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Cross-Breed Calf Mortality and Farm Management Practices of Smallholder Dairy Farms

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Abstract
A cross-sectional study was conducted from November 2015 to April 2016 with the objective of determining the annual calf mortality, investigating its major causes and assessing the effect of potential host and management related risk factors on the occurrence of cross-breed calf mortality. Purposive sampling method was used to select smallholder dairy farms of Dessie town and its environs. Retrospective data of one year (November 2014-November 2015) was obtained using structured questionnaire format. Total of 227 respondents engaged in smallholder cross-breed dairying were personally interviewed about their calf management practices and major calf health problems encountered. About 307 cross-breed calves were considered for this study. Majority of the respondents were educated and use dairy farm as secondary source of income The mean annual calf mortality was 10.2% (95% CI: 6.6, 14.2). Live born to weaning mortality accounted 8.1% (95% CI: 5.1, 11.2) and stillbirth 2.2%. Age specific mortality revealed high mortality at the first 3 months of age. The causes of calf mortality recorded during the study period were diarrhea (44%), pneumonia (28%), septicemia (4%), umbilical abscess (4%), bloat (8%) and unknown cause (12%). Among the risk factors delivery condition (OR=8.23, p=0.001) and method of colostrums feeding (OR=4.33, P=0.002) were found to be associated significantly. Majority of respondents (92.1%) responded that they allow free calf colostrums feeding of their new-born calves and 78% farm owner practice colostrums feeding of their calves before 3 hours. None of the farmers practiced navel treatment during birth of calves. In conclusion mean annual cross-breed calf mortality rate recorded was high, above tolerable range. The major causes appeared to be calf diarrhea followed by pneumonia. Improved calf management practices should be implemented to reduce cross-breed calf mortality to the optimum level.
Keywords: Calf mortality, diarrhea, pneumonia, smallholder dairy farm

1. INTRODUCTION

About 12 to 14% of the world population is estimated to live on dairy farms or within dairy farming households (FAO 2010). The increasing human population coupled with increasing demand for food security is a serious challenge for developing countries like Ethiopia. Over 85% of the Ethiopian population depends on subsistence agriculture (mainly crop and livestock production) for their livelihood. Thus, agriculture is the foundation of the country's economy and the major contributing sector to food security. Agriculture in the form of smallholder dairy production can aid the achievement of Millennium Development Goal 1 which seeks to eradicate extreme hunger and poverty through regular income, channelling dairy profits towards education and empowerment of women who are marginalised in the rural areas (UNDP, 2012). Smallholder dairy production is common in many parts of the developing countries, including Ethiopia, serving as an important nutritional source and income to millions of households (World Bank, 2011). Given the considerable potential for smallholder income and employment generation from high-value dairy products (Staal 2001), development of the dairy sector in Ethiopia can contribute significantly to poverty alleviation and nutrition in the country.

The success of any breeding program as well as the future of the smallholder dairy farms depends upon the rate of survival of calf crop produced and accordingly calf morbidity and mortality are of great concern of dairyman, because most of the dairy farms are confronted with acute problems of calf morbidity & mortality (Wudu *et al.*, 2008; Gitau *et al.*, 2010). Smallholder dairy farmers experience high calf mortalities which can go up to 50% (Moran, 2011). Shortage of dairy replacement heifers is one of the major hindrances to the development of smallholder dairy production in developing countries (Bebe, 2008).

Mortality rate in dairy calves varied from a low of approximately 2% to high of 20% with mortality on individual farm varying from 0- 60% (Radostits *et al*., 2007). African countries report a wide range of calf mortality between 3% and 47% during the first year of life, the majority of deaths occurring in the first 3 month of life (Zur, *et al*., 2005).

