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Research Article

Crossbred calf rearing method, pre-weaning morbidity and mortality in urban and peri-urban dairy production systems of Dangila district, Ethiopia

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Abstract: *The study was conducted to investigate the crossbred calf rearing method, pre-weaning morbidity and mortality in urban and peri-urban dairy production systems of Dangila district, Ethiopia. A total of 160 households were purposefully chosen from urban and peri-urban areas and interviewed using a pre-tested semi-structured questionnaire. For the monitoring study, 20 peri-urban households were purposefully chosen from a pool of 100 peri-urban households, and similarly, 10 urban households were chosen purposefully from a pool of 60 urban households. The findings revealed that the majority of dairy farmers in both urban and peri-urban dairy productions used colostrum feeding. In the study area, the most common methods of calf milk feeding were restricted suckling (49.4%) and bucket feeding (50.6%). Among the dairy farms monitored, 33.3% used separate houses, but during the survey, it was discovered that 59.4% used separate calf houses. According to the monitoring study, 36.67% of farms were found to have health problems in calves, which was similar to the survey result (41%). The major constraints for crossbred calf rearing were feed shortage and high cost, disease and parasite, water shortage, and lack of access to veterinary services. In this study, the overall incidences of crossbred calf morbidity and mortality rates were 19.4% and 0%, respectively. Therefore, improved calf management practices such as colostrum and other ration feeding, adequate housing, house hygiene, and proper waste disposal are strongly advised to prevent pre-weaning crossbred calf morbidity.*

Keywords: Colostrum feeding, crossbred calf rearing, peri-urban dairy, urban dairy

1. Introduction

Ethiopia has the largest livestock in Africa, with 65 million cattle, 51 million goats, and 40 million sheep (CSA, 2020). According to an IGAD (2010) estimate, the livestock sector provides a living for 60-70% of Ethiopians and accounts for 12-16% of the country's total GDP and 47% of total agricultural GDP. Despite having large number of cattle, dairy cattle perform poorly in terms of milk production and reproduction (CSA, 2020). On the other hand, the nation's estimated annual per capita milk consumption is 19 liters, which is significantly less than Kenya's (115 liters) and Uganda's (65 liters) figures (TRAIDE Ethiopia, 2021).

Among the production systems, the urban and peri-urban dairy production system is becoming an important supplier of milk products to urban centers

(Gebreyohanes *et al*., 2021). As a result, indigenous cattle have very limited milking potential, which makes it difficult to satisfy Ethiopia's growing demand for milk and milk products (Abdisa and Minda, 2016). In this sense, livestock intensification and the crossbreeding program are intervention measures to change the dairy industry (Shapiro *et al*., 2017). Urban and peri-urban dairy production systems with crossbred cows offer a lot of promise, among other possibilities, to ease the severe shortage of dairy products in Ethiopia's major urban centers (Gebreyohanes *et al*., 2021). Therefore, the future of such dairy farms depends on the calf crop's survival rate. Lack of dairy replacement heifers is one of the main obstacles to the growth of dairy production in developing nations (Awol *et al*., 2016). According to Mahder and Dinsefa (2016), proper calf care and management, especially for replacement heifers, is essential for the dairy industry to develop and thrive.

Several factors influence the health and vigor of calves shortly after birth. Proper nutrition is critical for calf growth and the overall profitability of the calf rearing enterprise (Konjit *et al*., 2013). A good nutritional strategy in young stock optimizes rumen development and growth while minimizing stress and disease. The living conditions of livestock have a significant impact on their health and productivity (Wudu *et al*., 2008; Konjit *et al*., 2013). The cleanliness of the barn has an impact on calf health, as calves housed in dirty barns are more likely to contract diseases than calves housed in clean barns (Wudu *et al*., 2008). The health of replacement calves is an important factor in the overall profitability of a dairy operation (Razzaque *et al*., 2009). Indeed, calf morbidity and mortality result in significant economic losses for dairy farmers (Mellado *et al*., 2014; Tsegaw *et al*., 2020).

Despite the fact that many similar studies on calf rearing methods, pre-weaning morbidity and mortality in urban and peri-urban dairy production systems in various areas of Ethiopia have been conducted, Ethiopia is a large country with a huge livestock potential, and most studies only target specific areas rather than the entire country. Furthermore, no previous research has been conducted, and no published information has been reported regarding crossbred calf rearing methods, pre-weaning calf mortality, and morbidity from the study area. Therefore, the objectives of this study were imitated to determine the prevalence of pre-weaning crossbred calf morbidity and mortality, analyze the potential risk factors associated with pre-weaning crossbred calf morbidity and mortality, and evaluate crossbred calf rearing methods in Dangial district, Ethiopia.

2. Materials and Methods

2.1. Description of the study areas

The study was carried out in the urban and peri-urban areas of Dangila district, Amhara region, Ethiopia. Dangila town's dairy farms were classified as urban dairy farms. Dairy farms in the outskirts of Dangila town, on the other hand, were classified as peri-urban dairy farms. It is bordered with Faggeta Lekoma district on the south, Guangua on the southwest, Jawi on the northwest, and West Gojjam Zone on the northeast. The district is situated in the north-western highlands with altitudes ranging from 1850 to 2350 m.a.s.l. The climate is mid altitude (local classification "*Woina Dega*"). The minimum and maximum daily temperatures of the district are 25 ^{0}c and 30 $^{\circ}$C, respectively. Annual rainfall is 1600 mm, with the main rainy season occurring June to September (DZDOLD, 2016).

