed quality and feeding practices have not yet been studied and current information is lacking. So there is no empirical data on the dairy feed quality and feeding practice.

Therefore, the aims of this study were to investigate dairy cattle feed resources, to identify feeding practice and to determine nutritional qualities in selected urban and peri-urban areas of Nekemte and Nedjo.

MATERIALS AND METHODS

Description of the Study Area: This study was conducted in Nekemte and Nedjo of Western Oromia Regional State on private dairy producers of urban and peri-urban areas. Nekemte town is located at 331 km West of Addis Ababa, capital city of the country. It is located in Eastern Wollega Zone of the Oromia Regional State. Geographically it is located at 9°05' N to 9°10' N latitude and 36° 30' E to 36° 40' E of longitude with elevation of 1770 meters above sea levels. Nedjo town is located at 497 km from the Addis Ababa to the West. This town is one of the twenty three *woredas* of West Wollega Administrative Zone and geographically located between 9°37' N to 9°44' N latitude and 35°14' to 35°40' E longitude. Both study areas are characterized by cultural foods known as "Anchote" which is commonly used on holy day (Meskel).

Sampling Technique and Sample Size: Nekemte and Nedjo towns were purposefully selected based on potential milk supply to the towns and suitability of the areas for dairy production. The study was categorized in to urban and peri-urban based on their potential milk supply and suitability of the areas for dairy cattle production system. A preliminary rapid survey was conducted before formal survey in order to select specific dairy farmers. For the study of dairy feed quality and feeding practice a total of 60 dairy farms (30 from urban and peri-urban each) were purposively selected based on owning crossbreed dairy cows and their involvements on dairy activities. This is because of the fact that it could have been to collect reliable information from dairy holders by interviewing about dairy feeding quality and feeding practice in the area. Furthermore, those production systems were later grouped into small holders and medium holder dairy farms based on their herd size and the number of milking cows they maintained. Consequently, dairy farms owning less than four cows and four to ten (4-10) dairy cows were clustered as small and medium-sized farms respectively as described by Girma *et al*. [12] in area of Southern Ethiopia. Data were collected through household interviews, using a pre-tested, semi- structured questionnaires and personal field observation.

Feed Sample Selection, Collection and Preparation: Major feed samples of the same feed type were selected from both study areas (Nekemte and Nedjo towns) of each production system for chemical analysis. The sample of the same feed types selected were: roughage (Teff straw, Millet straw, Grass hay), concentrate (Nouge cake, Maize flour & Pea hulls), 12 feed samples (6 from each site) & 1 concentrate mix sample from Nekemte and a total 13 feed samples were selected from studied areas for laboratory analysis. Collected samples were properly stored and all the feed samples were packed in waterproof plastic bags.

Chemical Analysis: The collected samples were weighed and dried in a forced air draft oven at 65°C to a constant weight and then was ground in a hammer mill (Arthur H. Thomas Company, Philadelphia PA., U.S.A.) with a 1mm screen. Dry matter (DM), ash and crud protein (CP) were analyzed according to AOAC [13]. Analysis for neutral detergent fiber (NDF) was performed using the procedures described by Van Soest [14]. Acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed using the procedures described by Van Soest and Robertson [15].

***In vitro*- Digestibility Experiment:** *In vitro* ruminal organic matter digestibility (IVDMD) was determined according to the procedure of Tilley and Terry [16]. Ruminal fluid was collected from three bulls in the afternoon (6 hours after they were offered Rhodes grass hay). Rumen digests was collected into a pre-warmed thermos flask. McDougall's buffer (based on the composition of sheep saliva) was prepared. Metabolizable energy (ME) content of feed sample was estimated from the organic matter digestibility (OMD) using the formula: ME (MJ/kg of DM) = 0.016*DOMD (g/kg of DOMD) as described by McDonald and his colleagues [17]. All laboratory experiments were carried out at Holeta Agricultural Research Canter, Animal Nutrition Laboratory.

Statistical Analysis: Descriptive statistics (mean, standard deviations, percentages and frequency distributions) were employed in the process of describing feed resources and feeding system. The quantitative data collected from dairy farmers were analyzed using Statistical Package for Social Sciences SPSS [18] version 20. General Linear Model (GLM) procedure of SAS [19] version 9 was used for feeds chemical compositions. The relationships between chemical composition and in vitro-digestibility among nutrient contents of feed were done by using Pearson correlation coefficients.