A few studies conducted on calf mortality 0-1 years in Ethiopia show mortality that range from3.6 to 30.7% (Wudu *et al.,* 2008; Ferede *et al*., 2014). The calf mortality represents an irrefutable and irrevocable financial source of economic loss to the dairyman due to loss of the present value of the calf and loss of genetic potential for herd improvement (Hossain *et al.*, 1992;

Debnath *et al.*, 1990, 1995; Samad *et al.*, 2002). Thus identification of the factors which can alter a calf's risk of death is an important prerequisite for avoiding excessive calf mortality (Debnath *et al*., 1995). Calf diseases that cause mortality are the results of complex interaction of the management practices, environment, infectious agents and the calf itself. Implementation of improved calf management practices is greatly suggested

to reduce the high level of calf disease problems (Wudu *et al*., 2008).
Although there were some research works carried out in certain parts of the country, on problem of calf mortality and its economical significance, information on calf morbidity and mortality is limited in study area, in and around Dessie town. Therefore, this study was targeted to fill the information gap in the area with the following specific objectives:

- ✓ To assess mortality rate of dairy calf in the study area.
- ✓ To identify cause of cross-breed calf mortality
- ✓ To identify potential management and host related risk factors associated with calf mortality.

2. LITERATURE REVIEW

2.1 Management of the Newborn Calf

The major factor which may predispose young farm animals to infection include: insufficient or no colostral immunity, overcrowding and poor hygiene which increase transmission of organism, naïve immune system in neonates and stress factors such as cold ambient temperature and frequent mixing of animals (Quinn *et al*., 2002), calf nutrition and calf vaccination status (Smith, 2009).

Management of calves is very important in approaching a problem of neonatal death losses and because of infectious agent are almost always present at some exposure level, the underlying them is to minimize the level of pathogen exposure and stress on the calf (Smith, 2009). In well managed dairy herd calf mortality usually does not exceed 5% from birth to 30 days (Radostitis *et al*., 2007).

The first weeks of life are critical to the growth and long term performance in a dairy calf (Smith, 2009). The emphasis is on insuring that the new born are born in a clean environment as well as barns, confinement pens and paddocks used as parturition areas must be clean and preferably have been left vacant for several days before the pregnant cow placed (Radostits *et al*., 2007)

2.2 Importance of Colostrum to New Born Calves

Calves are born with no immunity against disease. Until they can develop their own natural ability to resist disease through exposure to disease organism in their surroundings they depend entirely on the passive immunity acquired by drinking colostrum from their dam. Colostrum is the thick; creamy-yellow sticky milk first produced by cows initially following calving and contains the antibodies necessary to transfer immunity on to their calves. It is essentially milk reinforced with blood proteins and vitamins. It has more than twice the level of total solids than in whole milk, through boosted levels of protein and electrolytes. It also contains a chemical allowing newborn calves to use their own fat reserves to immediately provide additional energy (Moran, 2012).

Many studies demonstrated the importance of high level of serum immunoglobulin in reducing the risk of morbidity and mortality in calves (Gebremdhin, 2014; Konjit *et al*., 2013; Ferede *et al.*, 2014). There are also some studies which failed to demonstrate strong association between immunoglobulin status and morbidity and mortality (Cadlow, 1988; Sivula *et al*., 1996a cited in Wudu, 2004).

2.3 Economic Importance of Calf Mortality

Diseases of the new born calf and neonatal calf mortality are major causes of economic losses in livestock production. As Ferede *et al.* (2014) and Wudu *et al.* (2008), conclude in their study magnitude of calves morbidity and mortality were much higher than economically tolerable level and could affect the productivity of dairy farms through mainly decreasing the availability of replacement stock. Neonatal calf mortality in the first month of age is accounted to be 80-85% of the total mortality and is particularly high in the third week of life (Singh *et al*., 2009). A dairy farm management system should employ strategy that will reduce calf mortality and improve calf performance by controlling diseases (Radostits *et al*., 2007).

