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Cross-Breed Neonatal Calf Mortality and Health Problems in Small Scale Dairy Production in and around Bishoftu Town, Oromia

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Abstract

Calf mortality is perennial problems for dairy producers worldwide which impair appropriate heifer replacement. The common diseases which cause death in young calves were diarrhea and pneumonia, even though other diseases like novel ill, arthritis, bloat, septicemia, arthropod parasites, and nutritional diseases were also incriminated. A Longitudinal prospective observational study was conducted between November 2016 to April 2017 in urban and peri-urban small holder dairy farms of Bishoftu town on 158 live born calves selected from 60 dairy farms to identify the risk factors associated with calf mortality in cross-breed small holders in an intensive and semi-intensive dairy production systems. Questionnaire tool was used to collect information on the risk factors of calf mortality. Calf diarrhea was the leading cause of calf mortality with case-specific mortality of 3.1% among the causes of death recorded. The total cumulative incidence of mortality found in this study was 8.2 %. The association of 8 potential risk factors with dairy calf mortality was investigated. Of these factors, among others, delivery condition (OR=5.9, P=0.018), amount of colostrum (2L) (OR =0.17, P = 0.039), Age of calf (OR=6.5, P=0.046), and farm size≥8 (OR = 12.9, P = 0.007), were the risk factors found to be significantly associated with the death of calves. The present study suggested that the existence of high mortality in small dairy farms might be due to poor farm and calf management. Hence, special emphasis should be given to the amount of colostrum feeding; proper management as the farm size increases and especial care management of the first week age of calves were found important. Moreover, further investigation is suggested to identify the specific causative agents incriminating for calf mortality in dairy farms.

Keywords: Calves; Mortality; Risk factors; Small holder dairy farms

Introduction

In many developing countries, raising livestock is one of the main ways to raise people's standards of life. Livestock is essential to the national economy and the livelihood of rural inhabitants in sub-Saharan African nations ILCA. However, this sector is growing relatively slowly in sub-Saharan African nations. In particular, the tropics are not an ideal region for calf rearing due to the high temperature and humidity which introduce many potential disease problems to milk-fed calves Moran which impair appropriate heifer replacement. Calf morbidity and mortality are ongoing issues for dairy producers worldwide Heinrichs and Radostits. By enabling dairy farmers to undertake selective culling of underproductive heifers, heifer replacement significantly influences dairy farmers' capacity to raise productivity Moran. Although other illnesses such as navel illness Kasari arthritis, bloat, septicemia, arthropod parasites, and nutritional diseases are also reported, the two primary diseases are diarrhea and pneumonia Virtala, which are the most prevalent in young calves and pre-weaned calves, respectively. Development of the dairy farms in Ethiopia can have a substantial impact on the reduction of poverty and improvement of nutrition in the nation due to the significant potential for smallholder income and employment production from high-value dairy products. However, the percentage of calf crop survival determines the success of any breeding program as well as the future of smallholder dairy farms, therefore calf mortality and morbidity are of major concern Heinrichs and Radostits. Because most deaths occur within the first two weeks of life, the neonatal period (0-28 days) is crucial Wells. Calves frequently endure episodes of diarrhea during the first few weeks of life, when they are routinely fed whole milk or milk substitutes. These episodes are frequently brought on by infectious agents such Rotavirus, Escherichia coli, Cryptosporidium parvum, or Salmonella spp Amb. Cattle ranchers around the world suffer significant financial losses as a result of calf loss. Not only are there financial losses connected with death, but there are also losses of genetic material, intervention costs, performance losses, and reduced output later in life Wells. Mortality-causing calf diseases are the result of complicated interactions between the calf, its environment, its management practices, and its microbial pathogens. To reduce the extreme calf disease problems, it is strongly advised that appropriate calf management practices be implemented. Although there have been some studies on the issue of calf illness and mortality in the study region, they have tended to concentrate on large and research-oriented dairy farms. Since the number of small-scale dairy farms is rapidly expanding and calf mortality is a widespread issue, the current study's primary focus was on these farms. Its objectives were to:

- To evaluate neonatal calf mortality rate in small-scale dairy farms in urban and peri-urban areas of Bishoftu town and
- To assess potential management risk factors associated with calf mortality.