Dangila district has a total human population of 149,119 people, with 72,860 (48.86%) males and 76,259 (51.14%) females. Crop-livestock farming is the main source of livelihood. According to DZDOLD (2016), the district's livestock population includes 147,981 cattle, 46,928 sheep, 23,3636 goats, 103,144 chicken, 268 horse, 1671 mule, 12783 donkey, and 11,637 bee colony. Cattle are the most important livestock raised by the community in the area. The predominant soil type in the area is reddish brown, with a small fraction of reddish. Teff, millet, wheat, barley, and maize are the major crops grown in the area (DZDOLD, 2016).

Dangila town is one of the largest towns in Awi zone, Amhara regional state. It is around 80 kilometers from the regional seat of Bahir Dar and 485 kilometers from the country capital of Addis Ababa. Dangila town has a total population of 49,389 people, with 23982 men and 25,407 women. According to the DTOA (2016), the town has 22,102 cattle, 5,193

sheep, 943 goats, 40,435 chicken, 34 horses, 664 mules, 1040 donkeys, and 1,627 honeybee colonies.

2.2. Sampling technique and sampling frame

The sampling frame consisted of households in the study area that had at least one crossbred calf. The study locations were chosen specifically for their possible availability of crossbred dairy cattle, accessibility, and market orientation of dairy products. Five peri-urban kebeles were purposefully chosen out of 10 milk shed kebeles based on crossbred dairy cow potential and accessibility, whereas Dangila town was chosen as an urban site.

The sampling frame was those households who have a minimum of one crossbred calf in the study area. The study sites were selected purposively based on their potential for the availability of crossbred dairy cattle, accessibility and market orientation of dairy products. According to crossbred dairy cattle potential and accessibility, 5 peri-urban kebeles were selected purposively out of 10 milk shed kebeles while Dangila town was selected as urban site.

The sample size of respondents was determined by the formula provided by Yamane (1976) as indicated below.

$$n = \frac{N}{1+Ne2} \quad [1]$$

Where

- n = sample size
- N = population size
- e^2 = error limit (the error of 5 percentage points)

According to the above formula, 60 urban households from Dangila town who have dairy cows with a minimum of one crossbred dairy calf were selected purposively. From peri-urban areas, 100 households who have dairy cows with a minimum of one crossbred dairy calf were selected purposively.

Monitoring study was conducted for six months. Out of 60 urban households, 10 urban households from Dangila town were selected purposively. Similarly, out of 100 peri-urban households, 20 households were selected purposively. The households were selected from a list of dairy cattle owners registered as members of the peri-urban and urban households.

2.3. Data sources and methods of data collection

The primary data were collected from households with at least one crossbred calf. Secondary data were collected from the appropriate district livestock development office, kebele livestock development agents, and documents that have been written about the study area.

2.3.1. *Survey*

A semi-structured questionnaire was prepared and pretested to ensure its appropriateness and clarity on respondents. The pretested questionnaire was administered to dairy farm owners. The questionnaire was created to collect information on household characteristics, dairy calf care practices (colostrum feeding practices, watering, and housing and health management), and pre-weaning calf morbidity and mortality. Seven key informant interviews and six focus group discussions were conducted to substantiate and triangulate the information collected from the formal survey.

2.3.2. *Monitoring study*

The sampling units consisted of 32 females and 23 males, totaling 55 crossbred dairy calves ranging in age from birth to 6 months. They were monitored daily for six months and recorded using a structured recording format performed by an enumerator under the supervision of the researcher. Calf management practices such as the cleanliness of the calf enclosure, feeding, watering, the prevalence of sickness, disease signs, and death were documented in the format by asking calf attendants during frequent inspections.

2.4. Data analysis

For data analysis, the Statistical Package for Social Sciences software version 20 (SPSS 20) was used. In the process of examining and describing calf rearing practices, pre-weaning morbidity and mortality, and calf management constraints in the study area, descriptive statistical analysis was also used for descriptive data, which included frequencies, percentages, means, and standard errors. Logistic regression was used to analyze whether risk factors such as production system, sex and season (month) have association with occurrence of morbidity.

The following model was used to analyze the monitoring study.

$$AYijk = \mu + Pj + Si + Mi + eijk \quad [2]$$

Where,

- Yijk = Response Variables (calf survival, pre-weaning morbidity and mortality)
- μ = Overall mean
- Pj = Fixed effect of the production system (urban and peri-urban)
- Si = Fixed effect of the sex of calves
- Mi = Fixed effect of season (dry and wet)
- eijk = random error

3. Results and Discussion

3.1. Socio-economic characteristics of the respondents

The result revealed male-headed households predominated in urban (93.3%) and peri-urban (97%) dairy production systems, while female-headed households predominated in urban (6.7%) and per-urban (3%) dairy farms (Table 1). This finding was consistent with what Yeshwas (2015) found in the Bahir Dar milk shed, where male and female-headed households were 90.2% and 9.8%, respectively. Similarly, the findings agreed with those reported by Azage *et al*. (2013) in Yirgalem town, where 88.5% of households were headed by women and 12.5% were headed by men.

The educational status of the household heads in the study area was 15.6% illiterate, 35% read and write, 30% elementary education, 16.3% high school completion, and the remaining 3.1% were professionals (Table 1). The findings differed from those of Yeshwas *et al*. (2014) in the Gozamin and Bahir Dar Zuria districts, with the highest proportion of illiterates (50.0%), read and write (23.6%), primary (13.6%), and secondary school completed (12.8%). The current study's high promotion of respondents' educational enrollment allows it to identify and determine the type of management practices and extension service providers required for better calf management in particular and improved dairy farming in general.

