Full Length Research

Study on the causes of calf morbidity and mortality and its associated risk factors in South Omo Zone, South-Western Ethiopia

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ABSTRACT: A cross-sectional and longitudinal observational study with the objectives to identify calf management and husbandry practices and to investigate the major causes of calf morbidity and mortality and its associated risk factors was conducted in South Omo Zone from 2015 to 2016. A total of 85 calf owners were interviewed and 255 calves of those farmers were longitudinally followed for six months from the very first day of their birth. Accordingly, retained placenta 17/85 (20%), narrow pelvic outlet 17/85 (17.6%) and prolonged labour 8/85 (9.4%) were ranked as maternal-related calving problems whereas, 'navel ill' 34/85 (40.0%), dead birth 9/85 (10.6%), oversized calve 16/85 (18.8%) and abnormal presentation 9/85 (10.6%) were identified as calf-related problems. The traditional healers 31/85 (36.47%) and veterinarians 24/85 (28.23%) were dominant calving assistants in the study areas. Moreover, bloody diarrhea 24/85 (28.2%), ectoparasites 10/85 (11.8%), pneumonia 7/85 (8.2%) and constipation 3/85 (3.5%) were categorized as the major health problems that frequently affected the calves. From the calves longitudinally followed, 85 calves (33.3%) were encountered different health problems which resulted in calf morbidity and mortality. Identified health problems were not significantly associated (p>0.05) with study sites, sex and breed of calves. According to multiple logistic regression analysis, six variables (calf housing system, dam vaccination history, colostrum feeding frequency, calf house clearing frequency, parity of the dam and calf delivery problem) were significantly associated (p<0.05) with calf morbidity. However, none of the variables was significantly associated with calf mortality. Through six months follow-up, 4.41% crude calf mortality rate was recorded. Sudden death with unknown cause, bloody diarrhea, pneumonia, "evil eye" and physical damages were responsible for 36.36, 18.18, 18.18, 9.09 and 18.18% case fatality and responsible for 1.60, 0.80, 0.80, 0.40 and 0.80% crude mortality respectively. The crude mortality varies among sex; 3.13 and 6.67% respectively in male and female calves. Similarly, it was relatively higher in calves under one week of age (5.73%) and decreasing as the calf's age increased. It can be concluded that improving herd management and husbandry practices which negatively affecting calf health could minimize calf morbidity and mortality. Moreover, improving the whole herd health system and awareness creation to calve owners to improve the dynamism of their future replacement calve is very important in this area.

Keywords: Abnormal presentation, calving problem, colostrum feeding, retained placenta.

INTRODUCTION

The intensification of dairy production, especially under hot and humid climatic condition presents new disease to both dairy cows under the production system and to new borne replacement calves (Shapiro et al., 2015). Hence, it is common to see several factors that affect the health and strength of the calves immediately after birth which is more acute in developing countries due to bad calf management practices which aggravate the condition. Among predisposing risk factors, lack of proper nutritional strategy, poor hygiene and housing system and inappro-

priate immunization of new born calves greatly affect health, productivity and the whole vigority of the calves (Darsema, 2008; Wudu et al., 2008; Beam et al., 2009). A calf deprived calf hood cares is unable to mount a strong immune response when presented to an overwhelming disease challenge, because the immune system has not reached the level of maturity it needs to prevent infections (Beam et al., 2009).

Calf hood diseases have a major impact on the economic viability of cattle operations due to the direct costs of calf losses and treatment and the long term effects on performance (Wudu et al., 2008; Muktar et al., 2015). Calf diarrhea and pneumonia are the two major causes of calf mortality and morbidity in both intensive commercial dairy farm and small holder farming system. Other environmental and management risk factors known to affect calf health and survival include level of herd production, practice of prophylactic antibiotics, weaning age, separation or mixing of the calves. Therefore, it is important to realize that the costs of poor calf management go beyond losses of calf through mortality (Vasseur et al., 2010).