Materials and Methods

Study area

The study was conducted at Bishoftu Town. Bishoftu Town is

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located 45 km South East of Addis Ababa, capital of Ethiopia. It lays 9^0N latitude and 40^0E longitude at an altitude of 1850m above sea level. The rainfall is bimodal. It receives an annual rainfall of 1151.6mm of which 84% is received during the long rainy season covering June to September and the remaining in the short rainy season extending from March to May. The dry season extends from October to February. The mean maximum and minimum temperature of the area is 36^0C and 14^0C respectively, and mean relative humidity is 61.3% NMSA.

Study population

The sampling units for the study were crossbreed dairy calves of up to six months of age. All calves from small holder dairy farms managed under [1-4] intensive and semi- intensive system in urban and peri-urban constituted the study population. There were 150 smallholder dairy farms with a herd size of eleven cows in average which registered in the urban agricultural development office of Bishoftu town.

Study design

The study was a longitudinal prospective observational study that extended for six months from November, 2016 to April 2017. The sampling units (calves) were identified individually and observed throughout the study period in a two week interval.

Sampling procedure and sample size

First, dairy cattle were sampled by cluster sampling technique from all dairy farms of the town. A sampling frame, i.e., the list of dairy farms, was acquired from the urban agricultural development office of Bishoftu town at the beginning of the study. Dairy farms were selected from the list using a random sampling procedure to ensure the selection of proportional and representative sampling of dairy farms from both urban and per-urban sectors. Accordingly, 60 small holder dairy farms were visited on a cluster basis. In these selected farms, all calves less than two months and pregnant cow >seven months were included in the observation. Initially, the sample size using a simple random sampling method was determined at 11.6% expected calf mortality rate for Bishoftu Gebremedhin, for large dairy farms, 95% confidence level and 5% required absolute precision by using a mathematical formula. The adjustment for cluster sampling using cluster size and intra-cluster correlation was made as follows.

$$N = n[1 + ((m - 1) * p)]$$

Where,

N=sample size for cluster sampling

n= sample size calculated for simple random sampling

m=average cluster size

p= intra cluster correlation

However, in this particular case, as the average herd (cluster) sizes (calves per small-scale dairy farm) were small, the effect of intra-cluster correlation would be small and "N" will be very close to "n". So the sample size determined by simple random sampling was taken to be the sample size for the study .

$$n = \frac{(Z\alpha/2)^2(p(1-p))^2}{\Delta^2}$$

n=sample size

Zα/2= confidence level

P=expected prevalence

Δ=precision level

Accordingly, data on 158 calves of new born and born before two months before the start of the study were included. When a selected farm did not have a calf or calves (having calves under two months of age, a pregnant caw > seven month, or the owner is not interested eligible for the study and it was replaced by another farm.

Method of data collection

Observation of dairy farms for calf mortality was carried out for four months. For this study, calf was defined as young cattle less than six months of age and mortality was defined as death of calves above the age of 24 hours. For the observation, all calves in the selected farms that were under two months of age at the beginning of the follow-up period and those born in the subsequent months of follow-up were included. This way, each calf was observed for four months unless censured due to death. Individual records were prepared when a calf joined the study cohort. These were used to record genealogy of the calf, events surrounding the birth of the calf, routine management practices applied to the calf, and health problem incidents that happened during the observation. In the actual observation work, calves were regularly visited every two weeks. During this period, observations and in-depth interviews with farm owners or workers were made on different aspects associated with calf health problems and potential animal and management risk factors including: calf barn, sex and age of the calf, time of colostrum provision, milk supplementation after separation, naval disinfection, veterinary service, the amount of colostrum provision, age of separation from the dam, occurrence of calf mortalities and the general herd management aspect of the farm

Data management and analysis

Describing mortality problems

As animals in this longitudinal study were recruited at different times and were followed for different periods of time, and thus incident density (true rate) was used in describing death occurrence. Incident density was calculated by dividing the number of deaths by the number of calf weeks at risk. Number of calf weeks at risk was found by adding the number of weeks at risk [4-8] of obtaining a new death in each calf in the study period.

Statistical analysis

Questionnaire data were recorded on Microsoft Excel sheets and analyzed using SPSS version 20. Descriptive statistics was employed to determine calf mortality rate. First, the association of individual risk factors with a death variable was screened by univariable logistic regression. Those variables with p-value of less than 0.25 were selected forward for multivariable logistic regression. For all factors, a P-value of less than 0.05 was set to be the indication of association with death of calves.