Table 1: Socio-economic characteristics of respondents in the study areas

Variable	Category	Urban (N=60)		Peri-urban (N=100)		Overall (N=60)	
		N	%	N	%	N	%
Sex	Male	56	93.3	97	97	153	95.6
	Female	4	6.7	3	3	7	4.4
Marital status	Married	55	91.7	96	96	151	94.4
	Widowed	2	3.3	3	3	5	3.1
	Divorced	3	5.0	1	1	4	2.5
Education	Illiterate	3	5.0	22	22	25	15.6
	Read and write	27	45.0	29	29	56	35.0
	Elementary	10	16.7	38	38	48	30.0
	High school	15	25.0	11	11	26	16.3
	Diploma & above	5	8.3	0	0	5	3.1

N = number of respondents

According to the current study's findings, the age groups 41 to 50 had the highest percentage of respondents, while the age groups 20 to 30 had the lowest percentage of respondents (Figure 1). The average age of respondents in urban and peri-urban dairy farms was 49.57 ± 11.775 and 45.21 ± 12.776, respectively. According to Asaminew (2014), the average ages of respondents in Holeta urban and peri-urban districts were 44.93±2.82 and 43.73±2.82, respectively.

The average family size per household in urban and peri-urban areas was 5.82 ±1.927 and 5.90 ± 1.703, respectively (Figure 2). The average household size observed in this study was comparable to Melku (2016), who reported an overall mean family size of

5.91±4.42 in West Gojam Zone. The average family size in the study area was less than that reported in the Bure district, which was 6.22 people (Adebabay, 2009), 6.1 in Shashemene, and 7.2 in Hawassa (Azage *et al.*, 2013).