In Ethiopia, dairy cattle are reared under different production systems, management and milking conditions, but there is also little knowledge about the science of dairying especially among small holder dairy farmers (Duguma et al., 2012; Shapiro et al., 2015). As clearly indicated by the national livestock master plan, very high calf mortality has significant implications on the dairy production (Shapiro et al., 2015). A few studies conducted on calf mortality between 0 - 1 year in Ethiopia reported an overall mortality rates ranging from 10 to 33%. According to International Livestock Center for Africa, ILCA (1994), calf morbidity and mortality were ranked next to mastitis as the second biggest problem for dairy production in Ethiopia. Scours in neonatal period and pneumonia in older calves are known to be responsible for most of calfhood morbidity and mortality (Yifat et al., 2012). Complex interaction of environment, managerial practice, infectious agent and the calf itself act as risk factors for the occurrence of calf morbidity and mortality (Ferede et al., 2014).

Understanding the causes of calf morbidity and mortality, their methods of transmission and associated risk factors in the study area is the first step in developing effective programs to minimize their impact on calf health and thereby to reduce their threat to dairy production. Moreover, assessing calf owners' knowledge and attitude about calf mortality and morbidity and general management and husbandry practice is very important to extract prevention and control methods for calf health problems. At present, there is no investigation of dairy calf morbidity and mortality was carried out in the agro-pastoral and pastoral areas of South Omo Zone, Southwestern Ethiopia. Hence, large scale risk factor analysis and assessment of calf owner's management and husbandry practices are needed to quantify the calf morbidity and

mortality as well as to identify associated risk factors. Therefore, the objectives of this study are to identify calf management and husbandry practices, to determine the major causes of calf morbidity and mortality and its associated risk factors in mixed crop-livestock production system of South Omo zone, southwestern Ethiopia.

MATERIALS AND METHODS

Study area description

This study was conducted in South Omo Zone, Southwestern Ethiopia. Specific study sites were Debub Ari district and Jinka city administration which was selected based on access of infrastructure for timely monitoring of study, farming practices of farmers and previous history of occurrence of calf mortality. According to agricultural sample survey of central statistics agency (CSA) of Ethiopia, the total cattle population of South Omo zone (in million) as 1.75 (CSA, 2017). The zone is located between 4° 43' to 6° 46' North latitude and 35° 79' to 36° 06' East longitude and between 376 to 3,500 m above sea level with mean annual rainfall ranges between 400 and 1,600 mm. It has diverse agro-ecological districts ranging from hot arid to the tropical humid with average temperature ranging between minimum 10.1°C to maximum 27.5°C (SOFED, 2012). The rainfall pattern is erratic and usually bimodal occurring from September to November and from April to May (SOFED, 2012).

Study animals

The sampling units for this study were local and crossed (local X Holstein Friesian) breed calves of aged 24 hours and above. For the purpose of this study, calf was defined as young cattle less than six months of age, morbidity as any sickness with recognizable clinical signs which ultimately ended in death or warranted therapeutic intervention during the course of follow up period and mortality as death of calves above the age of 24 hours recorded in the inter study period.

Study design

A longitudinal observational and cross-sectional study designs were used to collect data on management and husbandry practices, major causes of calf mortality and morbidity and associated risk factors in the study areas. Longitudinal follow-up was conducted starting from 24 hours up to six months of calf's age. Calves of 24 hours of age were purposively identified and individually monitored for morbidity and mortality up to 6 months within the study period which was started in 2015 and ended in 2016. For the calves of > 24 hours of age at the commencement of

the study, retrospective survey was conducted to recall any health problem encountered. The sampled calves were withdrawn from the follow up when they completed their 6 months period.

Sample Size

Calves that were accessible and meet the requirements of inclusion criteria were involved in the study. Accordingly, a total of 255 calves of both sex groups (162 males and 93 females) and different blood level (229 local and 26 crosses of local and Holstein Friesian); owned by 85 calf owners from two study locations were involved. None of the calf contributed to this study was departed until the end of the study period.

Data collection

Data on calf management practices including post-natal care, colostrum feeding, housing system and previous history of calf diseases and overall health status in the individual calf owner's farms were assessed through questionnaire survey and visualization.

For longitudinal study, checklist was prepared to record any disease and death occurrence to study calves on each site. Animal health workers of each study site were used as enumerator. Animal health workers were trained on how to follow up the study calves and recording of disease and death occurrence prior to the commencement of this study. They were also aware of the cares to be taken on calves after the occurrence of disease conditions. In addition, calve owners were aware of calling animal health workers timely if any disease symptom occurs on their calves. All disease conditions on calves with their respective symptoms and clinical signs were recorded until the calves were departed from follow-up period. Weekly supervision was made by the main researcher on progress and perfection of data collection.