Results

Incident rate

Observation of 158 dairy calves for mortality cases was conducted for 6 months. The results of this study revealed that the cumulative mortality proportion in the first 6 months of calf hood was 8.2%. Among the causes of calf death recorded in this study, calf diarrhea was the leading cause of calf mortality with cause- specific mortality proportion of 3.2%, followed by septicemia (1.3%), pneumonia (1.3%) and nonspecific causes (1.3%). The mortality proportion of other causes

of death (bloat and accident) recorded in this study was equivalent to cause-specific mortality proportion of (0.63%). The calf death rate or incident rate was 0.0055/calf week. The average for the occurrence of mortality incidents was 10 weeks. Proportionally, the highest mortality incidents occurred in the first week of life, in which 61.5% of the total cases of mortality occurred. Again, 76.9 per cent of the total cases of crude mortality occurred in the first month of age and 100 per cent of the total cases of crude mortality occurred in the first three months of age.

Association of potential risk variables with incidence of calf mortality

A total of eleven different potential risk factors (sex, age, navel disinfection, time of colostrum ingestion, milk supplementation after separation from the dam, delivery condition, and amount of colostrum ingestion, age of separation from the dam, calf barn, and farm size and management system of the farm) were investigated for their potential association with the occurrence of crude calf mortality. Among the risk factors assessed, age of the calf (OR=6.5, P= 0.046), delivery condition (OR=5.9, P=0.018), the amount of colostrum ingestion (OR=0.17, P = 0.039) and farm size (OR = 12.9, P = 0.007) were found to be significantly associated with the death of calves while the other risk factors; separation of calf house from the farm and sex were not found to be significantly associated to the death of calves (Tables 1 and 2).

Description of household and livelihood characteristics of the farmers based on questionnaires and observation

The majority of the farm owners were male (61.7%) and the rest (38.3%) were female. 48.7% of the age of the owners was between 31-50 years while 26.6%, 16.7%, and 8.3% were above 51years, 25-30 years, and less than 25 years respectively. As far as household literacy is concerned; (16.7%), of the farm owners were illiterate 30% attended primary school 33.3% completed secondary school and diploma, and 20% were college graduates. The average herd size per household of the dairy cattle in the study area was 11 and ranged from 5 to 17 heads of cattle. The average number of cross-breed calves per household was 2. About 61.7% of the owners had farm experience more than ten years, while the rest 28.3% and 10% had 5-10 years and less than 5 years, respectively. About 86.7% of the farm owners have no calving pen. All owners use artificial insemination (AI) for breeding and 81.7% of the owners use dairy farms as a secondary source of income, where as 18.3% of the owners mainly depend on the farm for livelihood. As the owner replied that hypocalcaemia (36.7%), mastitis disease (33.3%), bloat (15%), pasteurellosis (10%), and others (5%) were the common diseases affecting dairy farms. Majority of the farmers (88%) had knowledge of the advantage of colostrum over ordinary milk and all of them did know the optimum time to feed colostrum to calves and provide milk supplementation after separation from the dam but the majority of them did not know the amount of colostrum needed for the new born calf within 24 hours. None of them practice naval disinfection and all of them call private veterinary practitioners whenever facing the health problems of animals. From farmers that mentioned calf health problems as a problem in dairy production, the majority of them (50%) complained diarrhea as a major cause of calf morbidity and mortality. Majority of the owners sold male calves at young age while they kept female calves for production purposes. The housing systems of the major dairy owners were loose and no separation between calf and cattle houses. Most of the owners employ a person who keep their cattle and care for their calves.

Table 1: Causes of mortality in dairy calves (N = 158) and crude mortality.

Health problems/syndromes	Mortality cases	Crude mortality (%)
Diarrhea	5	3.1
Pneumonia	2	1.3
Septicemia	2	1.3
Bloat	1	0.6
Nonspecific causes	2	1.3
Accident	1	0.6
Death rate	13	0.0055calf-weeks
Total (NO=158)	13	8.2

Discussion

In the present observation, the overall mortality percentage of live born calves up to four months of age on small holder dairy farms is found to be 8.2% which is considered as high. Different authors reported a wider range of calf mortality rates in Ethiopia. Reported calf mortality varies widely depending on many factors, some of which may be specific to the particular population being studied. The finding of the present study is in agreement with 9.3% and 10.2% mortality proportions reported by (Bekele. In contrast, the present finding was lower than the previous mortality reports in different parts of the country; 18.0% in Debrezei, 16-22% (up to 6 months age) in Wolaita Sodo Assefa, and 30.7% in Bahir Dar and Gozamen districts of Amhara Region. The relatively less mortality rate in this study compared with the findings of W in Debrezeit is probably due to the current better access to veterinary services in towns and their suburbs. In addition, the time elapsed for this investigation was lower than the previous one. In the present study, the major causes of calf mortality identified

Table 2: Multivariable logistic regression model output for potential risk factors of calf mortality.