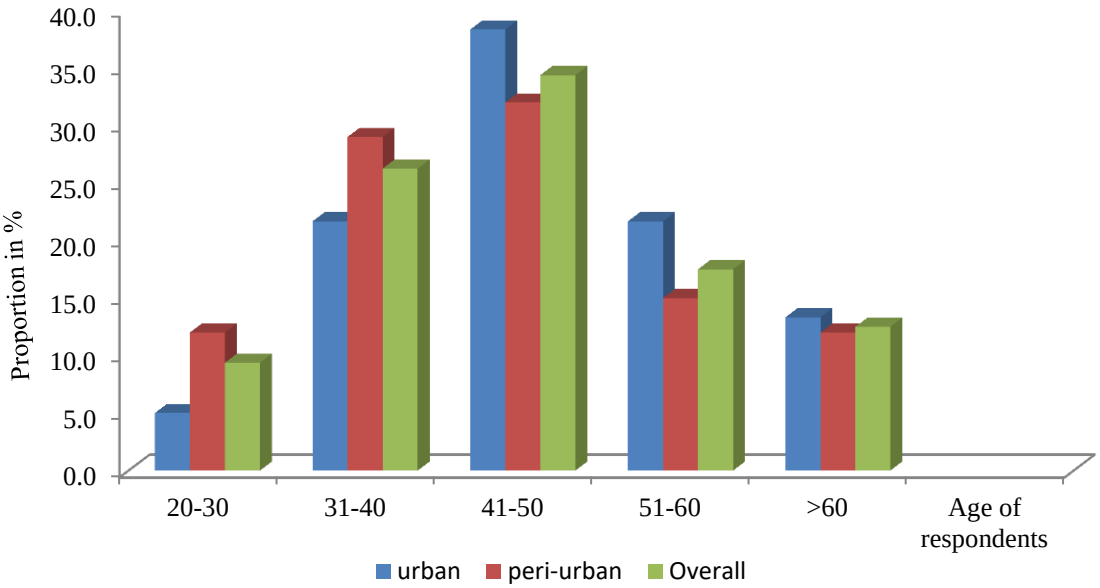

Figure 1: Age of respondents in the study areas

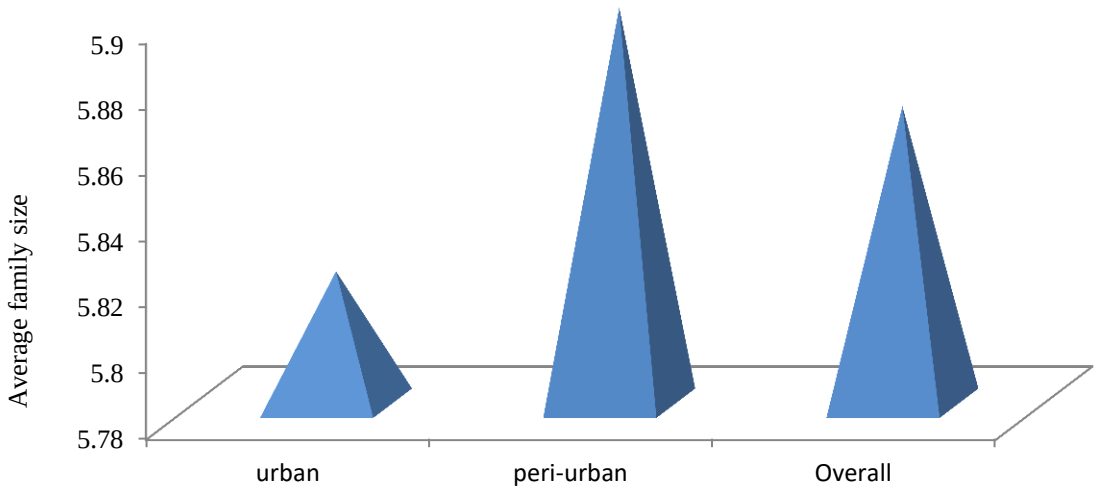

Figure 2: Average family size of respondents in the study areas

3.2. Calf housing and handling conditions

The practice of calf pen location in the study area of dairy farms calculated, 59.4% separate pen, 20% cow shed, 7.5% with sheep and goats, 3.8% in kitchen and 9.4% in household home (Table 2). In the study areas, only 11.2% of the dairy farms used bedding material in separate calf pen, whereas 88.8% of the farms did not practice bedding of calf pen. At the study sites, 61.7% and 69% of urban and peri-urban dairy farms have better management of female calves than male calves. The practice of calf pen location in the study area was equivalent to the

finding of Yeshwas (2015), who found that only 29.9% of dairy producers in Bahir Dar milk shed supply separate calf pen. In Mekelle, calves were housed separately from adult animals on 44.44% of farms and in the same barn with cows on 55.56% (Konjit *et al*., 2013). On 44.5% of the farms in Dessie town and its environs, calves were housed separately from adult animals (Awol *et al*., 2016). The use of bedding material was comparable to what was recorded at the Bahir Dar milk shed, with 7.73% using bedding for their calf pen and 92.27% not practicing calf pen bedding (Yeshwas, 2015). The priority in management given to female calves was consistent with the findings in Mekelle, with male calves receiving less attention and management care since their position in the farms was deemed unprofitable (Konjit *et al*., 2013).

Table 2: Calf housing and handling conditions in the study areas

Variable	Category	Urban (N=60)		Peri urban (N=100)		Overall (160)	
		N	%	N	%	N	%
Location of the calf pen	Separate pen	41	68.3	54	54	95	59.4
	With cows	19	31.7	13	13	32	20.0
	With shoats	0	0	12	12	12	7.5
	With family	0	0	21	21	21	13.1
If separate pen	Individual Pen	2	3.3	9	9	11	6.9
	Group pen	39	65	46	46	85	53.1
Bedding of calf house	Present	15	25.0	3	3	18	11.2
	Absent	45	75.0	97	97	142	88.8
Frequency to change bedding	Once/day	15	25	2	2	17	10.6
	Twice/day	0	0	1	1	1	0.6
Calves having better management	Female	37	61.7	69	69	106	66.2
	Male	0	0	0	0	0	0
	Both	23	38.3	31	31	54	33.8

N = number of respondents

3.3. Manure disposal and calving care

All dairy producers in urban and peri-urban farms used manual labor to dispose of manure, and none used a drainage system (Table 3). The frequency with which manure was disposed of varied across the study area. The daily frequency of disposing manure was 34% once, 54% twice, 10.6% three times, and 0.6% more than three times. During calving, no farmers in urban or peri-urban areas used navel treatment. The study area's use of family labor for manure disposal differed from the findings of Asefa and Ashenafi (2016) in Sodo town and its suburbs, where 58.9% of urban producers paid extra money to dispose of or transport animal dung out of town for carter men (farmers around the periphery of towns to fertilize their crops). Similarly, the majority of large (80.2%) and medium (73.6%) sized farms in Sebeta Awas district urban areas use hired labor to run their dairy operations (Dereje *et al*., 2016). The current study's findings were consistent with those reported for Shashemene-Dilla milk shed, where family labor was the dominant source of labor for urban and peri-urban dairy production (Azage *et al*., 2013). The findings were also consistent with the findings in Bishoftu town, where the majority of management activities in smallholder dairy farms were discovered to be performed by family members (Mulissa *et al*., 2011). The frequency of manure disposal was consistent with the findings in Mekelle, where the daily frequency of cleaning the calf house revealed that 33.33% cleaned it once, 46.3% twice, 11.11% three times, and 9.26% more than three times (Konjit *et al.*, 2013).

Table 3: Manure disposal and calving care in the study areas

Variable	Category	Urban (N=60)		Peri urban (N=100)		Overall (N=160)	
		N	(%)	N	(%)	N	(%)
Means of disposing manure	Drainage system	0	0	0	0	0	0
	Manual labor	60	100.0	100	100	160	100.0
Frequency of disposing manure	Once per day	16	26.7	39	39	55	34.4
	Twice per day	39	65.0	48	48	87	54.4
	Thrice per day	5	8.3	12	12	17	10.6
	>Thrice per day			1	1	1	0.6
Labor source for manure disposal	Family	60	100.0	100	100	160	100
	Hired labor	0	0	0	0	0	0
	Both	0	0	0	0	0	0
Navel treatment	Practiced	0	0	0	0	0	0
	Not practiced	60	100	100	100	160	100
Type of navel treatment	Clinical chemicals	na		na		na	
	Local chemicals	na		na		na	

N= Number of respondents, na = not applicable

3.4. Practice of colostrum feeding

The findings revealed that 93.3% and 88% of respondents in urban and peri-urban dairy farms, respectively, understand the importance of colostrum feeding. However, the remaining 12% of respondents were unaware of the benefits of early colostrum feeding (Table 4). All the urban and peri-urban dairy farmers in the study area feed colostrum to their calves within six hours of birth. Suckling (49.4%) and bucket feeding (50.6%) were the most common methods of colostrum feeding. The knowledge of feeding colostrum in the study area differed from that reported by Yeshwas *et al.* (2014) in the Bahir Dar milk shed, where 68.4% of respondents knew the benefit of feeding colostrum to calves over ordinary milk and fed colostrum within six hours of birth. According to a study conducted in Dessie town and its environs, only 46.3% of respondents understand the significance of colostrum feeding (Awol *et al*., 2016).

