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Incidence Rates of Calf Morbidity and Mortality in Dairy Farms in and Around Bahir-Dar, Ethiopia

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Abstract: A study on incidence rates of calf mortality and morbidity and different associated risk factors in dairy farms in Bahir Dar and its environs was conducted from October 15th, 2020 to April 8th, 2021 on 292 selected calves. The events on the study calves were recorded and longitudinally monitored up to an age of six months. The over all incidence of crude morbidity and crude mortality found in this study were 43.5% and 16.8% respectively. The most frequent disease syndromes were calf diarrhea with incidence of 21.9% followed by pneumonia 4.5%. The main causes of deaths were diarrhea (6.2%) and septicemia (1.4%). About 16 potential risk factors were analyzed for associations with morbidity and mortality, but only sex, age, of calves, age at first colostrums ingestion, weaning age of calf and cleanliness of calf house were significant. Male calves were more at risk of mortality to their counter female calves (X^2= 13.22, P < 0.05). Older calves were at lower risk of crude morbidity (OR = 2.64, X^2= 14.5, P < 0.05) than younger calves. Calves weaned earlier were more lost (X^2= 16.07, P < 0.05). Higher risk of crude morbidity were observed in calves that ingested their first colostrums meal latter than six hours of age as compared with those that ingested before six hours (OR = 1.88, X^2= A.74, P < 0.05). Similarly, calves housed at unclean house were at higher risk of crude morbidity than those housed in clean house (OR = 1.72, X^2 = 4.46, P < 0.05). Based on laboratory examination, *Eimeria oocytes* was detected from diarrheic calves of which out of 64 diarrheic calves examined for astrointestinal tract (GIT) parasite, 37 (57.81%) were positive for *Eimeria oocyst*. In conclusion, improving managemental practices and creations of awareness about the importance of different feeds of calf are recommended to alleviate the health problem of those diary calves with subsequent improvement of survival rates.

Key words: Bahir Dar · Calve · Eimeria · Morbidity · Mortality · Risk Factors

INTRODUCTION

Ethiopia has large livestock population in Africa with an estimated cattle population of 52 million, about 24.2 million sheep and 22.6 million goats, 4.8 million Camels and 28 thousand Pigs [1]. However, there are constraints that hindered the potential of livestock production include traditional management system, limited genetic potential, lack of appropriate disease control policy and veterinary services. Older calves above three months age are at lower risk of mortality than younger calves under three months of age. Regarding weaned calves, weaning age and age at first colostrum feeding will be additional risk factors [2]. The Ethiopian society in the coming few decades is characterized by an increased total population and accelerated urbanization. This demands a parallel increase in food production of which animal products are very important. Presently the per capita milk consumption in Ethiopia is only 20 kg per year, which is lower than the average for sub Saharan Africa [3].

FAO's recommended 200 liter per head per year which indicate the significance of the major suppliers of milk and milk products to the urban consumers [4]. The substantial demand-supply variance in milk and milk products for the major urban centers in Ethiopia is a great opportunity deficit can easily be appreciated. To fill this gap the traditional subsistence production is no more a feasible option. Currently, a number of urban and peri-urban dairy farms are for the development and flourishing of peri-urban dairy farms. Large commercial

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and market oriented smallholder urban and peri-urban dairy production systems have tremendous potential for development and could play significant role in mitigating the acute shortage of dairy products in urban centers [5]. For these systems to develop and flourish and to ensure their sustainability, the constraints with the systems need to be addressed. The major constraints for the development of peri-urban dairying and the development of livestock industry in general have been summarized as policy, socioeconomic, institutional, technical and technological [6].

Diseases are among the technical and technological constraints for the peri-urban and urban dairy production systems. The prevalence and incidence of calf diarrhea and crude Morbidity are apparently higher in large dairy farms than in the market oriented smallholder farms. However, the mortality was higher in the latter. Peri-urban and urban dairies are intensive production systems, which keep high-grade cows and have improved management practices [7]. This is usually associated with increased susceptibility to disease, poor survival rate and poor reproductive performance. Reproductive inefficiency, young mortality and some cattle diseases like mastitis, lameness, pneumonia and ketosis are the major health problems in intensive dairy production. In developed countries, an increase of 10-40% for mastitis, 10-20 % for calf mortality and 5-15% for lameness was observed to be associated with intensification of dairy production. Similarly, a three-fold increase in mastitis, calf mortality and lameness was observed from less intensive to more intensive groups in dairy production systems of different locality of Ethiopia milk shed. The future of any dairy production depends among other things, on the successful program of raising calves and heifers for replacement. Under most conditions, the average length of time a cow stays in a milking herd is about four years and, therefore, 25% of the milking herd must be replaced each year. This makes the cost of raising dairy replacement heifer substantial and only next to feed [8].