Risk factors	Group	Live births(n)	Death	Mortality rate %	OR	95.0%CI	P-value
Sex	Male	55	6	10.91	0.58	0.093-3.572	0.553
	Female	103	7	6.8	Ref*		
Age	≤1week	41	8	19.5	6.5	1.032-41.09	0.046*
	>1week	117	5	4.3	Ref*		
Delivery condition	Assisted	29	8	27.59	5.9	1.359-25.3	0.018*
	Normal	129	5	3.88	Ref*		
Amount of colostrum ingestion	Measured(2L)	101	3	2.97	0.17	0.03-0.915	0.039*
	Unmeasured	57	10	17.54	Ref*		
Calf barn	Separated	87	3	3.45	0.69	0.126-3.748	0.665
	Un separated	71	10	14.08	Ref*		
Farm size	≥8	81	11	13.6	12.9	2.02-81.3	0.007*
	<8	77	2	2.6	Ref*		

OR=Odd Ratio, CI=Confidence Interval, Ref*=Reference, *=Significant.

were diarrhea, pneumonia, septicemia, bloat, accident, and nonspecific causes. However, calf diarrhea was found to be the dominant Figure 1 cause of calf mortality with cause - specific mortality percentage of 3.1%. This finding is in agreement with the reports of (Lemma and in Ethiopia, and many other studies elsewhere, which reported diarrhea as the first most important health problems causing calf death (Olsson. Calf diarrhea as a leading health problem in growing dairy calves is a common finding. The high incidence of mortality in this study suggests the significant improvement of farm management and failure of adequate immunoglobulin due to the majority of the farm owners having the wrong perception that feeding a large amount of colostrum causes diarrhea in calves. The lower mortality rate recorded for pneumonia in this study is with the studies conducted by Rao and Nagarecenkar (1980), (Agerholm, and (Gitau which found pneumonia as the leading cause of calf mortality. The lower mortality incidence rate recorded for pneumonia in this study could be due to most of the owners using loose housing systems which provides good ventilation. This is supported by Blowey who indicated that low calf mortality due to pneumonia has occurred in calves kept in good ventilated houses. High proportion of mortality due to unknown cause which is characterized by sudden death needs a well-designed study. This investigation showed that mortality was higher during the first week of birth (OR=6.5; P≤0.046) and decreased with increasing age. Age was found to be the most important calf factor affecting their mortality. Among dead calves, 61.5% of deaths occurred in the age of less than 1 week. In this study, younger calves under the first months of age were at higher risk of mortality. Similar age pattern of mortality has been reported by previous studies (Wudu and Bekele. The higher risk of mortality in young calves observed in this study suggests the need of more careful management for very young calves. Other risk factors were assessed to determine the magnitude of their association with the occurrence of dairy calf mortality delivery condition. Mortality in calves delivered by assisting was higher compared to calves delivered normally (OR=5.9, p=0.018). The odds ratio (5.9), we estimated that the odds of death for cross-bred calves born assisted were around 6 times higher than calves delivered normally. When calves are suffering from pain after calving assistance, they become weak to stand and suckle. Murray. found that calves born following dystocia were more acidotic and took longer to attain sternal recumbence and stand, compared to calves born normally and Uigley noted that new born calves stressed due to dystocia are weak enough to adapt to life in the external environment. This stress to the calves probably reduced the immunoglobulin absorption efficiency as well as delayed or decreased intake of colostrum. Hence, the longer the calves are without adequate colostrum Ig, the more opportunity for the pathogens that provoke diarrhea to invade the gut. The logistic regression analysis of mortality in dairy calves with respect to the amount of colostrum ingestion revealed that the highest mortality rate was observed in calves which took inadequate and unmeasured colostrum (OR=0.17; p=0.039). Hence, this study agrees with the theory which says that absorption of enough quantity and quality of colostrum is a critical determinant for the health and survival of neonatal calves. Calves which did not receive adequate colostrum are shown to have a higher overall death rates. To ensure adequate protection against disease, calves rely on the intake of an adequate amount of quality colostrum within a few hours of birth (Arthington. In this study, significantly (OR=12.9, P=0.007) high mortality of dairy calves occurred in farms where greater than eight animals were kept. This finding is supported by Fra, Schouten, and Bekele. Herd size has been positively associated with an increased incidence of calf diarrhea, which is one of the leading causes of mortality. This may be due to overstocking or this difference might be owners who kept less than eight animals have given sufficient time for nursing the sick calves which might be the reason of lower mortality. Against to the present finding, other studies conducted in Waliata Sodo town on dairy calf morbidity and mortality Assefa revealed that calf mortalities were high in dairy farms when less than ten animals kept.