2.4 Major Causes of Mortality in Calves

2.4.1 Calf Diarrhea

Calf diarrhea is the commonest disease in young calves and is the greatest single cause of death
(Bekele *et al.*, 2009; Gebremedihin, 2014; Ferede *et al*., 2010). Calf diarrhea was found to be the predominant calf health problem with incidence rate of 42.9% (Wudu *et al*., 2008). Neonatal calf diarrhea remains the most common cause of morbidity and mortality in pre-weaned dairy calves Worldwide. This complex disease can be triggered by both infectious and non-infectious causes. The four most important enteropathogens leading to neonatal dairy calf diarrhea are *Escherichia coli*, rotavirus and coronavirus, and *Cryptosporidium parvum* (Meganck, 2014)

2.4.1.1 Bovine Rotavirus

Disease caused by Rotavirus is usually seen only in young animals, 1 to 8 weeks of age, but only rarely during the first week of life. Infection by Rotavirus leads to the destruction of epithelial cells of the apices of villi in small intestine. With virulent strain of Rotavirus, the loss of enterocytes exceeds the ability of the intestinal

crypts to replicate; hence, the villi height is reduced with a consequent decrease in intestinal absorptive area and intestinal digestive activity leading to diarrhea (Aiello, 1998).

2.4.1.2 Bovine coronavirus

Bovine *coronavirus* is a component of the acute diarrheal complex of neonatal calves, a very common and serious economical problem in dairy and beef operations. The disease occurs in farm and ranch calves 1 days to 3 or more weeks old (Gillespie *et al*., 1998)

2.4.1.3 Escherichia coli

All calves become colonized within a few hours of birth with many varied strains of *E. coli.* This constantly changing population of organism inhabits the calf's intestine for life and is entirely normal and healthy (Quinn *et al*., 2002). Some strains of *E. coli* have the ability to adhere to the intestinal wall and produce toxins that cause scours. An example of this *E. coli* K99, which is referred to as an enterotoxigenic *E. coli* K99 (ETEC). This strain is capable of causing disease in calves of less than one week age (Abraham *et al*., 1992).

2.4.1.4 Sallmonellosis

The organism *Salmonella Dublin* or *Salmonella typhimurium* are the main cause of salmonellosis in calves. *Salmonella typhimurium DT104* has been recognized as highly pathogenic to calves, resulting in a high incidence of mortality has a wide range of antibiotic resistance and is capable of rapidly developing new resistance patterns (Bernadette, 1999).

2.4.1.5 Cryptosporidiosis

Cryptosporidium parvum is the most common species found in calves and man, and it is transmitted readily to several new born species of mammals by the fecal oral route (Scott *et al*., 1995). Infection with *Cryptosporidium* is more commonly reported in calves less than 1 month age, and affected calves may shed large numbers of infective oocysts in the feces. While infection is generally self-limiting, fatalities associated with Cryptosporidiosis have been reported (Trotz-Williams *et al*., 2005).

2.4.2 Calf Pneumonia

Although it can affect pre-weaned calves, this is the most common of all the diseases of the Weaned calves and causes the highest loss in this age group, both in terms of mortality and reduced growth rates and accounts for about 15% of calf mortality from birth to 6 month of age (Heinrichs and Radostits, 2001). In calves pneumonia is usually caused by *Pasteurella multocida*, *Pasteurella hemolytica*, *Staphylococcus epidermis*, Streptococci, *Pseudomonas aeroginosa*, *Corynebacterium payogenes*, Mycoplasma, *Pestvirus* and *herpesvirus* (Zaman *et al*., 2006 cited in Mushtaq *et al.,* 2013).

2.4.3 Navel Ill (Omphaltis)

Localized inflammation or infection of the contents of the umbilical cord external to the body wall is referred to navel ill (omphalitis). In calves umbilical infections are very common. The umbilical cord consists of the amniotic membrane, the umbilical veins and arteries and the urachus. When amniotic membrane breaks up at birth umbilical vein and the urachus close, but they remain outside the umbilicus for some time. The drying period of umbilicus varies from 1-8 days. If after birth umbilicus is infected, it may result in omphalitis, omphalophlebitis or omphaloarthritis. The bacteria involved in these conditions are *E. coli*, *Proteus* spp., *Staph.* spp., *Bacteroides* spp, *F. necrophorum* and *Klebsiella* spp. Navel ill can lead to septicemia, arthritis, and fever, which cause the failed transfer of passive immunity. Prevention of navel ill is based on good maternity pen hygiene, reducing calf residency time in unhygienic calving pens, ensuring adequate early intake of good quality colostrum and navel antisepsis (Lorenz *et al*., 2011).

