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Evaluation of Urban Dairy Cattle Husbandry Practices and Available Feed Resources in Dire Dawa and Harar Cities, Ethiopia

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Abstract

The introduction of improved breeds, semen, land provision, forage production, policy reforms, and technological interventions have all been prioritized by the Ethiopian government for the development of dairy in urban and peri-urban areas. However, there is limited information on the real success of husbandry practices and feed resource utilization of urban dairy production systems. Tthis study was conducted to assess the husbandry techniques, feed resource and utilization, and milk production of dairy cows in urban dairy farms. The study was purposefully conducted in selected urban areas of Harar and Dire Dawa cities on 76 dairy farms. Data on some husbandry practices and common feed resources were collected using semi-structured questionnaires, assessment of farm notebook records for milk data, and focused group discussion. Commonly used feeds from each farm were collected and analysed for their nutritive value. Milk yield was recorded every day from 152 cows for four consecutive months. The study showed that farmers from small, medium, and large-scale farms fed cows on low quality concentrates of 3.76, 4.61, and 5.84 kg/day, respectively. The major identified feed resources for all farm scales were agro-industrial by-products. The quantity of concentrate supplement per cow per day was significantly different ($p<0.0001$) among the different farm scales. The average milk yield produced by a cow in the present study was low (9.57-13.07 litter/day). In the study area, most farmers fed lactating cows below the point of biological and economic optimum. Finally, this study recommended refresher training, regular monitoring and feed optimization technique to improve milk production in the urban dairy farming system.

Keywords: Farm-scales**,** Feed resources, Lactating cows, Milk yield

Introduction

The increased demand for milk and milk products among the urban population has been a driving force behind the establishment of urban and peri-urban farms (Habib *et al*., 2007). In Ethiopia, market-oriented dairy farming is an emerging industry and a significant supplier of milk and milk products to urban centers (Hailemariam *et al*., 2006). Commercial dairy farms located in urban and peri-urban areas always use purchased feed and fodder to provide their animals with stall-feeding. As a result, feed makes up over two thirds of the operating expenses (Habib *et al*., 2007). In addition, the system is extremely profit-driven and intensive feeding of a lot of concentrates to the animals to increase milk production. Due to the unusually high consumption of milk and milk products in urban areas, these urban dairy farms are therefore making a significant contribution to bridging the low supply and demand gap for milk and milk production (Tadesse and Mengistie, 2016).

Because feeds and veterinary services were readily available, most dairy farmers in urban and peri-urban areas maintained genetically improved breeds (Azage *et al*., 2013). Furthermore, urban dairy farmers have superior knowledge of dairy management, processing facilities, and artificial insemination (AI) services (Land O'Lakes, 2010). Despite this, cows raised on various commercial farm scales were yielding lower daily milk production between 5 and 15 liters per day (Azage *et al*., 2000) and 3208.56 liters overall per lactation (Dessalegn *et al*., 2016) than the 5807 liters recorded in other African nations (Naceur *et al*., 2012). Furthermore, Habib *et al*. (2007) pointed out that traditional feeding practices contribute to higher feed costs in urban and peri-urban dairy farming.

As a result, the government has consistently introduced improved breeds, semen, land provision, forage production, policy reforms, and technological interventions, placing a high priority on dairy development in urban and peri-urban areas. Additionally, a sizable amount of indirect subsidies are used to support these dairy systems and supply the inputs required for their production. Nonetheless, dairy farmers in eastern Ethiopia's urban and peri-urban areas follow a traditional production system that is primarily characterized by the low genetic makeup of cattle, meager amounts of supplemental feed, poor housing, and inadequate methods for milking and handling milk (Mengistu *et al*., 2016).

Therefore, to develop furtehr strategies and direct appropriate interventions to improve the dairy sector, evaluation of the current husbandry practices and potential feed resources is crucial. However, little is known about the husbandry techniques and feed sources used in the urban dairy production systems in the cities of Dire Dawa and Harar. Thus, the objectives of this research were to describe the husbandry techniques, feed resource and utilization, and milk production of urban dairy farms with varying herd sizes.