Ethical approval

Ethical approval for this research was granted from Livestock Research Directorate of Southern Agricultural Research Institute (SARI), Southern Ethiopia. Furthermore, calve owners were briefed about the objectives of the study and confidentiality of information provided and all participants gave their oral informed consent prior to the research.

Data analysis

All collected data were entered into Microsoft Excel Sheets to create a database and were imported to SPSS version 20 for descriptive analysis. Descriptive statistics (frequencies and percentages) were used to summarize different parameters of questionnaire and longitudinal survey. Association between calf morbidity and mortality and different risk factors was analyzed through multiple logistic regression analysis (via R- software packages) by separately taking calf morbidity and mortality as dependent variables and different calf management and husbandry factors as explanatory variable. Hence, odd ratio (OR) was used to express the effect of explanatory variables on the likelihood of outcome variable (calf morbidity and calf mortality). All tests were done at the 5% global significance level.

RESULTS

Calf management system and health problems survey

Among 85 calf owners, 35.3% (30/85) were not encountered any maternal related calving problems. However, 20% (17/85), 17.6% (15/85) and 9.4% (8/85) of the herdsmen ranked retained placenta, narrow pelvic outlet and prolonged parturition/labour respectively as maternal related calving problems. Whereas, 40% (34/85), 18.8% (16/85), 10.6% (9/85), 10.6% (9/85), 7.1% (6/85) and 12.91% (11/85) of the herdsmen respectively disclosed "navel ill"; oversized calf; abnormal presentation; dead birth, concurrent occurrence of dead birth, oversized calf and abnormal presentation; and concurrent occurrence of oversized calf and abnormal presentation as calf related calving problems (Table 1).

About 28.23% (24/85) of respondents consult veterinarian to assist cow during calving problem. However, 36.47% (31/85) of the calf owners use traditional healers to assist their cows. Moreover, 21.17% (18/85) of the respondents revealed that their cows were assisted by either traditional healers or veterinarian. Suckling 70.6% (60/85) was the dominant colostrum feeding method followed by assisted feeding 29.4% (25/85) (Table 2).

Majority of the calf owners allowed calves to consume colostrum twice per day 54/85 (63.52%) followed by three times 18.8% (16/85), without limit 15.29% (13/85) and once 2.35% (2/85) per day. Separate and aggregate housing of newly born calves was practiced by 54.11% (46/85) and 38.82% (33/85) of the calf owners respectively (Table 2). Among the respondents, 82.33% (70/85) perceived the presence of different calf diseases in their area. 54.11% (46/85) of the calf owners encountered death of calves due to different disease and other health problems. Treatment with modern drug 49.41% (42/85) was the major practice used by calve owners to treat their diseased calf. Drenching and smearing of different cultural drugs (ethno-veterinary practices) was practiced by 30.58% (26/85) of the respondents as disease treatment option (Table 3).

Pregnant dam vaccination was practiced by 51/85 (60%)

Table 1. Maternal and calf related calving problems.

Variables	Categories	Frequency	Percentage (%)
Maternal related calving problems	Retained placenta	17	20.03
	Narrow pelvic outlet	15	17.60
	Retained placenta and narrow pelvic outlet	15	7.60
	Prolonged labour	8	9.41
	No problem	30	35.32
	Total	85	100.00
	Dead birth	9	10.62
	Oversized calf	16	18.81
	Abnormal presentation	9	10.60
Calf related calving problems	Dead birth, oversized calf and abnormal presentation	6	7.10
	Oversized calf and abnormal presentation	11	12.91
	"Navel ill"	34	40.03
	Total	85	100.00

Table 2. Major management and husbandry systems practiced by calf owners.