2.4.4 Other Causes of Mortality

Other diseases in calves including arthritis, bloat, parasitic gastroenteritis, and parasitic pneumonia in grazing calves; arthropod parasites and nutritional diseases (like inadequate intake of energy, protein, vitamins, and minerals) are also reported (Heinrichs and Radostits, 2001).

2.5 Epidemiology of Dairy Calf Mortality

A range 15 to 25% pre weaning calf mortality is typical on many tropical dairy farms. It is often as high as 50% indicating very poor calf management (Radostits *et al*., 2007). This contrasts with US findings of less than 8% mortality from birth to 6 months while surveys of Australian farmers report only 3% losses (Moran, 2011). One study on prevalence and incidence of calf morbidity and mortality and associated risk factor was conducted in Hawassa town. The study shows the crude mortality rate was 9.3% (Bekele *et al.,* 2009). The overall incidence of crude mortality found in Wudu *et al*. (2008) study was 18.0%.

2.5.1 Determinants of Dairy Calf Mortality

Major diseases in dairy calves have multi-factorial etiology, resulting from interactions between the calf, infectious agent, management and environmental factors.

2.5.1.1 Calf Factors

Age

Age of calf is the most important factor affecting mortality. Approximately 75% of mortality, in dairy animals

less than one year of age, occurs in the first month of their life (Heinrichs and Radostits, 2001). It was the only risk factor significantly associated with risk of mortality in all calves (weaned and un-weaned). In all cases (mortality, morbidity and calf diarrhea), younger calves under three months of age were at higher risk as compared to older calves(Wudu *et al.* 2008).

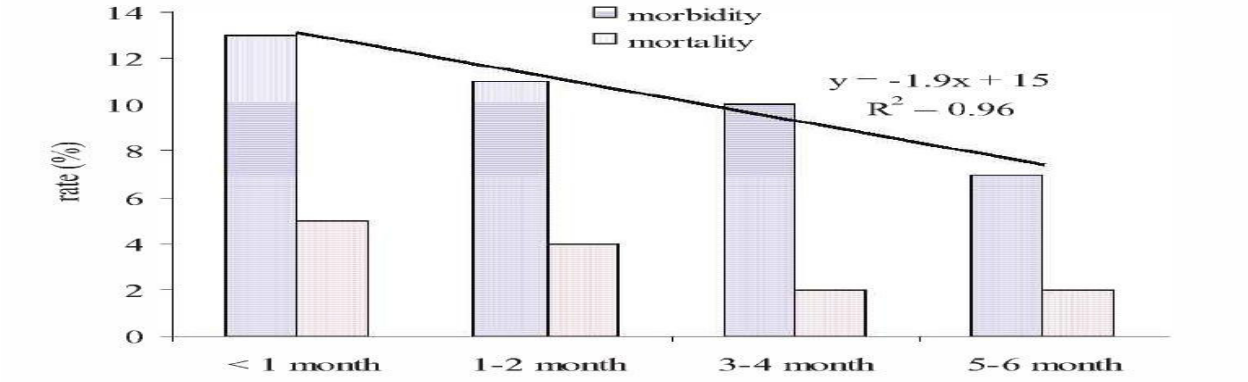

Figure 1: Strong inverse linear relationship of increasing age with morbidity and mortality Sourse**:** (Bekele *et al.,* 2009)**.**

All these and other studies showed that young age is the critical age for calves and producer need special attention for young calves.

Breed

Differences in susceptibility of calves to diseases are often observed among different breeds. Taurine breeds and their crosses are generally more susceptible to diseases in tropical climates. The occurrence of diarrhea and other calf diseases found to be higher in cross breed (Ali *et al*., 2015). The degree of mortality and morbidity rates were also found with increment trends as blood level of cross bred calves increases. The higher magnitude of mortality and morbidity was recorded from calves of above 75% exotic genetic influence than other percentages of exotic blood level influence (Ferede *et al*, 2014). In contrast to this study the breed of calf showed no significant variations in calf mortality rate (Mansour *et al*., 2014).