Materials and Methods

Description of the Study Area

Data were collected from urban dairy production systems situated in Harar and Dire Dawa regional administration, eastern Ethiopia. Harar and Dire Dawa milkshed areas are the major milk consumption areas and wider surrounding rural districts as a major source of supply for milk and milk products in general

(Ketema *et al.,* 2016). Dire Dawa City is located in the great east African rift valley between 90 25’ and 90 45’N latitudes and 410 40′and 420 10′E longitudes. The city is 515 km from Addis Ababa, the capital city of Ethiopia has an altitude of about 1200 m above sea level and is surrounded by escarpments of mountains. It receives 638.2 mm of average annual rainfall. The mean annual maximum and minimum temperatures of the area are 31.4^{0}C and 18.41 ^{0}C, respectively (Belachew and Zeleke, 2015). Harar, a walled city in eastern Ethiopia, is a regional city for the Harari region and a zonal capital for the East Hararghe zone of the Oromia region. It is located at about 527 kilometres from Addis Ababa at an elevation of 1,885 meters above sea level. The two cities are the major milk consumption centres in eastern Ethiopia. Harar and Dire Dawa, owing to their geographical proximity and relatively better access to transport facilities (Ketema *et al.,* 2016).

Sampling procedure and Data collection

A preliminary visit was made to each city's local agricultural office to determine which dairy farms to target. Subsequently, farms were purposefully chosen according to the number of lactating cows in the herd. Accordingly, a total of 76 dairy farms consisting of 23 small-scale (owned ≤ 10 milking cows; 10 farms from Dire Dawa and 13 from Harar), 34 medium-scale (owned 11 to 20 milking cows ; 18 and 16 farms from Dire Dawa and Harar, respectively), and 19 large-scale (owned >20 milking cows; 12 farms from Dire Dawa and 7 from Harar) were selected following the information obtained from local agricultural offices of study area and previous research findings (Ewonetu *et al.,* 2021). A multistage sampling procedure was applied to each farm to select milking cows. After an early stage, of crossbred Holestein Friesian milking cow selection was conducted using a purposive sample method, two milking cows from each farm were chosen at random because some farms had more than two milking cows in an early stage. Thus, a total of 152 milking cows were selected from 76 dairy farms. A record format was prepared by the team of researchers and distributed to each farm to record daily milk data for selected cows by the farm attendants and it was collected monthly. Each farm was visited once in a month to take records for milk yield, concentrate feed used, and crosscheck the existing husbandry practices. Some milk data records were also obtained straight from farms that had preiveous previous record notebooks. A semi-structured questionnaire survey was utilized to gather information on common feed resources and husbandry practices.

Laboratory analysis

Commonly used feeds in each farm were randomly collected and the same feed type were pooled, thoroughly mixed, sub-sampled (500 g) and analysed for their nutritional content at Haramaya Univery Animal Nutrition laboratory. The total ash and crude protein contents were determined according to the procedures described by AOAC (2012). Neutral detergent fiber (NDF), acid detergent fiber

(ADF), and acid detergent lignin (ADL) were analyzed following the procedures described by Van Soest (1991).

Statistical analysis

All the survey data were analysed for percentage and means while the concentrate supplementation and milk yield data were subjected to one-way ANOVA of SAS version 9.4. The statistical model: $Y_{ij} = \mu + F_i + e_{ij}$;
Where: Y_{ij} is the j^{th} observation of the i^{th} farm-scale; μ is the population mean; F_j is farm-scale (small, medium, and large); and e_{ij} is the random residual effect. The existence of significant effect among farms was separated by Duncan's multiple range test at 5 % level of significance.

Results and Discussion

Farm husbandry practices

Although, the majority of farm owners were unaware of the precise exotic gene inheritance of their crossbreed cows, Holstein Friesian crosses dominated all farm categories in the study areas, accounting for 83% of the herd (Table 1). Holstein Friesian crosses were more common because of their greater potential for milk production. This outcome is consistent with a study conducted in Kenya, wherein the majority of participants indicated that Friesian cows were their preferred breed for dairy (Lukuyu *et al*., 2011). Due to indiscriminate cross-breeding without adequate on-farm record and farm owners may not be fully aware of the genetic makeup of their cows. However, because the local cow breeds require less feed and the resulting higher concentration of milk solids, small-scale dairy farmers maintain a comparatively high number of these cow breeds (18.7%). Furthermore, unlike medium- and large-scale operations that use dairy farming as their primary business strategy, small-scale dairy farmers practiced it as a side business.