The timing of colostrum feeding post-partum in the study area corresponded to what was reported in Dessie town and its environs, where 78% of farm owners practiced colostrum feeding of their calves before 3 hours and 22% fed 3-6 hours post-delivery (Awol *et al*., 2016). In contrast to this finding, a report for selected districts in the West Gojam zone found that approximately 68.3% of urban and peri-urban dairy farms provide colostrum immediately after calving (Melku, 2016).

The method of feeding colostrum in the study area differed from that reported for Arsi Negelle and Shashemene areas, where 88.7% and 11.3% of respondents, respectively, used suckling and hand feeding (Mahder and Dinsefa, 2016). In contrast to the current findings, a report in the Sebeta Awas district found that 91.6% of the overall interviewed dairy cattle producers raised their calves through bucket feeding, while only 8.3% raised their calves through suckling (Dereje *et al*., 2016). Another contradictory report from Gozamin and Bahir Dar districts revealed that suckling (75.0%) and bucket feeding (25.0%) were the most common methods of milk feeding (Yeshwas *et al*., 2014).

Table 4: Practice of colostrum feeding to calves in the study areas

Variable	Category	Urban (N=60)		Peri urban (N=100)		Overall (N=160)	
		N	(%)	N	(%)	N	(%)
Colostrum feeding Knowledge	Yes	56	93.3	86	86	142	88.8
	No	4	6.7	14	14	18	11.2
Colostrum feeding duration	3 days	34	56.7	58	58	92	57.5
	4 days	9	15.0	28	28	37	23.1
	5 days	17	28.3	14	14	31	19.4
Colostrum feeding method	Suckling	22	36.7	57	57.0	79	49.4
	Bucket feeding	38	63.3	43	43.0	81	50.6
Colostrum 1st feeding	Immediately after calving	60	100	100	100	160	100
	6 h after calving	0	0	0	0	0	0

N = number of respondents

3.5. Milking and milk feeding of calves

Suckling (40%) and bucket feeding (60%) were the most common methods of milk feeding in urban dairy farms. Similarly, suckling (55%) and bucket feeding (45%) were the most common methods of milk feeding in peri-urban dairy farms (Table 5). The majority (81.7%) of urban dairy farmers began milking after a week, 8.3% after two weeks, 5% after three weeks, and 5% after a month. Similarly, the majority (73%) of dairy farmers in peri-urban areas began milking after a week, 5% after two weeks, 10% after three weeks, and 12% after a month. The majority of dairy farmers (55%) milked their cows twice per day, and 45 percent milked their cows three times per day. The majority of peri-urban dairy farmers (76%) milk twice per day, with 24% milking three times per day. About 40% of dairy farmers fed their calves 1-2 liters of milk per day, 58% fed 3-4 liters per day, and 2 percent fed more than 4 liters per day.

The method of milk feeding in the study area differed from that reported in the Arsi Negelle and Shashemene areas, where 88.7% and 11.3% of respondents, respectively, used suckling and hand feeding (Mahder and Dinsefa 2016). In contrast to the current findings, a report on the Sebeta Awas district found that 91.6% of the overall interviewed dairy cattle producers raised their calves through bucket feeding, while only 8.3% raised their calves through suckling (Dereje *et al*., 2016). Another contradictory report from Gozamin and Bahir Dar districts revealed that suckling (75.0%) and bucket feeding (25.0%) were the most common methods of milk feeding (Yeshwas *et al*., 2014). Contrary to what was reported in urban and peri-urban dairy farms in West Gojam Zone, cows were not milked for about two weeks during which calves were kept with and allowed to suckle their dams freely in the current study (Melku, 2016).

The amount of milk fed to calves on a daily basis in the study area differed from the findings reported in the Sebeta Awas district, where approximately 74.3% of dairy farmers fed their calves 3 - 4.5 liters of milk per day, while 22.4% fed more than 4.5 liters per day during the first months of calves' life. Small urban (22.2%) and peri-urban (33.3%) farms provided less milk (3 liters), possibly in search of high milk for the market. Similarly, in the second month of calf life, 88.3% of dairy farmers provide 3 - 4.5 liters of milk per day, while 8.3% the farmers fed more than 4.5 liters of milk, and 3.3% of them fed less than three litters (Dereje *et al*., 2016).

Table 5: Milking and milk feeding of calves in the study areas

Variable	Category	Urban (N=60)		Peri urban (N=100)		Overall (N=160)	
		N	(%)	N	(%)	N	(%)
Milk feeding method	Restricted suckling	24	40	55	55	79	49.4
	Bucket feeding	36	60	45	45	81	50.6
Start of milking cows following calving	Within a week	0	0	0	0	0	0
	After a week	49	81.7	73	73	122	76.3
	After 2 weeks	5	8.3	5	5	10	6.3
	After 3 weeks	3	5.0	10	10	13	8.1
	After a month	3	5.0	12	12	15	9.4
Frequency of milking	Twice/day	33	55.0	76	76.0	109	68.1
	Thrice/day	27	45.0	24	24.0	51	31.9

N = number of respondents

3.6. Feed sources and feeding system of calves

The findings revealed that the age at which non-milk feed was introduced varied across farms in the study area. Among the respondents, 17.5% of the households introduce non-milk feed after two weeks, 31.9% after three weeks, and 50% after a month (Table 6). Straw, hay, crop residue (primarily millet and 'teff'), concentrate mixtures (wheat bran and noug cake), and other non-conventional feeds such as local brewery by-products ('*atela*' and '*brinti*') mixed with concentrates were the major feed sources in the study area.