2.5.1.2 Environmental and managmental risk factors

Feeding Management

Ingestion and absorption of enough quality and quantity of colostrum is a critical determinant for the health and survival of neonatal calves. Leaving the newborn dairy calf with the cow is no guarantee that the calf will obtain sufficient colostrum and a high proportion fail either to suck early or to absorb sufficient immunoglobulins from ingested colostrum. This problem can be alleviated to some extent by assisted natural sucking but this can fail because not all calves requiring assistance are detected. An alternate approach is to milk 2 L of colostrum from the dam, bottle feed each calf as soon after birth as possible, then leave the calf with the cow for 24 hours and allow it to suck voluntarily. While this will not be as effective as a system based entirely on artificial feeding of selected colostrums, it is an approach that is suitable for the smaller dairy farm. The chance of calves surviving the first few weeks of life is generally reduced if they do not ingest and absorb these antibodies into their blood system. It takes far fewer disease organisms to cause disease outbreaks in such calves than if they can acquire immunity from their dam. Calves without adequate passive immunity are four times more likely to die and twice as likely to suffer disease, than those with it (Moran, 2012).

Several studies reported that calf diarrhea incidence was reduced from 36% to 11% within a year by the introduction of early colostrums feeding and improved housing hygiene (Cockram and Rowan, 1989; Lance *et al.*, 1992 cited in Ali *et al*., 2015).In his survey of calf morbidity and mortality in dairy farms in Debrezeit Wudu (2004) reported a close relationship between calf mortality and when calves drink their first colostrum. If later than 6 hour after birth, calves had higher morbidity and mortalities than if they consumed it early in life. For each hour delay in colostrum feeding in the first 12 hour of life, the chance of a calf becoming ill increase by 10% (Moran 2012).

Calf Housing

Housing has a significant effect on the health of the calves, with unclean barns predisposing calves to pneumonia (Wudu *et al* 2008). On most dairy farms, calves are taken from the maternity area soon after birth and placed in the calf-rearing barn. This is due to stressed and calving cows shed bacteria at a much higher level than their unstressed peers. Pre-weaned calves that share the housing facility with adult cows, sick cows or recently weaned calves have a much greater risk of exposure to pneumonia and fecal pathogens. Calf to calf contact increases the number of pathogens in the environment. This is rarely the most important risk factor but distancing calves or creating barriers that prevent cross suckling, licking or manure contact can reduce the rate of exposure (McGuirk, 2015).

3. MATERIALS AND METHODS

3.1. Study Area

The study was conducted in and around Dessie town, located in north-central part of Ethiopia in Amhara National Regional State, about 401 km North East of Addis Ababa. **The** town has a mountainous *topography* and located at a latitude and longitude of $11^0 8'$ N, $39^0 38'$ E with an elevation between 2,470 and 2,550 m above sea level. The area has a bimodal rainfall, with a mean value varying between 39.63 to 1000mm. The mean maximum and minimum daily temperature is 26.7ºC and 12.37ºC, respectively. The relative humidity of the area ranges between 23 to 79% (CSA, 2013).

3.2 Study Animals, Study Design and Sampling Technique

There were 9,750 dairy cattle in the study area (DARDO, 2015). Study animals were cross-breed dairy calves (Local Zebu breed × Holstein-Friesian) of up to 1 year of age in and around Dessie town. A cross-sectional study was carried out to determine the annual calf mortality rate of dairy calves and identify potential risk factor associated to mortality of calves. Smallholder dairy farm owners were selected purposively based on the availability of cross-breed dairy animals and total of 227 respondents who owned crossbred calves of up to one year age were interviewed, and 307 cross-breed calves were used for this study.