Calf morbidity and mortality are rank as next to mastitis problem for the different settings of many dairy productions in Ethiopia. Calf diseases that cause morbidity and mortality are the results of complex interaction of the management practices and environment, infectious agents and the calf itself [9]. Scours in neonatal period and pneumonia in older calves are known to be responsible for most of calf hood morbidity and mortality. Among other factors, calf diseases that cause morbidity and mortality are the major problems faced in raising replacement stock. High prevalence and incidence of calf morbidity and mortality incurs great economic loss to dairy producers. This arises from death loss, treatment cost, decreased lifetime productivity and survivorship. It also causes the loss of genetic material for herd improvement and decreases the number of dairy heifers available for herd replacement and expansion. Calf morbidity and mortality are perennial problems for dairy producers worldwide. Calf mortality shows wide variation ranging from 1 to 30 % [10].

It is an established fact that development of urban and peri-urban dairy production requires above all a sound knowledge of the magnitude, the causes and predisposing factors of diseases of intensification to institute appropriate intervention. Addis Ababa is one of the urban centers where market oriented smallholder farms are flourishing rapidly with 100% increase in number of dairy farms in the last five years. There are some studies in different parts of Ethiopia, which show high calf mortality ranging from 7 to 25%. In a study that included stillbirth and abortion, mortality rate was reported as high as 67%. These studies were mostly done on government and research centers and are less relevant to the smallholder setup, which is a predominant system in the country [6].

Therefore, the present study initiated with this background and has the objectives of describing the incidence of calf morbidity and mortality, investigating the potential management and host factors related to the risk of calf morbidity and mortality and identifying the *Eimeria oocytes* involved in causing calf diarrhea.

MATERIALS AND METHODS

Study Area: This study was carried out in dairy farms found in Bahir Dar and the surrounding areas. It is located 570 km North West of Addis Ababa and experiences a bimodal rainfall pattern with a long rainy season from June to October and a short rainy season from March to May. 1730 meter above sea level attitude 11°29' N latitude and 37°29' W longitude. The average annual rainfall and average maximum and minimum temperature for the area are 800mm and 15°C to 21°C, respectively [11].

Study Population and Sample Size: The study was longitudinal prospective observational study that extends for six months from October 15, 2020 up to April 15, 2021.

The sampling units for the study were both local and crossbred dairy calves of up to 6 months of age from two large dairy farms namely Jerusalem dairy farm and Andassa livestock research center (38 calves) and representative random samples of calves from small holders (254 calves) were identified individually in Bahir Dar and its surrounding.

The sample size for estimating disease problems using simple random sampling methods is calculated by the formula of Thrusfield [12] as follows.

$$n = \frac{Z^2 X (P\exp\ (1 - P\exp)}{d^2}$$

where,
n = sample size
Z^2 = confidence level
P = expected prevalence
d^2 = precision level, using expected calf mortality of 7.5% that were reported by Daresm [13] confidence level of 95% and required absolute precision of 5%; a sample size of number of calves will be 106 calves for small holder farms. However, to increase level of accuracy and precision of determining prevalence, sample size was increased to more than two folds (292).

Study Design and Sampling Procedure: The sampling units (calves) were identified individually and monitored throughout the study period. The questionnaire survey was conducted during the first study period to know about general conditions of calves and farms. When a calf joined the study cohort, birth history of the calf was recorded. When a selected farm did not have calf or calves eligible for the study (having calves under three months of age or pregnant cows with due calving date in the next three months), it was replaced by another farm mostly from neighboring. If it was not followed-up a full term of six months were recorded for withdrawn calves.

During each regular visit monthly, clinical examinations of calves for any abnormalities like diarrhea, pneumonia, septicemia, lameness, navel infections, dermatological and GIT disturbance, un-thrifteness and nutritional deficiency were diagnosed. About ten gram of fecal sample were collected from untreated diarrheic calves from rectum keep in plastic bottle and brought to parasitological laboratories where *Emeria* oocyte were examined by using floatation method. Where sample were not immediately examined they were stored at a refrigeration temperature about 4°C until examination. *Emeria* oocyt in face of infected calves were detected by using floatation methods. Other causes of diarrhea were not examined due to unavailability of laboratory materials.