In all three farm scales, natural mating was the most common breeding technique (Table 1), which is in line with Solomon *et al*. (2014) finding that most farmers in the Metekel zone rely on natural mating when artificial insemination facilities are not available. The overall artificial insemination (AI) adoption rate was 21.6%. This demonstrated how artificial insemination (AI) services are low even though they are widely used and successful in the developed world, with Ethiopia still having a low success rate of 27% (Desalegn, 2008). Farmers indicated that feed shortage, problems in heat detection, the cost of the artificial insemination service (AI), the distance to the AI service center, and the scarcity of inputs for the AI service activity, specifically, liquid nitrogen and semen were the main obstacles to the AI delivery system in the study area. Only local government offices offered the AI service in the study area, and they did so only after receiving a call from dairy farmers. The AI service coverage by private partners was limited. The limitations of AI services found in this study were consistent with those found in another study (Eyassu and Reiner, 2014). The majority of small-scale farms used AI services because they were highly motivated to keep improved dairy cattle through the use of superior bulls' semen.

Table 1: Characterization of farm husbandry practices in the study area

Variables	Farm-Scales			
	Small (n=23)	Medium (n=34)	Large (n=19)	Overall (n=76)
Herd size (mean)	13.7	27.3	43.8	28.7
Management system (%)				
Intensive	100.0	100.0	100.0	100.0
Semi-intensive	0.0	0.0	0.0	0.0
Cattle breeds kept (%)				
Holstein-Friesian crosses*	56.4	93.6	98.30	82.8
Jersey crosses*	24.9	6.40	1.70	11.0
Indigenous	18.7	0.00	0.00	6.2
Pupose of the farm (%)				
Main business	11.30	91.60	100.00	67.60
Side business	88.70	8.40	0.00	32.40
Breeding methods (%)				
Artificial insemination (AI)	31.40	13.80	19.60	21.60
Natural mating	53.20	78.10	71.30	67.50
Both AI and natural mating	15.40	8.10	9.10	10.90
Milking system (%)				
Manual	100.00	97.30	96.80	98.00
Mechanical	0.00	2.70	3.20	2.00
Farm manager (%)				
Owner (professional)	2.90	0.00	0.00	1.00
Owner (not professional)	97.10	100.00	88.60	95.20
Hired professional	0.00	0.00	4.60	1.50
Hired unprofessional	0.00	0.00	6.80	2.30
Record keeping practice (%)				
Daily milk yield record	0.00	2.70	6.30	3.00
Total milk yield sold record	34.20	76.40	87.80	66.13
No record+	100.00	90.90	95.90	95.60
Reasons why NKR (%)				
Lack of awareness on its benefits	12.88	21.60	14.30	16.26
Lack of business orientation	17.11	18.2	27.80	21.04
Busy with other activities	59.26	46.8	46.00	50.69
Don’t know record keeping	10.75	13.40	11.90	12.02

n=Total number of farms observed,*unknown blood level, +Records related to date of birth, breeding, vaccinations, past health problems, treatment given, daily milk yield for individual cows, NKR-Not Keeping Record

Like most developing nations, the majority of participating dairy farmers (98%) relied on hand milking (Chye *et al.*, 2014). While records of birthdates, breeding dates, vaccinations, health issues, treatment, daily milk for individual cows, and identification number records were lacking, most medium and large-scale farms maintained inconsistent records for total daily milk yield and sales (Table 1). According to a report (Tadele and Nibret, 2014), 82% of dairy farmers in and around Maksegnit town did not keep any records, and those who did have extremely incomplete records. The lack of planning and systematic record keeping hinders national efforts to develop the dairy breed and industry. Because they thought it would be cumbersome, most dairy farmers only kept accurate records for the total amount of daily milk produced and sold. However, they neglected to keep record of information about individual cows' daily milk yield, vaccination history, breeding history, past health issues, and dates of birth (Table 1). The owners of almost all farms did not have enough skill and knowledge, though they ran the farm in the conventional manner with little to no advancements in management of dairy cattle. Cicek *et al*. (2007) also proposed that improved management practices and the adoption of dairy technologies in Western Turkey are positively correlated with the educational backgrounds and occupations of producers. However, in central Thailand, Yeamkong et al. (2010) reported that the lower level of milk production per cow in large-scale farms is due to insufficient knowledge and incompetence of employees to perform daily tasks.