3.3. Data Collection

A structured questionnaire which has been composed of various questions focused on calf management and health concerns was filled directly by face to face interviewing of 227 heads of households. Major risk factors including season of calf birth, condition of birth, sex, age, time and method of colostrum feeding were the different variables covered during the interview. Data on history of calf deaths, illness, and type of feeds and health care were also recorded. Major syndromes of diseases of calves were recorded during the data collection process and were summarized and categorized in to five disease conditions/syndromes based on owners' traditional disease description knowledge with cross referenced to scientific disease interpretation.

3.4. Data Management and Analysis

The collected data from the study area entered in to Microsoft excel and analyzed using STATA version 11 statistical software (STATA Corporation, College Station, TX) to evaluate the association among the risk factors and calf mortality, and descriptive statistics was used to calculate calf mortality rate. A statistical significance was set at a p-value of <0.05.

4. RESULTS

4.1. Description of Household and Livelihood Characteristics of the Farmers

Majority of the respondents were educated; as indicated in Figure 2 below, 30% were elementar,
26% secondary, 18% tertiary school and 14% can read and write. The rest 12% were illiterate. The average herd size per household of the dairy cattle in the study area was 4±3 and ranging from 2 to 10 heads of cattle. The average number of cross-breed calves per household was 1. Majority (88%) of the owners use dairy farm as secondary source of income, where as 11.9% of owner mainly depend on the farm for livelihood.

4.2. Calves Management

From total of 227 smallholder dairy farms 307 calves were surveyed, 134 (43.6%) were females and 173 (56.4%) were males. Of the 307 calves, 17 (5.5%) were delivered assisted while 290 (94.5%) were delivered normal. The study indicated that only 46.3 % of the respondents know the importance of colostrum feeding. Among smallholder dairy farmers and /or attendants, 92.1% (n=209) responded that they allow free calf colostrums feeding of their new-born calves, by leaving with their dams, while 7.9% (n=18) dairy farmers practiced hand feeding for their new born calves.

In 55% of smallholder dairy farms the pregnant cows at late gestation period had an access to both roughage and concentrate food. The rest 45% farmers fed their pregnant cow the roughage available in their hand. Among the respondents, 78% (n=177) farm owner practice colostrums feeding of their calves before 3 hours and 22% (n=50) feed 3-6 hours post delivery. Majority the farmers fed whole milk for calves to two times per day. No special starter feed was used in any of the farms rather same feed given to cows were used for calves. Majority (70%) of the farmers used roughage (hay, grass) for their calves as non milk feed where as the rest 30% used both concentrate and roughage. But age to introduce non-milk feed and weaning age varied from farms to farms. The average weaning age of calves in thus farms was approximately 5 month with a range of 3-9 month. The weaning age was lower for male calves as compared to female calves. Claves were housed separately away from adult animals in (44.5%) of the farms.

None of the farmers practiced navel treatment during birth of calves. Vaccination was not commonly practiced to prevent diseases of calf. Only 27.6% of farms have vaccination for their calves. The remaining

farms used prophylactic treatment as disease prevention strategy. The measurements taken by farmers when the calves get sick include; call for veterinarian (60.4%) and take to veterinarian (39.6%).

4.3. Estimates of Calf Mortality

Between November 2015 and November 2016 a total of 307 calves were born alive and 7 stillbirths was recorded in 227 smallholder dairy farms of Dessie town and its environs. As summarized in Table 1, the overall annual mortality rate was 10.2% (95% CI: 6.6-14.2). Live born to weaning mortality accounted 8.1% (95% CI: 5.1-11.2).

Table 1: Annual calf mortality rate in smallholder dairy farms in and around Dessie town

	No. of death	Mean mortality (%)	95%CI
Overall annual mortality rate	32*	10.2	6.6-14.2
Stillbirth	7*	2.2	0.4-4.1
Live birth to wean mortality rate	25**	8.1	5.1-11.2

The mortality distribution by age (Table 2) showed 1-3 months of age indicating higher mortality of calves at early age. The rate of stillbirth during and immediately before parturition was also found to be high (2.2%). Mortality in males was higher than females (Table 2).