The age to start solid feeding to calves in the current study differed from those reported in the Aleta Chuko district, where 21% began feeding the calf after two weeks, 4 percent after three weeks, 56% after one month, and 19% after two months (Kibru *et al*., 2015). In contrast to the current findings, Dereje *et al*. (2016) found that 20.1% of farms in the Sebeta Awas district begin feeding at 7-15 days, 56.5% at 15-30 days, and 23.4% at >30 days of calf age. The sources of feed in the current study were consistent with the findings of Yeashwas (2015) in Bahir Dar milk shed, where the majority (83.7%) of the farms used roughage (crop residue, hay, grass) for their calves, while the remaining 16.3% used both concentrate and roughage. The current study was also comparable with the findings of Awol *et al*. (2016) in Dessie town and its environs, where 70% of farmers used roughage (hay, grass) as non-milk feed for their calves, while the remaining 30% used both concentrate and roughage.

3.7. Water sources and watering practices

In the current study, the main sources of water were rivers (4.4%), wells (56.9%), tap water (32.5%), and springs (6.3%) (Table 7). The majority (86.7%) of respondents on urban farms acquired water from taps, while 13.3% obtained water from wells. In peri-urban dairy farms, however, wells (83%), rivers (7%), pipe water (5%), and springs (5%), is the primary sources of water for dairy calves. Frequency of watering in the study area was 57.5% twice a day, 38.7% three times a day and 3.8% of the farms provided free access (*ad libitum*) to their calve.

The sources of water in the current study differed from what was reported for the Shashemene-Dilla milk shed, where the peri-urban dairy farms used a river (46%) followed by a well (29.8%) and pipe water (24.2%) as the primary source of water, whereas the majority (71.8%) of respondents in the urban dairy farming system (Hawassa, Shashemene, Yirgalem, Dilla) rely on pipe water and well. The frequency of watering in the current study contradicted the findings of Yeshwas (2015), who found that 31.2% of respondents in the Bahir Dar milk shed gave their calves' free access to water and 68.8% gave their calves' limited access to water. The results differed significantly from those reported by Azage *et al*. (2013) for the Shashemene-Dilla milk

shed, where around 36% of households in the urban and peri-urban system water their calves once a day and 64% water twice a day.

Table 6: Feed sources and feeding system of calves in the study areas

Variable	Category	Urban (N=60)		Peri urban (N=100)		Overall (N=160)	
		N	%	N	%	N	%
Age of solid feed supply to calves	After 2 weeks	16	26.7	12	12.0	28	17.5
	After 3 weeks	24	40.0	27	27.0	51	31.9
	After a month	20	33.3	61	61.0	81	50.0
Feed sources	Crop residue	32	24.1	100	31.1	132	29.0
	Hay	53	39.8	88	27.3	141	31.0
	Concentrate	40	30.1	34	10.6	74	16.3
	Green feed	8	6.0	100	31.1	108	23.7
Season of feed shortage	Rainy season						
	Dry season	60	100.0	100	100.0	160	100.0
Feed conservation experience	Yes	60	100.0	100	100.0	160	100.0
	No	0	0	0	0	0	0

N = number of respondents

Table 7: Water sources and watering practices in the study areas

Variable	Category	Urban (N=60)		Peri urban (N=100)		Overall (N=160)	
		N	%	N	%	N	%
Source of water	River	0	0	7	7.0	7	4.4
	Well	8	13.3	83	83.0	91	56.9
	Tap water	52	86.7		5.0	52	32.5
	Spring	0	0	10	5.0	10	6.3
Frequency of watering	Once a day	0	0	0	0	0	0
	Twice a day	43	71.7	49	49.0	92	57.5
	Thrice	15	25.0	47	47.0	62	38.7
	Ad libitum	2	3.3	4	4.0	6	3.8
Water related problem	Scarcity	2	3.3	30	30.0	32	20.0
	Parasite	0	0	13	13.0	13	8.1
	Impurity	8	13.3	36	36.0	44	27.5
	No problem	50	84.0	21	21.0	71	44.4

N = number of respondents

3.8. Health management of calves

The majority (58.8%) of respondents in the research area stated that health issues did not exist on their farms. However, 41% of respondents stated that calves' health was a serious issue in dairy farms (Table 8). The majority of dairy farmers (78.1%) were unaware of their calves' blood levels, while only 21.9% were aware of their calves' blood levels. In the farms studied, public clinics (41.3%), private clinics (28.1%), and both public and private clinics (30.6%) provided veterinary services. Access to veterinary services was more difficult for peri-urban dairy farms than for urban dairy farms, where both public and private clinics were more accessible.

The health of the calves at the current farms contradicted the findings of Konjit *et al*. (2013), who discovered health concerns in calves in 66.67% of semi-intensive and 66.67% of intensive farms in Mekelle. The current study found that dairy producers' understanding of calves' blood levels differed from the findings reported in West Gojam

zone, where calves' blood levels ranged from 0 to 75% exotic blood level (Melku, 2016). The difficulty in accessing veterinary clinics in the examined farms was consistent with the findings of Tadele and Nibret (2014), who found that 13.8% of dairy farms in and around Maksegnit town experienced difficulty accessing veterinary services.