Data Management and Analysis: More than 40 potential risk variables which include host, management and environmental factors were considered to analyze their effect on calf mortality and morbidity. But, analysis were made only using 16 of the predisposing factors and the rest of the factors either they had very small observations per category or similar responses were recorded for all calves. Biological and questionnaires data collected from study sites were entered and stored in Microsoft excel spread sheet program and coded for analysis. Statistical analysis was done on SPSS window version-11.5 statistical software.

Descriptive statistics was employed to determine calf mortality and morbidity rates. Logistic regressions were used to analyst whether predictor factor such as management practice, environmental and animal factor have association with occurrence of mortality and morbidity. The associations of parasitic infections with animal factors have been analyzed using fishe's exact test. The linear relationship between calf risk factors and mortality as well as morbidity was determined using intercooled data version 8.0. Categorical data were analyzed first with the chi square (X^2) for independence as a screening process. A P-value ? 0.05 was considered as statically significant.

RESULTS

Study on 292 dairy calves for clinical health problems was monitored longitudinally for six months to determine the incidence of calf mortality and morbidity rates. The results showed that the incidence of crude morbidity and crude mortality were 43.5% and 16.8 % respectively. Among the syndromes the principal causes for both morbidity and death was diarrhea directly accounting for the 64 cases of 127 morbid and of which 18 cases of the total 49 deaths with incidence morbidity rate of 21.9% followed by pneumonia (4.5%), dermatological problems (3.4%) and crude mortality rates as it accounts (6.2%) followed by septicemia (1.4%) and pneumonia (1.0%).

The cases recorded as unknown when the calves were dead without observing any syndromes mostly epidemic disease were that of foot and mouth disease which occurred due to an outbreak. A total of 16 different risk factors were investigated for their association with the occurrence of crude morbidly and mortality in farms (Table 1).

Table 1: Summary of syndromes that caused mortality and morbidity in dairy farms

Syndromes	Morbidity cases	Mortality cases	Crude morbidity (%)	Crude mortality (%)	Case Fatality (%)
Diarrhea	64	18	21.9	6.2	28.12
Pneumonia	13	3	4.9	1.0	23.14
Septicemia	7	4	2.4	1.4	57.07
Navel ill	7	2	2.4	0.7	28.57
Lameness	6	1	2.1	0.3	16.66
Dermatological problems	10	1	3.4	0.3	25.0
Nutritional deficiency	3	1	1.0	0.3	33.33
GIT disorder	8	2	2.7	0.7	25.0
Unthrifteness	9	2	3.1	0.7	22.2
Unknown	0	15	0	5.1	-
Total	127	49	43.5	16.8	-

Table 2: Potential risk factors associated with calf mortality and morbidity

			Morbidity				Mortality			
Factors	Groups	Number of calves	Number of affected	MB1 rate (%)	MB2 rate (%)	P-value	Number of affected	MT1 rate (%)	MT2 rate (%)	P-value
BC	Normal	268	108	40.3	37		41	15.3	14.3	0.000
	Dystopian	24	19	79.2	6.5	0.000	4	33.3	2.7	
Sex	Male	128	74	57.8	25.3		33	25.5	11.3	0.000
	Female	164	53	32.3	18.2	0.000	16	9.8	5.5	
Age	≤ 3 months	201	108	53.7	37		45	22.4	15.4	0.000
	≥ 3 months	91	19	20.9	6.5	0.000	4	4.4	1.4	
Breed	Local	65	19	29.2	6.5		5	7.7	1.7	0.016
	Cross	227	108	47.6	37	0.006	44	19.4	15.1	
AFCI	≤ 6 hours	245	85	34.5	29.1		36	14.7	12.3	0.029
	≥ 6 hours	47	42	89.4	14.4	0.000	13	27.7	4.5	
WA	≤ 3 months	54	45	83.3	15.4	0.000	19	35.2	6.5	0.000
	≥ 3 months	238	82	34.5	28.1		30	12.6	10.3	
HC	Clean	182	43	23.6	14.7	0.000	24	13.2	8.2	0.030
	Unclean	110	84	76.4	28.8		25	22.7	8.6	
TIF	≤ 1 months	80	41	51.3	14.0		18	22.5	6.2	0.000
	≥ 1 months	212	86	40.6	29.5	0.066	31	14.6	10.6	

MB1= morbidity within group MB2 = morbidity within total, MT1 = mortality within group, MT2 = mortality within total, BC = birth condition, EFCI = age at first colostrums ingestion, WA = weaning age, HC = housing cleanliness, TIF = time introduction to feed