Variables	Categories	Frequency	Percentage (%)
Delivery assistant	Veterinarian	24	28.23
	Traditional healers	31	36.47
	Veterinarian and traditional healers	18	21.17
	No assistant	12	14.11
	Total	85	100.00
Colostrum feeding methods	Suckling	60	70.60
	Assisted feeding	25	29.40
	Total	85	100.00
Frequency of colostrum feeding/24 hrs.	Once per day	2	2.35
	Twice per day	54	63.52
	Three times per day	16	18.82
	No limit	13	15.29
	Total	85	100.00
Calf housing system	Separate	46	54.11
	Aggregate	33	38.82
	No housing	6	7.05
	Total	85	100.00

of the calf owners after pregnancy check-up by veterinarian. Bloody diarrhea, ectoparasite, pneumonia, and concurrent occurrence of bloody diarrhea, pneumonia and ectoparasite were the major diseases of the calves as responded by 28.2, 11.8, 8.2 and 18.8% of the calf owners respectively (Figure 1).

Longitudinal morbidity

Throughout the study period, the incidence of morbidity was 33.3% (85/255) due to different diseases and health-related problems. Multiple logistic regression analysis (MLR) revealed that calf housing condition, dam vaccination history, colostrum feeding frequency, calf house clearing frequency and calf delivery problems were significantly ($p<0.05$) associated with calf morbidity in the study areas. The risk of calf morbidity in separate housing system was lower by a factor of 0.30 as compared to aggregate (group) housing of calves. Moreover, the risk of calf morbidity in calves managed without house was higher by a factor of 12.20 than calves in aggregation with others (Table 4).

Calves from vaccinated dam had morbidity lower by a

Table 3. Owners response on calf disease, death, treatment methods and dam vaccination practice.

Variables	Categories	Frequency	Percentage (%)
Presence of calf disease	Yes	70	82.33
	No	15	17.64
	Total	85	100.00
Occurrence of death	Yes	46	54.11
	No	39	45.88
	Total	85	100.00
Measure to calf disease	Treat with modern drugs	42	49.41
	Traditional Rx methods	26	30.58
	Both modern and traditional Rx	17	20.00
	Total	85	100.00
Vaccinating pregnant cow	Yes	51	60.00
	No	34	40.00
	Total	85	100.00

Rx= Treatment.
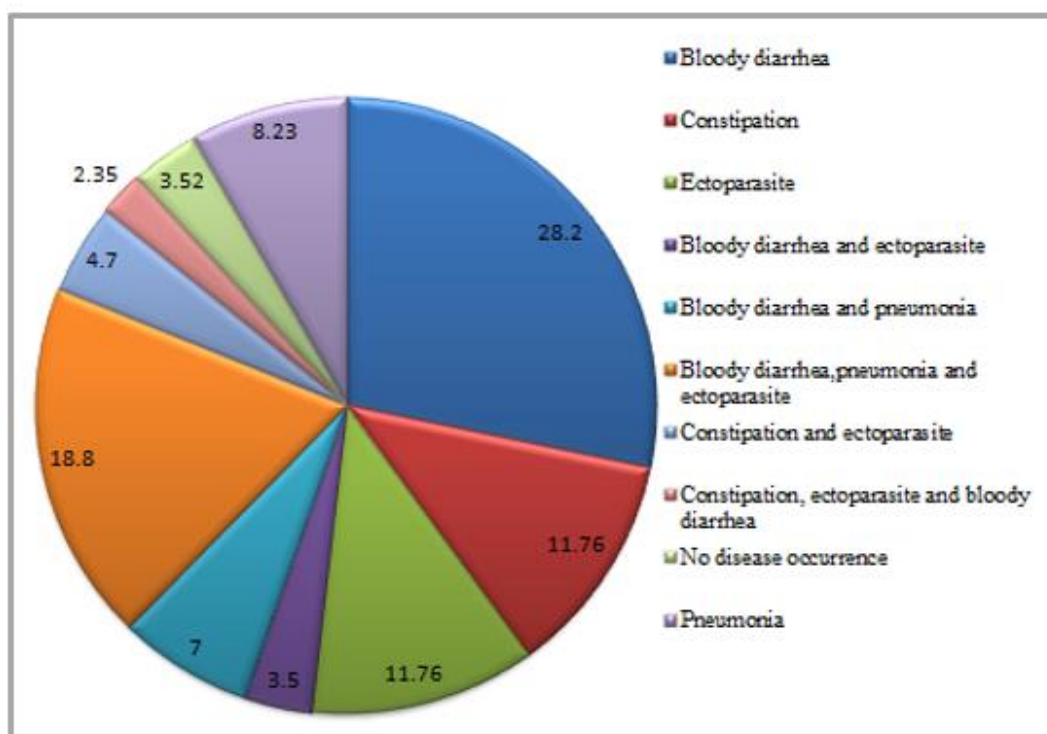
Figure 1. Major causes of calf morbidity in the area as ranked by calve owners.