Available dairy feed resources and their chemical composition

Agro-industrial by-products and high-roughage diets were commonly utilized as feed resources (Table 2). Agro-industrial byproducts from various factories, including peanut cake meal, wheat bran, wheat short (fine particles of wheat bran), and brewer's byproducts, were produced in large quantities in the study area. Because of their accessibility, these by-products are available with reasonable price and easily found in retail shops. According to Ulifina *et al*. (2013), these by-products are primarily utilized and could serve as a viable source of feed for livestock keepers who are commercially oriented and reside close to processing industries.

All farm categories primarily used native grass hay, though small-scale dairy farms largely replaced it with crop residues. This overreliance on hay was due to Ethiopia's high hay marketability as a feed source and the scarcity of land for urban dairy farmers to produce better fodder. The high marketability of hay as a feed source in Northern Ethiopia was consinstenlty reported by Tesfaye and Gangwar (2015). The majority of medium sized and large-scale farms only grow maize, possibly because the seed is more readily available at retail and less expensive than other cereal crops. Every farm used common salt as an additional mineral supplement. The ruminant premix was too costly and unavailable at retailers in the study areas, only a small number of farmers from medium and large-scale farms used it.

Table 2: Major feed resources used by dairy farm category and their nutrional composition

Feed resources	(%) used farm types			Nutrients (% of DM)						
	Small (n=23)	Medium (n=34)	Large (n=19)	DM	CP	EE	NDF	ADF	ADL	Ash
Roughages										
Grass hay	42.31	81.82	84.21	91.2	8.4	3.9	72.7	47.1	8.8	12.1
Crop residues*	46.15	6.06	0.00	-	-	-	-	-	-	-
Forages**	11.54	12.12	15.79	-	-	-	-	-	-	-
Agro-industrial by-products										
Wheat bran	50.00	72.73	57.89	93.1	15.3	4.8	43.1	9.5	4.2	3.9
Wheat short	42.31	39.39	36.84	90.3	12.0	3.3	41.8	13.7	3.7	6.8
Brewery waste	38.46	36.36	26.32	93.2	18.1	8.3	57.2	29.9	5.9	4.7
Peanut cake	0.00	78.79	57.89	94.7	37.3	9.6	34.7	13.8	6.3	6.2
Soybean meal	0.00	24.24	47.37	93.2	38.5	8.9	18.7	9.6	3.5	8.0
Concentrate mix¥	23.08	12.12	42.11	91.4	11.0	6.2	44.5	14.9	4.6	8.6
Cereal grains										
Crushed maize	0.00	15.15	31.58	89.0	7.1	5.3	27.9	3.9	0.6	2.3
Others used as supplements										
Common salt	96.15	100.00	100.00	-	-	-	-	-	-	-
Premix#	0.00	9.09	26.32	-	-	-	-	-	-	-
Mineral##	0.00	18. 18	68.42	-	-	-	-	-	-	-

DM-Dry matter, CP-Crude protein, EE-Ether Extract, NDF-Neutral detergent fiber, ADF-Acid detergent fiber, ADL-Acid detergent lignin, * -Maize or sorghum Stover, **- Improved forages like elephant grass, #-Ruminant premix, ##-locally available limestone, ¥Commercial concentrate mix.

Table 2 also lists the main dairy feed feed resources that are currently available along with their nutritional compositions. Since high dry matter (DM) contents of feeds on dry basis prevent the growth of mold in feeds, it was suggested that all feeds evaluated in this study are suitable for use and storage. The dry matter (DM) content of compound feed and most of the major ingredients were higher than the acceptable ranges, 88.36 - 90.72 (Alexander, 2014). The differences in oil seed type, extraction technique, and efficiency may account for the higher crude protein (CP) values of oilseed cakes compared to the values (28–35%) reported for protein sources in Ethiopia (Adugna, 2008). CP content of wheat bran was lower than the value(19.47%) reported in the previous study (Mengistu *et al*., 2016). Nonetheless, wheat short(fine particle of wheat bran) had a lower CP value of 17.8 (Adugna, 2008). The disparities in the outcomes could be the result of different raw materials, different processing techniques (e.g. oil seeds), and longer post-milling material storage. The CP value for brewery waste in this study is lower than the range of values (23.4–28.36%) reported in western Oromia (Ulifina *et al*., 2013). The types of grains (barely, wheat, oats, corn) used as raw materials for beer making, the degree of their inclusion, strain variations, variations in the nutritive value of the grains used, fermentation times, processing methods, and analytical techniques can all be responsible for variations in the chemical composition of brewery waste. The CP value of native grass hay in the present study was 8.4, which is higher than 4.73% (Shewngzaw *et al*., 2013) and lower than 9.48 (Tufan *et al*., 2016).