RESULTS AND DISCUSSION

Factors Affecting Household Characteristics of Urban and Peri-urban Dairy Areas

Household Characteristics: The overall average age of the respondents was 47.9±5.5 year in the study areas. Majority (88.3%) of household was male headed. The overall mean family size was 5.4±1.7 persons/ household and there was no difference (P > 0.05) among the farm sizes. This was comparable to 5.83±1.85 of average family size in Holeta reported by Van Soest and Robertson [15].

Herd Size and Dairy Cattle Composition: The average mean of herd size of crossbreed cattle per household had significant (P<0.05) difference across the farm size. The smallest mean herd size of crossbreed cattle per household (2.26±0.48) was observed in peri-urbam small farm size while larger mean herd size (7.07±1.62) was observed for medium urban farm size. This result is in line with Girma *et al*. [12] who reported dairy cattle owned per household with value of 2.6 and 7.5 herd sizes for small and medium farm respectively in urban area of Shashamane milk shed.

Increase in crossbreed cattle proportion in urban and peri-urban might be due to market orientation by the producers as crossbreed cows were primarily reared for generating income from sale of milk.

Proportion of milking cow was higher than other classes of herd in the study area. Highest proportion of milking cow in the dairy herd probably shows that farmers keeping crossbred cattle for milking playing a significant role for the economy of dairy farmers through selling of raw milk and dairy as sources for income generation.

Dairy Feed Resources and Feeding Practice in Urban and Peri-urban Dairy: Dairy household in urban and peri-urban areas of Nekemte and Nedjo had various feed resources for their crossbred dairy cattle. Natural pasture hay, crop residue and concentrate were major feed resources in the surveyed areas. Generally, 17 types of dairy cattle feed resources were identified and categorized in to: Natural grass hay, green fodder (trees), rhodes grasses, elephant grasses, native grass grazing, finger

Table 1: Age, sex, family size and educational status of the respondents in the study areas

	Nekemte		Nedjo			
Variables	Small (n=15)	Medium (n=15)	Small (n=15)	Medium (n=15)	Overall	P-value
Age of HH (mean)	47.5±3.9	46.9±5.4	49.9±6.3	47.8±5.3	47.9±5.5	0.323
HH head in %						
Male	43.3	40	46.6	46.6	88.3	
Female	6.7	10	3.4	3.4	11.7	
Family size	5.6±2.1	5.1±1.8	5.7±1.3	5.3±1.6	5.4±1.7	0.227

Table 2: Cattle herd size per households in the study areas

	Urban		Per-urban			
Cattle breeds	Small (n= 15)	Medium (n= 15)	Small (n= 15)	Medium (n= 15)	Overall mean	P-value
Crossbreed	2.66±0.5^{b}	7.07±1.6^{a}	2.26±0.5^{b}	6.00±1.9^{a}	4.13±1.1	<0.0001
Indigenous	1.46±1.9	2.8±3.7	2.20±1.2	2.9±1.55	1.3±1.7	<0.3019

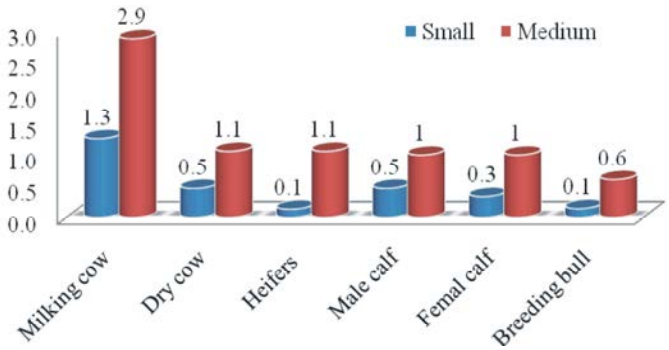

Fig. 1: Nekemte urban crossbred herd composition

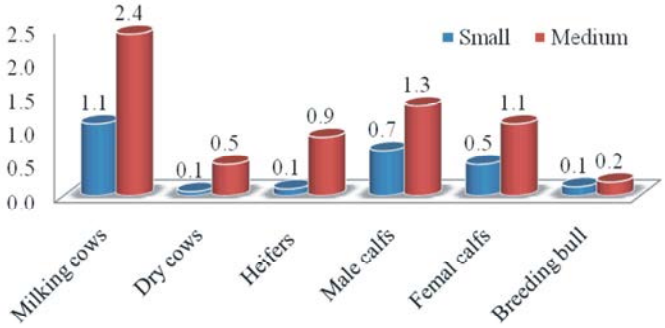

Fig. 2: Nedjo peri-urban crossbred herd composition

millet straw, teff straw, maize stovers, sugarcane top; agro-industrial by products (AIBP): Nouge (*Guizotia abyssinica*) cake, wheat bran, commercial concentrate mixture, brewery yeast, maize powder/grain, hulls/pulse of pea and bean from small scale flour processing by products local brewery wastes ("attela") and grain mill flour processing by-products in the study areas.