factor of 0.14 as compared to calves from non-vaccinated dams (Table 4). Calf morbidity was higher by a factor of 27.62, 10.14 and 2.65 when the calf allowed to consume colostrum once, twice and three times a day, respectively as compared to those calves consume colostrum without a limit (Table 4). Similarly, calf morbidity was higher by a factor of 6.51, 1.33 and 0.34, respectively when the calf's house was cleared once, twice and three times per week as compared to clearing calf's house every day. Likewise, calves involved with calving problem were more morbid

Table 4. Association of management related variables with calf morbidity (MLR analysis).

Variable	Categories	No of calves followed	Morbidity (%)	Multiple logistic regression		
				OR	OR 95% CI	P-Value
Sex	Male	162	30.86	1.00	0.41-2.46	0.99
	Female	93	37.63			
Breed	Local	229	31.44	0.88	0.26-3.04	0.84
	Cross	26	50.00			
Housing condition	Separate	98	16.32	0.30	0.11-0.79	0.019*
	Aggregation	122	33.60			
	No housing	35	80.0	12.20	3.01-56.18	0.000*
Dam vaccination	Vaccinated	94	30.85	0.14	0.06-0.35	0.000*
	Non-vaccinated	161	34.78			
Colostrum feeding frequency	Once	6	66.66	27.62	1.68-553.7	0.02*
	Twice	162	38.27	10.14	2.77-45.05	0.001*
	Three times	48	22.91	2.65	0.55-13.50	0.22
	No limit	39	20.51			
House clearing frequency/week	Everyday	30	13.33			
	Once	31	70.96	6.51	1.41-33.46	0.02*
	Twice	88	35.22	1.33	0.37-4.94	0.65
	Three times	106	26.41	0.34	0.08-1.31	0.11
Colostrum feeding method	Suckling	178	35.39	0.97	0.34-2.81	0.95
	Assisted	77	28.57			
Parity	Primiparous	65	41.53	1.18	0.44-3.16	0.73
	Multiparous	190	30.52			
Calving problem	Yes	70	78.57	22.71	8.85-66.32	0.000*
	No	185	16.21%			

OR= Odds ratio *= significant associations, 95% CI = 95% confidence interval.

than calves born without calving problem (Table 4).

On the other hand, multiple logistic regression analysis revealed that sex, breed, colostrum feeding method and parity of the dam had non-significant (p>0.05) association with calf morbidity (Table 4). Traumatic injury from Gumeter Peasant association (PA) (11.63%) and bloody diarrhea from Bazet PA (12.77%) were the highest cause of specific morbidity reports. Ectoparasite infestation was common to all study PAs (Table 5).

Longitudinal mortality study and its suspected causes

Throughout the experimental period, eleven (11) calves died due to different health problems with resultant crude mortality of 4.41% (Table 6). There was no significant (p>0.05) association between calf mortality and study sites, sex and breed of the calves.

The major causes of calf's death were sudden death with unknown cases, bloody diarrhea, pneumonia, evil eye and physical damage which were responsible for 36.36, 18.18, 18.18, 9.09 and 18.18% case of fatality respectively. These causative factors were also responsible for 1.60, 0.80, 0.80, 0.40 and 0.80% crude mortality. The crude mortality rate of 3.13 and 6.67% respectively in male and female calves was recorded during the study period (Table 6).

The record of the death indicated that as the age of the calf increase, mortality of the calf decrease. It was relatively higher in calves under one week age (5.73%) (Table 7).