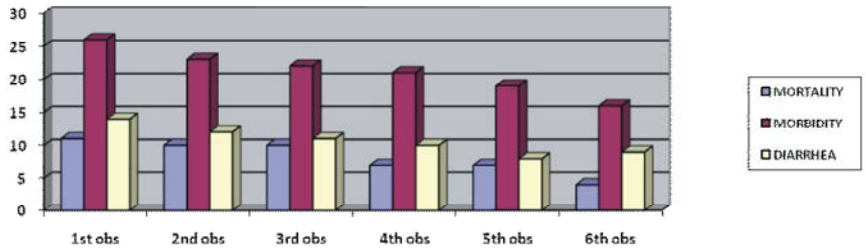

Fig. 1: Relative proportion of morbidity, mortality and diarrhea with follow up observation

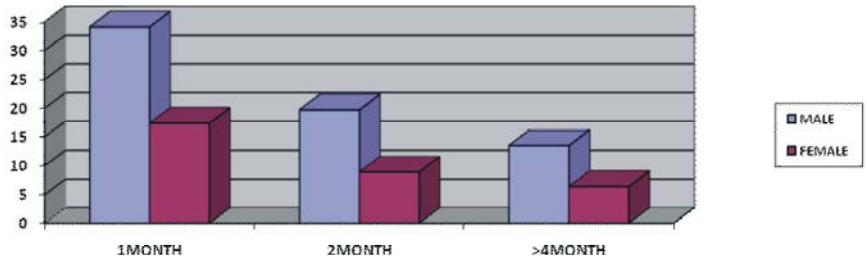

Fig. 2: Relative proportion of death losses by sex with age increases

Such an analyses was also done for calf diarrhea as it was the leading causes of morbidity and mortality. Of the 16 factors considered for analysis, only eight factors were found significantly ($P < 0.05$) associated with crude calf mortality and crude calf morbidity. Thus include birth conditions, sex, breed and age of the calves, age at first colostrums ingestion, housing cleanliness, weaning age and time of introduction to other feeds (Table 2).

Keeping the effect of other factors constant, the risk of mortality in older calves was only ¼ times that of in younger calves. Calves weaned at age before age of 3 months were 2.97 times more risk of mortality than those weaned after 3 months of age. The risk of morbidity was 1.88 times higher far calves which ingested their first colostrums meal later than six hours after birth than those ingested within six hours after birth. Similarly, the incidence of morbidity in calves which were housed in unclean houses was 1.72 times higher than those housed in clean houses. In addition to other health problems parasitic infestation was the most prevalence in investigated dairy farms. Fecal examinations of sample using floatation technique from diarrheic calves was done only for *Eimeria* oocyts of which 64 samples examined for *Eimaria* oocytes 37 (57.8%) samples were positive (Fig. 1).

Proportionally the highest morbidity, mortality and diarrhea incidents occurred in the first weak of life. Some 17% of the total cases of morbidity and diarrhea and 21% of the total cases of mortality occurred in the first weak of life. Again 60% and 51.5% of the total cases of crude morbidity and crude mortality respectively occurred in the first months of age and 86.1% and 83.3% of the total cases of crude morbidity and crude mortality respectively occurred in the first three months of age. It appeared that proportion of death was recorded in male calves compared to female calves particularly during the first few months of age. This investigation showed that both mortality and morbidity was higher during the pre-weaning period and decrease with age (Fig. 2).

From questionnaire result and observation in follow up days, the farms included in this study were under semi-intensive system of proportion. They kept local and crossed breed animals (Holestein X Fogera breeds and some Holestein X Boran). Most of the farms raise their own replacement stock, (both male and female; calves), unlike two large dairy farms which raise only heifers calves. Navel treatment during birth and separate calving pen were practiced in some farms. Thought, the knowledge of immunological importance of colostrums was present with same calf-takers, unlike two large dairy farms feeding colostrums at the right times was not practiced in any of dairy farms.

In most of farms milk feeding was applied at least two times. About 46.4% smallholder dairy farms used a separate calf house where as others in a group with their dam. In the wo large dairy farms Andassa live stock research center and Jerusalem dairy farms, there were either or both veterinarians and animal health technicians that employed to deal with different researches and health aspects of farms.