Concentrate feed supplementation

Table 3: Concentrate feed supplementation for lactating cows (n=76)

Parameters	Farm scales			P-value	SL
	Small (n=23)	Medium (n=34)	Large (n=19)		
Amount of concentrate offered (kg/cow/day)	3.76[c]	4.61[b]	5.84[a]	<0.0001	***
Concentrate supplement per liter of milk (kg/litter of milk)	0.39	0.41	0.45	0.4566	NS
Milk yield (Liter/cow/day)	9.57[c]	11.29[b]	13.07[a]	<0.0001	***

a,b,c- Different superscripts in a row are significantly different at P<0.05, NS=Non-significant, SL= Significant

The amount of concentrate feed provided to milking cows varied (P<0.05) among dairy farm types (Table 3). The amount of concentrate supplementation per cow based on milk yield was not significantly different (p<0.0001) between farm types. The quantity of concentrate required per cow/day to yield a liter of milk is less than the findings published by Assaminew (2014). The same study revealed that for small-scale farms, the concentrate feed supplement was 4.61 kg/day and 0.47 kg/kg of milk yield; in medium-sized farms in Holetta, the concentrate feed supplement was 5.14 kg/day and 0.48 kg/kg of milk yield. Compared to other farm sizes, large-scale farms used larger amounts of concentrate. This indicates that they give more care to their cows as they have comparative advantages in milk production and higher economic return which is consistent with the study reported by Gelila (2017). Nonetheless, the quantity of feed utilized in all farm sizes were less than 6.5-10.5 kg/day in the previous finding (Kavanagh, 2015). In small and medium-sized dairy farms, the concentrate fed to milking cows (kg/cow/day) was less than the recommended concentrate diet quantity (0.5 kg/kg of milk), which satisfies the point of biological and economic optimality of dairy farms as advised by Pandey and Voskuil (2011).

Milk production

The mean daily milk yield at the peak lactation stage varied significantly (p<0.0001) among farm types (Table 3). In all of the farms included in the study, the total recorded daily milk yield per cow was less than 16.51 liters/day (Ewonetu and Adane, 2021) and 20 liters/day (Urassa, 2012) that reported in a previous study for crossbred cows in Ethiopia. In line with past research findings in Dire Dawa, small-scale farms produced lower yields than medium and large-scale farm scales (Gelila, 2017). This might be attributed to differences in feed quantity and quality. Research reports state that the daily milk production for urban dairy production systems in Adama, Akaki Kality and Bishoftu were 11.3, 10.8 and 11.6 liters, respectively (Dessalegn *et al.*, 2016). The daily milk yield for crossbred cows under different farming scales and locations in Ethiopia has been reported by several authors to be between 8.37 and 16.5 liters (Eyassu and Reiner, 2016;

Dessalegn *et al*., 2016). The aforementioned discrepancies in performance are ascribed to variations in genetic composition and husbandry practices.

Conclusions

The present study showed that most dairy farmers in the cities of Harar and Dire Dawa hired inexperienced workers (95.2%), hand-milked their cows (98%) and kept only records of total daily milk produced and sold (66.13%). While medium-scale (81.82%) and large-scale (84.21%) urban dairy farmers use hay as a roughage source, small-scale dairy farmers (46.15%) primarily use crop residues. Urban dairy farmers primarily used agro-industrial by-products like wheat bran, wheat short, brewery waste, soybean meal, and peanut cake to prepare a concentrate ration. The quantity of concentrate fed daily and the amount of milk produced daily per cow varied significantly amongst farm scales. The study's urban dairy farmers, classified as small, medium, and large-scale, fed their cows 3.76, 4.61, and 5.84 kg of concentrate per day and produced 9.57, 11.29, and 13.07 liters of milk per cow per day, respectively. This study recommends that urban dairy farmers in the study area be trained in the use of technologies such as milking machine and artificial insemination and should also capacitated on dairy animal feeding to meet point of optimal biological requirement of cows.

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