Among feed resources, natural pasture hay and crop residue constituted the largest share of feed resources in both study sites while commercial concentrate mix contribute highest share to feed Nekemte urban dairy cattle production area.

AIBP feeds were the most important supplementary feeds for their crossbred dairy cattle in Nekemte and Nedjo areas and feed supply through purchase. AIBP mainly commercial concentrate mix feeds supplied for dairy farmers in Nekemte dairy production area is supplied by Gibe Didessa Multipurpose Farmers' Cooperative Union for their members and non-members, while dairy farmers in Nedjo areas commonly used non-conventional feeds like attela (local brewery residue), flour and grain mill by products. Dairy farmers in Nedjo area acquire AIBP feeds from Nekemte and Addis Abeba by traders and the routes of supply are not regular. Moreover, feed processing plant was not available in Nedjo study area.

The investigation of the current study with regard to identified major feed resources is in agreement with previous works of Zewdie and Galati and his colleagues [20, 21] who reported that natural pasture, crop residue, AIBP and non- conventional feeds like attela commonly dairy feeds resources in urban and peri-urban areas of different parts of Ethiopia.

Feeding Systems and Feeding Practice of Dairy Cattle in Urban and Peri-urban Areas of Nekemte and Nedjo: Two major type of feeding systems (stall-feeding or zero grazing and semi-grazing) were identified in the study areas as indicated in Table 3. Overall, 78.3% and 21.7% of respondents practice stall-feeding (zero- grazing) and semi- grazing respectively.

In urban dairy production systems, 43.4% and 6.6% of medium and small dairy producers used stall feeding and semi-grazing feeding systems respectively. The feeding practices for crossbred cows in the study area were agro-industrial by products feeding and they supplied with in amount 2 times higher composed of noug seedcake and wheat bran and pulses of peas. Consequently, daily roughage feed supply to animals was not measured by any of the dairy farmers rather feed was provided roughly based on the availability of feed in this study areas.

Table 3: Diary feeding systems in Nekemte and Nedjo survey areas in (%)

	Urban		Peri-urban		
Variable (%)	Small (n= 15)	Medium (n= 15)	Small (n= 15)	Medium (n= 15)	Overall mean
Grazing system					
Stall feeding (Zero-grazing)	36.7	43.4	36.7	40	78.3
Semi-grazing	13.3	6.7	13.3	10	21.7

Table 4: Chemical compositions and nutritional parameters of major feed resources

Chemical	Major feeds type in the study area						
and IVDMD	Millet straw	Teff straw	Pasture hay	Maize flour	Pea hulls	Noug cake	Concentrate mix
DM (%)	92.4±0.2^{b}	92.6±0.3^{b}	90.1±0.7^{d}	90.4±0.05^{d}	92.9±0.1^{b}	93.6±0.6^{a}	91.2±0.2^{c}
Ash	10.1±0.9^{a}	7.4±0.7^{b}	4.4±1.8^{c}	1.1±0.1^{e}	7.4±0.6^{d}	10.5±0.5^{a}	6.4±0.1^{b}
OM	89.8±0.9^{e}	92.5±0.6^{d}	95.6±1.8^{c}	98.8±0.1^{a}	97.0±0.5^{b}	89.4±0.1^{e}	93.5±0.1^{d}
NDF	61.6±0.3^{b}	77.4±0.2^{a}	69.1±0.2^{b}	18.4±0.2^{f}	60.9±0.8^{b}	36.7±0.3^{c}	39.1±0.4^{d}
ADF	40.9±0.9^{c}	42.9±0.1^{a}	41.3±0.8^{b}	2.6±0.1^{f}	42.8±1.0^{a}	26.5±2^{d}	9.4±0.0^{e}
ADL	3.7±0.1^{d}	2.2±0.5^{e}	6.4±0.2^{c}	1.26±0.1^{e}	7.3±0.1^{b}	12.6±0.0^{a}	3.6±0.1^{d}
CP	6.12±0.8^{e}	5.03±0.3^{e}	6.9±0.2^{e}	8.3±0.4^{d}	20.0±0.4^{c}	35.7±0.8^{a}	22.1±0.5^{b}
IVDMD	48.4±0.6^{f}	50.6±1^{e}	43.9±3.8^{f}	83.4±0.4^{a}	54.8±0.6^{d}	61.3±0.6^{c}	73.4±0.1^{b}
ME	6.5±0.1^{e}	7.4±0.0^{d}	5.9±0.6^{e}	11.8±0.0^{a}	7.6±0.0^{d}	8.5±0.0^{c}	10.3±0.0^{b}