DISCUSSION

Cow-related calving problem such as prolonged labour in this study might be associated with disease and lack of

Table 5. Causes of morbidity reported by peasant association (PA)

Causes of morbidity	Percentage of morbidity in each PA					Total (N= 255)
	Gumeter (n=43)	Meytser (n=57)	Ayda (n= 53)	Alga (n=55)	Bazet (n=47)	
Traumatic injury & skin lesion	11.63	-	1.89	-	-	2.35
Lice	2.33	5.26	7.55	5.45	-	4.31
Tick and lice	6.98	8.77	5.66	5.45	4.26	6.27
Constipation	9.30	-	1.89	7.27	2.13	3.92
Mange and lice	2.33	-	1.89	3.64	-	1.56
Bloody diarrhea	6.98	3.51	3.77	3.64	12.77	5.88
Sudden death	4.65	1.75	-	-	2.13	1.56
Evil eye	4.65	-	1.89	3.64	-	1.96
Pneumonia	-	1.75	-	1.82	2.13	1.17
Tick	-	1.75	7.55	1.82	2.13	2.74
Mange and tick	-	-	1.89	-	-	0.40
Mange	-	-	-	3.64	2.13	1.17
Total	44.18	22.80	33.96	33.36	26.65	33.33

PA= Peasant Associations, n= number of calves from each PA, N= total calves followed/6 months.

Table 6. Crude mortality, case fatality and causes of death.

Causes of death	Sex		Total dead	Crude mortality rate	Case fatality rate
	Male	Female			
Sudden death	1	3	4	1.60%	36.36%
Bloody diarrhea	1	1	2	0.80%	18.18%
Pneumonia	0	2	2	0.80%	18.18%
Evil eye	1	0	1	0.40%	9.09%
Physical damage	2	0	2	0.80%	18.18%
Total dead	5	6	11	-	-
Average total population	(162+157)/2=159.5	(93+87)/2=90	(255+244)/2= 249.5	-	-
% of death by sex	3.13% (5/159.5)	6.67% (6/90)	4.41% (11/249.5)	-	-

Table 7. Calf mortality rate in different age groups.

Sex	Death /age				Total dead	Total pop.	Average total pop.
	< 1 week	1 week-1 month	1-3 month	3-6 month			
Male	4	1	0	0	5	162	159.5
Female	3	2	1	0	6	93	90
Total	7	3	1	0	11	255	249.5
% of death	5.73% (7/	2.45%	0.81%	0.0%	4.41%		

quality feed especially during dry season which causes weakness of the dam to contract uterine muscle during labor. Previous study by Wudu et al. (2008) suggested that calves from dams with inadequate nutrition at late pregnancy or affected with prolonged anorexia, fever, or septicemia may be weak and may be involved with calving problem. Reported retained placenta by 20% of interviewed calf owners was higher than 5 to 15% incidence of retained placenta reported by Mordak et al. (2017) in healthy dairy cows. This increased incidence

might be due to poor management of pregnant dam which cause placental retention.

Lack of breeding cow selection was the root cause for calving problem associated with narrow pelvic outlet on local breeds. Similar reports were declared by Swalve (2007) and IAEA (2009) which stated that narrow pelvic outlet in heifer could aggravate calving problem. Also, Asmare and Kiros (2016) showed that incidence of dystocia is three to four times as frequent in females calving for the first time compared to females in the second

parity. Thus, Asseged et al. (2004) and Bleul (2011) recommended crossing of local breeds of cow at second parity and above with exotic bull to avoid the problem.

According to this study, "navel ill"; was one of the major health problems of new born calves. This might be associated with high exposure of the calves to unhygienic environments in dam's barn. Previous finding by Wudu et al. (2008) was consistent with current finding which revealed that calves housed in unclean barns were at higher risk of morbidity than calves housed in clean barns due to high pathogenic exposure in the barn.

Early and adequate colostrum ingestion is essential for passive transfer of immunoglobulin (Ig) and for long-term survival of the new born calves. Colostrum ingestion by suckling was commonly practiced in the study areas and it might have effect on efficiency and amount of colostrum received. The method of colostrum feeding affects the efficiency and amount of colostrum absorbed by the new born calves. According to Besser et al. (1991), failure of passive transfer (FPT) of immunity is greater when calves are allowed to suckle, although efficiency of Ig absorption is improved. Cho and Yoon (2014) and Cuttance et al. (2017) described another drawback of suckling as it highly exposes the calves to different infectious agents in the barn which may result in clinical disease. Since the calf management system in the study area was extensive type, the extent of FPT of Ig might be more serious. Previously, Bielmann et al. (2010) declared that high prevalence (19-40%) of FPT of colostrum worldwide was more severe problem in extensive farming condition.