Conclusion and Recommendations

The present study has estimated that the calf mortality proportion of 8.2% is higher than the economically tolerable level in dairy cattle. Mortality was higher at the lower age of calves, in the first months of life. It has also found that age of calves, unmeasured amount of colostrum, feeding and delivery condition, and farm size were important risk factors associated with calf mortality. This is a great hindrance to improve smallholder dairy production and productivity in the study area. The leading disease condition associated with mortality was found to be diarrhea. Known fact that the observed farms raise their own replacement stock and have small herd size, it is recommended that special emphasis should be given naval disinfection of newborn calves, having confinement pens and paddocks used as parturition areas, the amount of colostrum feeding, implementation of proper management as the farm size increases and especial care management of first week age of calves were found important to minimize calf mortality. Moreover,

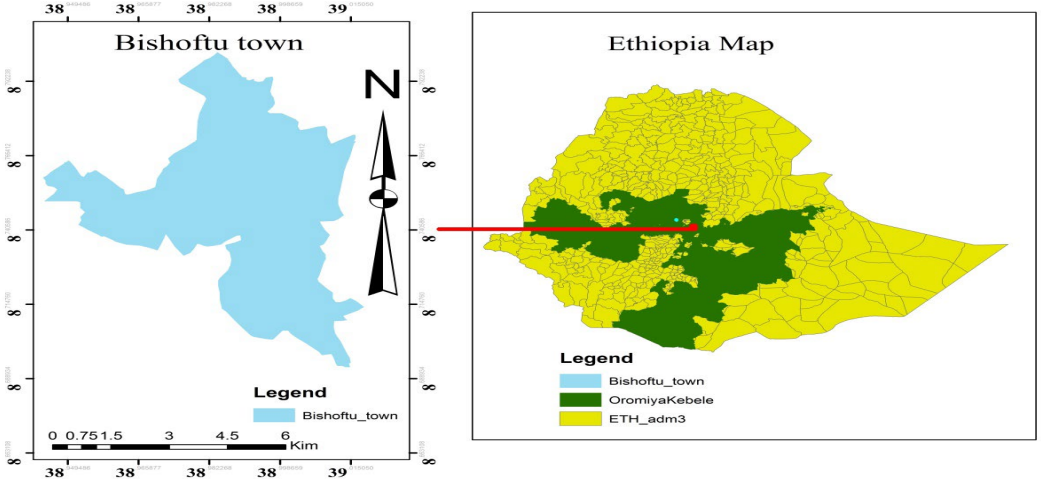

Figure 1: The map of Ethiopia and location of the study site, Bishoftu town, in East Shoa.

further investigation is suggested to identify the specific causative agents incriminating for calf mortality in dairy farms of the study area.

Declaration

Ethical considerations: Since the research was undertaken by collecting data using questionnaires it did not abuse animal welfare protocols. All procedure of data collection was carried out in accordance with relevant guidelines. This research studies comply with international guidelines.

Limitations of the study

This research was mainly focused on evaluating neonatal calf mortality rate and assessing potential management risk factors associated with calf mortality in small-scale dairy farms. Therefore, this research could not address the isolation, identification, and molecular characterization of major causative agents of calf mortality and it will not reveal information about the antimicrobial resistance pattern of the causative agents within the study area, which is supposed to aid the effective prescription of antimicrobial drugs to reduce the problems of drug resistance developments. Since the study was conducted on the small scale dairy farms, the finding of this research will not be extrapolated to the entire population of the study area.

Availability of data and materials

Since we want to work with the scientific and research community, the data underlying the findings of a paper should be publicly available wherever possible and as open as possible. We therefore firmly support and endorse the Findability, Reusability, and Accessibility of this article. So, we prefer to deposit the data in a public repository that meets appropriate standards of archiving, citation, and curation.

Competing Interests

We declare that the authors have no competing interests or other interests that might be perceived to influence the results and/or discussion reported in this paper.

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We write this to inform you that, we are from a lower-income economy country and we haven't any supporting body (Funding Institution) that makes the payment for the Article processing charge (APC). Hence, I would like to ask for the cancellation of APC and publishing this article without any fee

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