* Means in the same rows with different superscripts letters (a-f) are significantly different (P<0.05).

This result is consistent with the research work by Belay [7] who reported of 79.9% of respondents use stall feeding system and partial-grazing (7.4 %) in Jimma town. Contrary to finding of this study Girma *et al.* [12] made a report on that 95.8% and 4.2% of dairy farmers practice stall feeding and semi-intensive feeding practice respectively in Shashamane milk shed. As majority of respondents addressed, practicing of zero-grazing system was due to problem of access to land for feed production in the study area.

Chemical Composition and *In vitro*-digestibility of Major Feed Resources: The chemical composition and *in-vitro* dry- matter digestibility (IVDMD) of major feeds resources used in Nekmte and Nedjo study area is shown in Table 4. The ash content of feed samples was significantly highest (P<0.05) in noug cake and millet straw and the least was recorded in maize flour & grass hay. The CP contents of feed samples was significantly highest (P<0.05) in Noug cake and the least recorded in teff straw and millet straw. However, there were similarities (P>0.05) in CP contents between crop residue and natural grass hay. Feeds with the CP level less than 7.5% inhibits voluntary feed intakes and the activity of microbial action declines, resulting in lower digestibility of roughages [22].

Crop residue was evaluated for CP contents and lowers than the minimum level of 7% required for optimum rumen microbial function [23]. Crude protein value for natural pasture hay in the present study was 69.1g/kg DM comparable to pervious work (67g/kg) DM of CP content reported by Gashaw [24]. However, the CP content of pasture hay was higher than CP contents of 65g/kg DM [25]. Among protein supplements in the present study, noug cake had higher CP value (357g/kg, DM) followed by commercial concentrate mix.

Overall, the present study revealed that, the average mean of CP contents was 14.8%, this indicated that of feed staff was as lower in CP value hence quality of feeds in this study is generally low. According to Seyoum *et al.* [26], feeds contents for protein supplements should be (CP = 32.6%) for good quality supplements.

The NDF contents of feed samples was significantly highest (P<0.05) in teff straw and grass hay and the least recorded in Maize flour. The NDF content in natural pasture hay (691g/kg) DM is slightly comparable to 669 g/kg DM for pasture hay in southern Ethiopia (Gambela district) reported by Mengistu *et al*. [27]. Roughage feeds with contents of NDF less than 450g/kg DM contents categorized as high quality and between the range of 450 to 650g/kg DM contents considered as medium quality and those more than 65% as low quality roughages [28]. Roughage feeds (Teff straw and grass hay) categorised as low quality feeds. The ADF contents of feeds samples was significantly highest (p<0.05) in Teff straw and natural grass hay and the least recorded in maize flour. ADL contents highest in noug cake and least recorded in maize flour.

***In vitro*- Digestibility Experiment:** The *in vitro*- dry matter digestibility (IVDMD) of feeds sample in the present study was significantly different (P<0.05) across the feeds sample. The IVDMD of feeds sample in the

Table 5: Correlation coefficient of chemical compositions and nutritive value of major feeds

	DM	Ash	NDF	ADF	ADL	CP	IVDMD	ME
DM	1							
Ash	0.555	1						
NDF	0.408	0.437	1					
ADF	0.388	0.315	0.957	1				
ADL	0.503	0.400	0.262	0.246	1			
CP	0.535	0.276	-0.086	-0.130	0.858	1		
IVDMD	-0.192	-0.419	-0.907	-0.923	-0.283	0.169	1	
ME	-0.192	-0.419	-0.907	-0.923	-0.283	0.169	1	1

present study was significantly highest ($p<0.05$) in maize flour and the least recorded natural grass hay. The lowest IVDMD in grass hay is associated with higher lignin contents compare to other roughage feeds. Lower value of IVDMD for Finger Millet straw and grass ha might be due to prolonged time required for crop maturity and delayed harvest time in natural grass hay might be that take over intensive lignifications.