Majority of calf owners vaccinated pregnant cows to prevent disease infections. Grooms (2006) stated that vaccination programs in breeding stock should be designed to prevent diseases that cause reproductive losses such as failure to conceive, embryonic death, abortion and stillbirths. Additionally, vaccinating the breeding herd also protects the developing fetus and has the additional benefit of increasing antibodies in colostrum which protect the new born from diseases they likely to be exposed to (Godden, 2008; Chase et al., 2008 and Kirkpatrick et al., 2008). However, few herdsmen hesitate to vaccinate pregnant cow because of fear of abortion which was also recommended by Samartino et al. (2000) as to take care when vaccinating pregnant cows because some vaccine strains may cause abortion.

The current overall calf morbidity of 33.3% was lower than morbidity reported in Sodo and Ada'a Liben districts of Oromia by Asmare and Kiros (2016) and Wudu et al. (2008) who reported crude morbidity of 66.7 and 62%, respectively. This variation in morbidity might be due to management difference specifically of health management difference among the indicated areas.

Bloody diarrhea (28.2%); ranked the first among causes of calf morbidity in this study area. The morbidity associated with bloody diarrhea was higher than16.5 and 18.6% incidence of diarrhea through questionnaire and longitudinal survey respectively, by reports of Admasu and Hassen (2016). However, the later also identified the causative agents for diarrhea as *Escherichia coli (E. coli), Salmonella*, *Cryptosporidium* and mixed infection of *E. coli* and *Salmonella* with their respective prevalence of 26.3, 10.3, 52.6 and 10.5% from diarrheic calf. On the other hand, 3.5% of morbidity reported for pneumonia was similar to 3.3% reported by Asmare and Kiros (2016) for pneumonia as cause of calf morbidity in Sodo town and its suburbs.

Ectoparasites of single and mixed infestation (11.8%) were prominent causes of calf morbidity in current study areas. This might be due to lack of scheduled acaricide application and also because of poor animal husbandry condition in the farm. Previously, higher ectoparasite infestation of 26.8% as cause of calf morbidity was reported by Admasu and Hassen (2016) through calve owners' interview. Studies indicated that ectoparasite infestations can easily be minimized or totally avoided by improving the husbandry condition of the herd (Regasa et al., 2015). Moreover, wise acaricide application of ectoparasites can enhance control of infestation to the barest minimum (Muhammad et al., 2008; Stromberg and Moon, 2008).

Significant difference in morbidity among calves from primiparous and multiparous dam might be associated with variation in Ig concentration between the parities. Primiparous dams had lesser exposure time to pathogens which resulted in deficiency of important Ig in their colostrum secretions with consequent failure of passive transfer of immunity. In agreement with current result, study conducted in China by Liu et al. (2009) disclosed that immunoglobulin concentrations in primiparous cows significantly differed from older cows, with multiparous cows secreting 1.3-1.6 times higher antibody concentration. Similarly, Downey et al. (2011) showed that younger dams passed fewer maternal antibodies to their offspring compared to older dams.

Lower morbidity of calves from vaccinated dam might be associated with higher Ig concentration in vaccinated dam's colostrum that protected calves from susceptibility to disease infections. In agreement with this, Moran (2011) suggested preparturient vaccination as effective in improving colostrum quality and aids in protecting calves against mortality and morbidity. Moreover, because antibodies are being transferred for the formation of colostrum before parturition, vaccinating cows at specific times may ultimately affect the immunoglobulin concentrations (Murphy et al., 2005).

Post parturition colostrum feeding frequency had significant effect on calf morbidity as feeding the calves without limit for the first 12-24 hours after birth resulted in lower morbidity than interrupted feeding. This might be associated with decrease in colostrum Ig concentration as result of interruption. The report of Godden (2008) and Chigerwe et al. (2008) supported this finding that postponing first colostrum collection or consumption for 4-6 hours and 14 hours respectively resulted in a 17% and

33% decrease in IgG concentration. Also, it was recommended that four quarts of colostrum should be fed between birth and 4 hours after the calf is born to ensure high absorption rates without any interruption (Kirk, 2011). Moreover, as time increases, the percentage of Ig absorbed decreases because the intestinal tract of the calf only temporarily allows absorption which ultimately resulting in a failure of passive transfer of immunity (Kirk, 2011).