Table 8: Health management of calves in the study areas

Variable	Category	Urban (N=60)		Peri urban (N=100)		Overall (N=160)	
		N	%	N	%	N	%
Presence of health problem	Yes	8	13.3	49	49	57	36
	No	52	86.7	51	51	103	64
Knowledge of blood level of calves	Yes	12	20	19	19	31	19.4
	No	48	80	81	81	129	80.6
Use of traditional medicine	Yes	0	0	0	0	0	0
	No	60	100	100	100	160	100
Use of veterinary service	Yes	60	100.0	100	100	1600	100
	No	0	0	0	0	0	0
Source of vet service	Public clinics	28	46.7	28	28	56	35.0
	Private clinics	9	15.0	41	41	50	31.3
	Both	23	38.3	31	31	54	33.8
Problem to access vet. service	Yes	0	0	60	60	60	37.5
	No	60	100.0	40	40	100	62.5

N = number of respondents

3.9. Weaning of calves

Among the overall interviewed dairy producers 1.3% weaned their calves at 3 months of age, 8.8% at 4 months of age, 21.9 % at 5 months of age, 56.3% at 6 months of age and 11.9% more than 6 months of age (Table 9). This study differed from the findings of Dereje *et al*. (2016) in the Sebeta Awas district, where 59.9% of dairy producers weaned their calves at 3 months, 25.9% at 4 months, and 14.1% at more than 4 months. Awol *et al*. (2016) reported that the average weaning age of calves in Dessie town and its environs was 5 months, with a range of 3-9 months. According to Yeshwas (2015), the average weaning age in most urban dairy farms of the Bahir Dar milk shed was 6.8 months, whereas peri-urban dairy farms had a slightly longer weaning age (8 months). In contrast to the current study, another study found that dairy farms in Mekelle wean their calves at varying ages, with 7.4% weaning their calves at less than 3 months and 92.6% weaning after 3 months (Konjit *et al*., 2013).

The result showed that the majority (75.6%) of respondents weaned their calves on their own, while the remaining 24.4% had their calves weaned by the cow. The majority (63.2%) of respondents weaned their calves when the cows became pregnant in order to maintain the foetus and the cow, 17.3% used the milk for sale or processing, and the remaining 19.5% weaned the calves in order to manage the cow for the next breeding.

Table 9: Weaning practice of calves in the study areas

Variable	Category	Urban (N=60)		Peri urban (N=100)		Overall (N=160)	
		N	%	N	%	N	%
Weaning age	Three months	0	0	2	3.3	2	1.2
	Four months	3	5.0	7	11.7	10	1.2
	Five months	15	25.0	15	25.0	30	18.8
	Six months	36	60.0	55	91.7	91	56.9
	>Six months	6	10.0	21	35.0	27	16.9
Who weans the calf	Cow	14	23.3	45	45.0	59	36.9
	Owner	45	75.0	55	55.0	100	62.5
	calf refusal	1	1.7	0	0	1	0.6
Reason for weaning by owner	For milk consumption	7	15.6	12	21.8	19	19
	To maintain pregnancy	13	28.9	33	60.0	46	46
	For the next breeding	25	55.6	10	18.2	35	35

N = number of respondents

3.10. Constraints of calf rearing system

The major constraints of calf rearing in the study area were feed shortage (86.3%), feed cost (42.5%), disease and parasites (25%), shortage of water (24.4%), and lack of access to veterinary service (22.5%) (Table 10). Most dairy cattle owners (100%) identified feed shortage as the most significant constraint in urban dairy farms, followed by feed expense (42%), disease and parasites (12%), and water deficit (4%). In the peri-urban areas, the most significant constraint was again identified as a lack of access to veterinary services (78%), followed by a lack of water (35%), disease and parasites (28%), and feed expense (26%).

Table 10: Constraints of calf rearing system in the study areas

Constraints	Urban (N=60)		Peri urban (N=100)		Overall (N=160)		
	N	%	N	%	N	%	Rank
Feed shortage	60	100.0	78	78	138	86.3	1
Feed cost	42	70.0	26	26	68	42.5	2
Disease and parasites	12	20.0	28	28	40	25.0	3
Lack of access to vet service	0	0	36	36	36	22.5	5
Shortage of water	4	6.7	35	35	39	24.4	4

N = number of respondents

3.11. Calf morbidity and mortality during the monitoring period

According to the monitoring study, 36.67% of farms were found to have health problems in calves, which was similar to the survey result (41%). The monitoring research found that the incidence of morbidity and mortality was 19.4% and 0%, respectively. The lack of mortality in this study could be attributed to the small herd size of the smallholder dairy farms, which allows farmers to easily monitor calves, the increased attention and managed care given to crossbred calves due to their economic importance, and farmers also take measures to avoid calf health problems. The findings of Debele *et al*. (2021) demonstrated a significant frequency of calf morbidity (50.12% cumulative incidence) on dairy farms in Hawassa, Southern Ethiopia. Other researchers' findings revealed an overall cumulative incidence of 34.1% calf morbidity in North Shewa, Amhara region, Ethiopia (Rahma *et al*., 2020). Rahmeto *et al*. (2023) also found a high rate of calf

morbidity (40.29%) on urban and peri-urban dairy farms in southern Ethiopia.