The finding of the current study value of IVDMD contents for crop residues were in line with the report of Nugusu and Yossef [25]. Noug cake had IVDMD content of 613g/kg DM that is slightly comparable with 631g/kg DM of IVDMD, which was reported by Girma *et al*. [12]. From this study result, average mean of IVDMD 476.3g/kg DM for crop residue and natural grass hay indicates low nutritive value which limit feed intake, suggesting the need for either improvement of the nutritive value of these feed resources or supplementation with good quality feed for reasonable dairy cattle production.

Metabolisable Energy (ME) contents of feed samples was significantly highest ($P<0.05$) in maize flour and concentrate mixture and the least recoded in natural pasture hay and finger millet straw. The differences in ME of various feedstuffs might be reflected different contents of fermentable carbohydrates and available nitrogen in cereals. In general, predicted ME values were very low in the feedstuffs having high NDF and lower CP contents. The lowest ME value was observed in natural pasture followed by millet straw might be those roughages feeds are deficient in fermentable carbohydrates, reflected by relatively low OM digestibility [29]. From the present study, the ME (overall mean 8.3MJ/kg DM) content of feed lower than the reported thresholds by Seyoum *et al.* [26] not is adequate and readily available to dairy cattle animals.

Correlations between Chemical Composition and Digestibility: The correlations between chemical compositions and *in vitro*- dry matter digestibility of feed sample in this study is presented in Table 5. The current study result indicated that NDF was positive and strongly correlated with ($r= 0.95$, $P<0.05$) with ADF, whereas negatively correlated with IVDMD ($r= 0.90$, $P<0.05$) and ME with($r= 0.90$, $P<0.05$). This findings is in agreement with the work of Andualem *et al*. [30] who reported a strong positive correlation ($r= 0.99$, $P<0.05$) in Essera District of Southern Ethiopia. ME was negatively correlates ($r=0.\ 90$, $p<0.05$) with NDF and with ADF ($r= 0.907$, $P<0.05$). This implies the NDF and ADF are best indicators of nutritional value, negative association between NDF and IVDMD implies increase NDF and ADF contents decrease IVDMD leads to decrease availability of CP and ME of feeds, which directly affects performance of dairy animals.

CONCLUSION

In this study, survey was conducted to assess the dairy feed quality and feeding practice in urban and peri-urban areas of Nekemte and Nedjo towns in Western Oromia Region, Ethiopia. Among major feed resources in the study areas: natural pasture hay, crop residue and agro- industrial by products (nuog cake and concentrate mix) and non-conventional feeds like attela and grain mill by products were the most important ones.

Natural pasture hay and crop residue are main basal roughage feeds for dairy animals in the study areas. During dry seasons some farmers use different mechanisms to improve feed shortage in quantity and quality by increase use of concentrate and of non-conventional feeds like attela.

Nutritive value of laboratory analysis showed that crop residue and grass hay are lower in its protein contents. The mean *in vitro*- dry matter digestibility (IVDMD) main basal feeds are lower than the minimum level required for quality roughages. The energy contents of roughage feeds are lower in nutritional value.

The NDF contents of roughage feeds high hence low digestibility, which leads low quality of nutritive value. The supplementary feeds for CP and energy of feed ingredient in the study area sufficiently support minimum dairy requirement.

Energy contents of supplementary feeds commonly used commercial concentrate and maize. Among protein supplements noug cake and hulls pea are major protein feeds sources. Hulls of peas and beans are important protein sources that could be helps dairy holders to complement a nutrient and help to reduce cost of milk production by reducing over dependency on the costly feed supplements.

Therefore, the present study was concluded that the quality roughage feed sample is generally low quality. There should be good supplementation of protein and energy rich feed to support dairy cattle nutrient requirement mainly during dry season is essential.

Recommendation: Therefore, based on the current finding the following recommendations are forwarded:

- ✓ Strategic energy and protein rich feed for supplementation and sensitize dairy farmers to use of other optional feeds resources like fruit waste, hulls of grass pea and beans to feed dairy cattle.
- ✓ Technical interventions for adoption of legume forage, use of urea treatment, timely harvesting and adequate storage of hay could be beneficial in alleviating deficiency of dairy nutrients.
- ✓ Conduct training for dairy households and dairy farm managers on feeding management is more attractive for further dairy development interventions.

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