Smallholder dairy farms call private veterinary practitioners, whenever facing health problems of animals like bloating, dystocia and other accidental and emergency disease and during artificial insemination needs. Similarly calf loss was one of health problems in the farms together with reproductive problems or mastitis and ecto-parasitic infestation especially tick infestation. Similarly about 10% of dairy farms had experienced the calf loss in the past years.

To summarize the major findings of whole study in brief in the incidence of crude calf morbidity and mortality was 43.5% and 16% respectively, in the study herds. Among the different disease conditions diagnosed, calf diarrhea was the predominant calf health problem followed by pneumonia. From a number of putative risk factors analyzed for their association with incidence of calf mortality and morbidity, birth condition, breed, sex, age of calves, age at first colostrums ingestion, weaning age and house cleanliness were found most important in affecting the occurrence of calf health problems.

DISSCUSSIONS

The study showed that 16.8% (N = 49) mortality and 43.5% (N = 127) morbidity cases were recorded. Previous estimates indicated that a calf mortality rate of 20% can reduce net profited by 38% and therefore, in a profitable dairy farm, calf mortality rate should be kept below 5% [14, 15]. Thought it was lower than the 25% and 50% as reported by Sisay and Ebro [16] and Hassen and Brannag [17] respectively. These findings were much higher than the three to five percents calf mortality that can be achieved through good calf management and above the economically tolerable level at least by the standard of the western production systems [18].

Findings of previous researcher on calf mortality reported by Alemu and Teshome [14], it showed 12.9% and 13.5% mortality in Holeta and Adamitulu cattle farms respectively, Fekadu and Tefera [19] reported 13.22% mortality in Adamitulu and Abernossa cattle ranches,

Mukasa and Azage [20] work revealed 5% to 4% mortality in Ethiopia and Bekele *et al*. [21] reported 9.3 mortality and 29.3% morbidity in Hawassa, Daresm [13] reported 8.7% at North West Amhara Regions and Wudu *et al.* [22] reported 18.0% at Debre-Zeyit Dairy farms and low prevalence of 3.4% mortality was reported by Hailemariam *et al.* [23] from Abernossa ranch. In the present study, diarrhea (21.9%) was the most frequently observed disease syndromes followed by pneumonia (4.5%). Moreover, diarrhea was the most common condition associated with calf deaths (6.2%). Similar to the current finding, some authors have identified three most important disease problems in young calves such as; septicemia, diarrhea and pneumonia [21, 22, 24, 25].

On the other hand, there are studies which found pneumonia as leading cause of calf mortality [26]. The relatively lower incidence of pneumonia in this study might be due to a small herd size of farms and mostly these studies were done on large herd size, which has strong correlation with environmental stress that exposes calves to respiratory problems. It was observed that a 50% decrease in stocking density was increasing the ventilation rate by 20% times thereby decreasing the risk of pneumonia [27]. The occurrence of health problem of calves diagnosed less frequently were navel ill and septicemic conditions (2.4%).

In agreement with these findings, there are similar reports of lower incidences of these disease conditions than diarrhea and pneumonia [6].

From different analyzed potential risk factors of calf loss, mortality rate was significantly five times higher than in their counter female calves. That was assumed to be attributed to less attentions and management care given to male calves, as their role in the farm was considered as irrelevant. Moreover, male calves have less absorption ability of serum immunoglobulin than female calves and they could become more immuno-deficient than their counter females. This discrepancy in the mortality or survival pattern between the two sexes became discernible at about 240th day, probably indicating preferential care and management for female for the purpose of early growth and breeding [28].

Age was the important factor found to affect crude mortality and morbidity. Younger calves under three months of age were at higher risk as compare to older calves. Age as a result was confirming the findings of previous work done by different research in different farms, Fekadu and Tefera [19] that could attributed the poorly developed immune systems of the calf to fight against disease causing agents. Different researchers like Wudu *et al*. [22] found that in the six months period, the mode age for all outcomes was 19% and 13%, 36% and 32% and 91% and 84% of crude mortality and morbidity had occurred within the first week of life, one and three months of age respectively.

These are relatively similar findings from the present study, which is 60% and 51.5% of the total cases of crude morbidity and crud mortality respectively occurred in the first months of age and 86.1% and 83.3% of the total cases of crude morbidity and crude mortality respectively occurred in the first three months of age. The relatively higher risk of mortality in young calves observed in this study suggests the need of more careful management fore very young calves as compared to older ones. Additionally, there was statistically significant different in rates of calf mortality due to variation in weaning age of calves. The higher mortality of rates was observed in calves weaned at early age of life as compared to those weaned at higher age (OR=2.79). Early weaning was reported to increase risk of mortality, which was found 50% higher mortality in calves that were weaned at 3-4 weeks as compared to those weaned at seven or more weeks [17].