Table 2**:** Distribution of calf mortality by age and sex category

Age		No. of death	Mean mortality (%)
	Stillbirth	7	2.2
	0 day-1 month	0	0
	1-3 month	19	6.2
	Above 3 month	6	2.0
Sex		13	52
	Male	12	48
	Female		

4.4. Causes of Calf Mortality

Disease was the sole cause of calf mortality in the study dairy farms. Among disease conditions/ syndrome inferred as causes, calf diarrhea was the predominant cause of calf loss (44%) followed by pneumonia (28%). The other causes of death include, bloat, septicemia unknown cause and umbilical abscess (Table 3).

Table 3: Major cause of calf mortality rate

Disease condition	No. of deaths	Cause specific mortality rate (%)
Diarrhea	11	44
Pneumonia	7	28
Bloat	2	8
Septicemia	1	4
Umbilical abscess	1	4
Unknown	3	12

4.5 Association of Potential Risk Variables with Mortality

A total of five different potential host and farm management related risk factors (parity of dam, delivery condition, method of colostrum feeding, frequency of milk feeding, and sex) were investigated for their association with calf mortality. Two factors (method of colostrum feeding and delivery condition) were found significantly ($p < 0.05$) associated with calf mortality. The rest three variables (sex, parity and frequency of milk feeding) were not found to be significantly associated to the death of calves (Table 4).

Table 4: Factors potentially associated with mortality of calves in the study farms

Risk category .	Mean mortality (%)	Odd Ratio	95% CI	P-value
Parity				
Monoparous	10.5	1		
Multiparious	7.6	0. 1	0.44-3.2	0.803
Delivery condition				
Normal	6.2	1		
Assisted	41.2	8.23	2.7-25.3	0.001
Sex				
Male	8.2	1		
Female	8.1	0.64	0.28-1.4	0.278
Method of colostrum Feeding				
Suckling	7.4	1		
Hand feeding	12.2	4.33	1.7-11.1	0.002
Frequency of milk feeding				
Twice	9.6	1		
Thrice	5.5	2.33	0.88-6.2	0.085

5. DISCUSSIONS

In the present investigation, mean cross-breed calf mortality rate of 10.2% was recorded which is considered as higher rate. This finding is in agreement with 9.3% and 11.6% mortality rate reported by Gebremedhin (2014) and Bekele *et al*. (2009) but higher than the 3 to 5% calf mortality rate that can be achieved through good calf management and above the economically tolerable level (Heinrichs and Radostits, 2001) and 6.29% mortality reported by Islam *et al.* (2015). In contrast, the present finding was lower than the previous mortality reports in different parts of the country; 18.0% in Debrezeit (Wudu *et al*., 2008), 16-22% (up to 6 month age) in Wolaita Sodo (Assefa *et al.,* 2014), and 30.7% in Bahir Dar and Gozamen districts of Amhara Region (Ferede *et al*., 2014). According to Radostits *et al*. (2007) calf mortality rates up to one year of age can go as high as 50% in the tropics due to bad management, poor adaptation of exotic breeds to the prevailing tropical environment and endemic diseases. The reason for relatively low annual mean mortality rate , in this study could be herd size of the smallholder dairy farms was small and the farmers can easily monitor calves and take measures to avoid calf health problems.

Age specific mortality in this study was inversely related with age, higher in the first 3 months of age and declining gradually. This could be explained by failure of passive immunity in hand feeding practices and high susceptibility of new borne calves to many of infectious diseases causing diarrhea and pneumonia (Quinn *et al*, 2002).