External parasitism was the leading cause of calf morbidity during the follow-up period, with an incidence rate of 6.1%, followed by calf diarrhea (5%), calf pneumonia (1.7%), navel ill (1.7%), lumpy skin disease (0.6%), alopecia (0.6%), and dermastophilosis (0.6%) (Table 11). Among the risk factors examined for study, the production system, disease type, calf sex, and month (season) were found to be substantially associated with calf health problems ($P<0.05$). During the follow-up period, there was a significant difference ($P<0.05$) in disease incidence between disease types. Female crossbred calves (11.7%) had a substantially higher incidence rate ($P<0.05$) than male crossbred calves (5.6%).

The monitoring study showed that disease incidence was higher in the dry season (5.6%) than in the wet season (1.7%). The current study's morbidity and mortality rates differed with the findings of Yeshwas (2015), who found morbidity and mortality rates of 47.3% and 17.9% in the Bahir Dar milk shed, respectively. In contrast to the current study, a survey on Sodo town and its suburbs revealed 66.7% morbidity and 20% death (Asefa and Ashenafi, 2016). The current study also contradicted the findings of Yeshwas *et al*. (2014) in the Gozamin and Bahir Dar Zuria districts, where pre-weaning morbidity and death were 58.4% and 30.7%, respectively.

The causes of disease in the study region differed from those found by Yeshwas (2015) at the Bahir Dar milk shed, where calf diarrhea was the primary cause of calf morbidity with a 25.2% incidence rate, followed by pneumonia (8.6%), septicemia disorders (5.8%), and naval ill (5.8%). Similarly, the current study contradicted with the findings of Awol *et al*. (2016) in Dessie town and its environs, where calf diarrhea (44%) was the leading cause of calf loss, followed by pneumonia (28%). In contrast to the current study, Yeshwas *et al*. (2022) reported that the most common calf health problems on dairy farms in Northwestern Ethiopia are diarrhea and pneumonia.

The disease risk factors identified in the studied dairy farms differed from the study reported by Konjit *et al*. (2013) in Mekelle where farming system, age at first colostrum feeding, ventilation, and calf treatment were significantly associated with calve health problems. Yeshwas *et al*. (2022) reported that calf age, vigor status at birth, calf breed, colostrum ingestion, and herd size are predictors of calf morbidity on Northwestern Ethiopian dairy farms. Poor ventilation, poor barn cleanliness and bedding management, humidity, dampness, overcrowding, and a lack of regular cleaning and disinfection all contribute to a high number of aerosolized organisms, noxious gases, and other contaminants in calf houses, leading to high calf morbidity (Wudu *et al*. 2008). The significant difference in incidence among identified disease types in the current study was in agreement with Awol *et al*. (2016) in Dessie town and its environs and Konjit *et al*. (2013) in Mekelle. Other scholars' findings have also supported the current findings (Rahma *et al.*, 2020; Tsegaw *et al*., 2020; Debele *et al*., 2021; Rahmeto *et al*., 2023).

The current study found a difference in sickness incidence between female and male calves, which was consistent with a report by Asefa and Ashenafi (2016) in Sodo town and its outskirts, where more female calves were sick than male calves. In contrast to this study, Konjit *et al*. (2013) in Mekelle revealed that male calves (77.77%) had more health problems than female calves (47.42%). In the current study, more female calves were sick because there were more female calves among the studied animals (58 %) than male calve. Another explanation for this finding was that the majority of female calf owners (70%) did not use a separate calf house, 60% disposed of manure every two days, and 62% practiced unsanitary bucket feeding of milk. Similarly, the difference in disease occurrence between dry and wet seasons in the current study was consistent with the findings of Yeshwas *et al*. (2014) in the Gozamin and Bahir Dar Zuria districts, where season was one of the risk factors found to have a significant effect on ($P < 0.05$) calf morbidity and mortality.

Table 11: The binary logistic regression of incidence rate of disease and parasite in the study areas

Risk variables	No of calves	Incidence No (%)	P-value
Production system			0.011
Peri-urban	34	15(9.4)	
Urban	21	16(10.0)	
Disease type			0.001
Calf diarrhea		9(5.0)	
Calf pneumonia		3(1.7)	
External parasite		12(6.1)	
Navel ill (Omphalitis)		3(1.7)	
Lumpy skin disease(LSD)		1(0.6)	
Alopecia		1(0.6)	
Dermatophilosis		1(0.6)	
Sex			0.001
Female	32	19(11.7)	
Male	23	9(5.6)	
Month			0.040
February		9(5.6)	
March		9(5.6)	
April		4(2.2)	
May		5(2.8)	
June		3(1.7)	
July		3(1.7)	

4. Conclusion and Recommendation

The current findings revealed that the majority of dairy farmers in both urban and peri-urban dairy production systems understand the importance of colostrum feeding and provide it to newborn calves on time. However, crossbred calf morbidity rates exceeded the economically tolerable level, and the production system, disease type, calf sex, and season are important determinants of crossbred calf morbidity. External parasitism was the most common cause of calf morbidity, followed by calf diarrhea, internal parasitism, and calf pneumonia. The main constraints in raising crossbred calves were lack of feed and high cost, disease and parasites, water shortage, and lack of access to veterinary services. Therefore, to prevent pre-weaning crossbred calf morbidity, improved calf management practices such as colostrum and other ration feeding, adequate housing, house hygiene, and proper waste disposal are strongly advised.

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Declaration of interest's statement
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