It was observed in this study that calves housed separately were less diseased than calves housed aggregately. Similar report was documented by Pereira et al. (2014), Wójcik et al. (2013) and Cuttance et al. (2017) as group/aggregate housing of pre-weaning calves had positive correlation with the prevalence of calve disease because in group housing system the number of infectious pathogens responsible for the occurrence of the disease were very high. However, Klein-Jöbstl et al. (2014) disagree with this study result and stated that grouping/ aggregating large number of calves together was not significantly associated with the appearance of diarrhea on the farm but the number of the calves in the group had significant role in the disease occurrence and transmission among the group members.

Frequent cleaning of calf's house/barn significantly lower prevalence of calf morbidity because frequent and daily house cleaning decrease the load of pathogens. Maunsell and Donovan (2008) also revealed significant association of hygienic measures with calf morbidity in general and calf diarrhea in particular. However, study conducted on farms with history of calf diarrhea and without calf diarrhea in Australia (Klein-Jöbstl et al., 2014) indicated that house clearing frequency did not have significant role in the prevalence of calf diarrhea.

Problematic calving might be associated with weakness and discomfort of calf with subsequent reluctance to consume adequate amount of colostrum. This in turn results in inadequate Ig concentration in the calf's serum to defend against herd specific pathogens. Previous studies (Quigley, 2002; Morter, 2011) indicated that calves are not physically strong to consume the recommended amount of colostrum right after birth because of birthing process and such calves were at high risk of contracting morbidity and mortality due to FPT.

Calf crude mortality of current study area was 4.41%. Higher mortality of 20, 22, 9.3, 30.7 and 17.9% was respectively declared by Asmare and Kiros (2016), Wudu et al. (2008), Megersa et al. (2009), Ferede et al. (2014) and Ferede (2015) from different parts of Ethiopia. Moreover, mean annual calf mortality in Ethiopia was in the range of 9.2 to 14% and 26 to 29% in mixed crop-livestock and pastoral production system respectively (Fentie 2016). Clostridial disease which is capable of killing animals quickly and with few warning signs was tentatively suspected to be the cause for sudden death; the leading cause of mortality in the study area. Factors such as overheating and change in weather and poor digestibility of colostrum allows over growth of clostridium

bacteria with subsequent production of toxin lade to calf death.

Mortality due to neonatal diarrhea and pneumonia might be associated with inadequate and poor feeding of colostrum (major factor affecting the immunity), poor sanitation and weather condition of the environment which were significantly observed during longitudinal study period. Moreover, other factors in the area such as stress resulting from management practices and sub-optimal nutrition can also aggravate the occurrence of neonatal diarrhea and pneumonia.

Higher mortality of young calves might be associated with increased susceptibility of calves to infectious agents due to their under developed immunity. Minda and Abdissa (2016) declared consistent finding and supposed diarrhea and pneumonia as the major causes of calf morbidity and mortality and were significantly highest in calves of age 0-3 months as compared to calves of 4-6 months. Similarly, analysis of survival times to death carried out by Assegid et al. (2004) indicated that younger calves (less than a month) had higher death rates than older calves. Likewise, findings of Ferede (2015) indicated 67.9% of mortality rate in the first three months as compared to 16.1% mortality above three months.

Conclusion

It is evident in this study that calf morbidity and mortality were perceptible in South Omo Zone and perceived as the major bottleneck for rearing of replacement calf and the whole livestock production system. Management and husbandry factors such as calf housing system, dam vaccination history, colostrum feeding frequency, calf house clearing frequency and calving problems were significantly associated with calf morbidity. However, none of the management factors were significantly associated with calf mortality. Therefore, improving herd management and husbandry practices could be recommended to minimize the problem. Moreover, improved herd health management and awareness campaign among calve owners to improve the vigor and productivity of future replacement calve is very important in the area. Additionally, further investigation should be conducted on the factors negatively affecting the health and productivity of dairy cattle and replacement calves for further improvement of the sector.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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