Calves those are in close contact with manure or other liquid runoff will have continues exposure to pathogens in the environment (OR=1.72). Warm and humid calf housing will compounding bedding contaminations, specially when there is calf to calf contact, inadequate sanitation and accumulations of waste in porous stall base, or dumping feed refusals in to calf pens [21]. the higher risks of morbidity associated with dirtiness of calf house seen in this study agrees with Shiferaw *et al.* [26] who reported the effect of hygiene of the microenvironment of the calves in the occurrence of calf mortality and morbidity in Holleta, Ethiopia. As calves from the immediate environment acquire most of infectious agents, the high risk of calves morbidity in unclean houses observed in the present study is logically supported.

Breed is another significant factor for calf mortality and morbidity, in which crossbreeds are at more risk of mortality and morbidity than those local breeds. From different previous studies, European crossbreeds are reported to be more susceptible to diseases and parasites as the local breeds adapted to the environment [29]. Similarly, calves from dystocia or prolonged labor were found at higher risk for losses than those born from normal delivery. Other studies also demonstrated higher risk of calf morbidity in calves of beef herds with high rate of dystocia than those herds with low dystocia rates,

especially diarrhea, in calves of difficult birth could be due to inadequate passive transfer of colostral immunity. Such calves either would like vigor to suckle on time or will fail to absorb even if they managed to suckle. Calves from prolonged labor develop respiratory acidosis, which interferes with absorption of colostrial immunoglobulin [30].

From questionnaires of the present study, there were a few number of farmers know about the importance of colostrums to calves and none of them knows when to feed it to calves and most of them never apply because most of calf owners wrongly believes that colostrums causes diarrhea. These shows lack of basic calf managements techniques in dairy producers due to a high percentage of failure of passive transfer of immunity. The calves born at the time of fasting were lucky because humans did not use colostrums for any other purposes and thus the calves have the opportunity to get colostrums freely [31].

According to the previous studies, delayed colostrums intake (latter than 6 hours of age) associated with high risk of morbidity agrees with other reports such as Olsson *et al*. [32] who found that each hours of delay in colostrums ingestions in the first 12 hours of age increased the chance of a calf becoming ill by 10%. 61% of the colostrial immunoglobulin containing 80 mg of IgG was absorbed in six hours and decreases sharply thereafter. This indicates that the first six hours were the period in which maximum absorptions of colostrial immunoglobulin takes place [31].

Mastitis, repeat breeding and different dermatological abnormalities in related to Ecto-parasitic infestations and calf losses due to epidemically spreader Foot and Mouth Disease like lesions (especially in Bahir Dar milk development unions) were among the priority problems. In brief, in the present investigations, 43.5% morbidity and 16.8% mortality were found in dairy calves in and around Bahir Dar. This high calf loss in the study herds could affect the productivity of dairy farms due to reducing breeding potential and replacement stock.

CONCLUSSIONS AND RECOMMENDATIONS

The main calf mortality and morbidity rates recorded in this study was moderately higher than those the economically tolerable 5% rate and the major causes of calf losses were found to be diarrhea, pneumonia, septicemia and different dermatological calf health problem responsible for the majority of calf illness and death. Sex, breed and age of calf, weaning age, age of the calf at which it feed colostrums at the first time and cleanliness of the calf barns were found to be important risk factors affecting the calf mortality and morbidity rates in the farms. This study also showed that progressive enhancement on the awareness of farm managers and workers to improve managements and strict adherence to herd/calf health care measures enabled to reduce calf losses rates in the study farms. Thought identifications of *Eimeria oocytes* were with the available laboratory facility, calf diarrhea is the syndromes of great etiological complexity and hence amore comprehensive study should be conducted to identify the major infectious causes involved. Generally, this indicates that much remained to be learned about the major causes of calf losses and low performance of calf industry, especially at small scale mixed farming system in the region suggesting the need for further works in the area. Based on the result of this study, the following recommendations are forwarded:

- Attention should be given to good husbandry and management system while designing developmental progressive herd or calf health care strategies,
- Additional studies ion prevalence and incidence rates of calf mortality and morbidity and associated risk factors on the farm, with special attention to both large and stallholders' dairy farms should be applied,
- Future researches on causes of non-parasitic diarrhea in calves should be identified, i.e. the role of viral and bacterial infections.

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