Calf diseases that cause mortality are the results of complex interaction of the management practices, environment, infectious agents and the calf itself. The major surveyed calf diseases/ syndromes were diarrhea (44%), pneumonia (28%), bloat (8%) septicemia (4%), naval ill umbilical abscess (4%) and unknown cases (12%). The calf diarrhea was the leading cause of calf mortality followed by pneumonia which is in agreement with the previous reports (Lemma *et al*., 2001; Wudu, 2004; Bekele *et al*., 2009; Gebremedhin, 2014). This high occurrence of diarrhea is similar to 42.9% report of Wudu *et al.* (2008). Calf diarrhea as a leading health problem in growing dairy calves is a common finding. Works revealed that calf diarrhea is common in the first month of life. The high incidence of mortality in this study suggests the significance improving farm management and failure of adequate immunoglobulin due to majority of the farm owners (53.7%) have no awareness about importance of colostum to calves. However (92.1%) of the smallholder dairy farm owners allow calves to suckle colostrum by leaving new born calves with their dams. Leaving of calves to dam does not guarantee for the intake of the desired quantity of colostrums by calves. No effort has been done to identify causes of diarrhea and pneumonia during this study. However, previous reports indicated that viruses such as rotavirus and coronavirus; enterogenic bacteria particularly E.coli and salmonellosis, and protozoal infections such as cryptosporidium and coccidia were incriminated as causes of diarrhea and consequent mortality at early age (Aiello, 1998; Gillespie, 1998;Quinn *et al*., 2002; Wudu *et al.,* 2008; Trotz-Williams *et al*., 2005).

On the other hand, the relatively higher incidence of pneumonia in this study might be related to farm

management practices, calves in majority of the smallholder farms were housed in the same barn with their dams which increases the number of pathogens in the environment due to contact with dams , faces and other calves. High proportion of mortality due to unknown cause which is characterized by sudden death need well designed study.

Risk factors statistically associated with calf mortality were delivery condition of dam (p=0.001) and method of colostrum feeding (p=0.002). The odd ratio (4.33%) methods of colosrum feeding of crossbred in this finding indicates that crossbred calves which were given colostrum by bucket (hand feeding) were 4 times exposed to the risk of death than calves allowed to suckle from dam. This finding is against the study (Fasil, 2011), there was no a significant variation between method of colostrums feeding and the occurrence of calf mortality. Besser *et al*. (1991) found that failure to passive transfer immunity was less frequent in dairies that used artificial feeding (nipple bottle-feeding and tube feeding), than in dairies that allow cross bred calves to suckle. This is suggested to be due to either secretion of insufficient and poor quality colostrums by the dam at late pregnancy or absorption failure in suckling calves. The present work also showed that cross bred calves born assisted were around 8 times at high risk of death than calves delivered normally. When calves are suffering from pain after calving assistance, they become weak to stand and suckle. Murray *et al*. (2014a) found that calves born following dystocia were more acidotic and took longer to attain sternal recumbency and stand, compared to calves born unassisted.

Parity and sex were not significantly associated with calf mortality. This finding will support the insignificant effect of sex on calf mortality reported by Assefa *et al*. (2014). But the result disagrees with (Zelalem *et al*., 1998) who had reported sex to be significant in calves with age below 3 months.

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6. CONCLUSION AND RECOMMENDATIONS

In conclusion, the degree of annual mean mortality, 10.2%, found in this study was higher than the economically tolerable level in dairy cattle. Mortality was higher at lower age of calves, in the first 3 months of life. This is a great hindrance to improve smallholder dairy production and productivity in the study area. It has also been found that factors such as method of colostrum feeding, and delivery condition were important determinant factors of cross breed calf mortality. Diarrhea and pneumonia were the main causes of crossbred calves death revealed in this study area. Cause-specific mortality rates of these causes were higher than reports so far in other area of Ethiopia. In addition to these considerable cross breed calf mortality was found due to unknown causes.

Therefore, based on the above conclusion the following recommendations are forwarded:

- A more comprehensive study is suggested to identify the major infection causing agents involved in diarrhea, pneumonia and other septicemic conditions in farms.
- Further comprehensive research on the role and association of different epidemiological factors such as calf (host factor), environmental and etiological factors that might influence calf morbidity and mortality is also recommended.
- There should be education to create awareness about disease of calves as well as way of transmission for smallholder dairy farmers.
- Implementation of improved cross breed calf management practices such as allowing calves to take adequate and quality colostrums within 24 hours of birth, improved health care, housing and feeding through sustainable training and optimization of appropriate crossbreeding should be warranted, to reduce calf mortality to optimum level

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