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Review Article

CALF MORTALITY: CAUSES AND ASSOCIATED RISK FACTORS

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Abstract: Calf mortality is one of the major problems of calf rearing on dairy farms worldwide. Dairying is becoming one of the most important parts of the livestock sector, where calves are the future herd of a dairy farm in India. The health and management of replacement animals is an important component of total herd benefits. However, calf mortality is an important factor in profitability and productivity in the success of dairy production. Different researchers have also evaluated numerous determinant factors in calf mortality. In addition to calf diseases, calf risk factors such as age and sex, dam risk factors such as parity and birth type, poor management, and environmental factors like calving, colostrum feeding time, and amount, poor housing, and herd size were also reported as determinants of calf mortality. However, many studies on calf mortality focus on risk factors at the individual (calf) level and herd-level risk factors for disease. Most of those recently listed studies were mostly concentrated on government research centers and central parts of the country, which are less relevant to the smallholder farming system. Therefore, a further study based on specific causes of disease and associated risk factors and its economic significance in a production system is required.

Keywords: *Age, Calves, Colostrum, Housing, Mortality*

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Introduction

Calves are the future of the livestock industry. Scientific management of calf rearing plays a key role in dairy development. The successful result of the dairy enterprise depends on better management practices and the survival of the calf crop produced. Calf mortality is one of the major obstacles for dairy farmers. The minimum mortality rate is usually acceptable at up to 5% on dairy farms under standard managemental conditions [1], and decreases in calf mortality by up to 20% increase the net profit of dairy farms by around 40% [2]. Production efficiency traits can be utilized for the selection pressure of future dairy cows for both reproduction and production potential and profitability [3]. A high calf mortality rate is a major problem in replacing cull cows or increasing herd size. It resulted in a shortage of replacement heifers and the need to buy animals, further increasing the replacement cost of the herd [4]. High survival rate in a dairy farm helps to expand the selection pressure, which is one of the main factors controlling profitable returns and genetic gain [5]. Proper nutrition is fundamental for calf growth, the general profitability of calf-rearing enterprises, and for minimizing stress and disease. Housing conditions also affect health and productivity [6].

Classification of calf mortality

Calf mortality can be classified into four types, *viz*., abortion; perinatal mortality (up to 24 h of life); neonatal mortality (24 h to 28 days); and older calf mortality (29-182 days) [7].

Abortion

Abortion is usually defined as the birth of calves between 50 and 270 days of gestation in dairy animals. Pregnancies lost before 42 days are usually mentioned as early embryonic deaths, whereas a calf that is born dead between 260 days and is defined as a stillbirth. However, the loss of any pregnancy can represent a significant loss of income to the producer, and suitable action should be taken to stop abortions and investigate the causes of abortions that may occur.

Perinatal Mortality

Perinatal mortality could be explained as the death of the perinate before, during, or within 24 hours of calving, following a gestation of a minimum of 260 days, regardless of the cause of death or the circumstances related to calving. The perinatal period is the most hazardous time in the life of all animals. Around 75% of perinatal mortality occurs within one hour of calving, with the remainder occurring either pre (10%) or post-partum (15%). Calves who died (90%) in the perinatal period were alive at the start of calving, and so much of this loss is a preventable welfare problem [8]. Traditionally, perinatal calf mortality was considered an indicator of management quality, but it was a welfare concern that appeared to be all but ignored on dairy farms [9]. However, it is now considered the most crucial indicator of welfare level [10]. Perinatal calf mortality rates are one of the most used population-level welfare indicators on dairy farms [11]. Calving management and care of a newborn are considered the most critical areas of herd management affecting calf welfare.

Neonatal Mortality

Neonatal mortality that occurs between 24 hours and 28 days is called neonatal mortality. The range of neonatal mortality varies from 8.7 to 64% throughout the world. Calf mortality acts as one of the major hurdles and 20% calf mortality reduces net profit by approximately 40% [2].

Colostrum and its role in new born calves

The first secretion present in the mammary gland at or near parturition is termed colostrum, which contains immune, growth, mineral, vitamin, and tissue repair factors. Timely ingestion and absorption of colostrum immunoglobulin are necessary for the survival of ruminant neonates since maternal antibodies are not transported across the placenta to new born calves and the immune system takes weeks to months to mature and become protective against disease [12]. Maternal colostrum contains several different types of immunoglobulins, IgG, IgA, and IgM.

However, IgG accounts for roughly 85% of total immunoglobulin in cow colostrum and it is absorbed in the largest amount by the gut of the calf. Dams allowed to nurse their calves have a lower chance of failure of passive transfer than calves separated from their dam within 3 hours of birth because they drink too late and too little colostrum. Colostrum feeding by nipple bottle within 1-4 hours after birth and at 12 hours of age substantially reduces the probability of failure of passive transfer. Calves cared for by female workers are less likely to develop failure of passive transfer, probably because women are more patient with newborn calves that refuse to suckle. Inadequate colostrum intake of calves in the first 24 hours makes them more likely to get sick (9 times) and die (5 times) [13]. Delay intake of 1st colostrums within 30 minutes of birth reduces immunoglobulin concentration of colostrum up to 2 mg/ml [14].

3 QS principle for colostrum feeding

Quality: - provide good quality colostrums, Quantity - ensure calves ingest sufficient antibodies, and Quickly - timing the first feed to ensure efficient absorption from the gut to the blood [15].

The cause of calf mortality

The major causes of calf mortality can be classified as infectious or non-infectious. The infectious causes are diarrhea and pneumonia, caused by bacteria, viruses, and protozoa. The highest mortality in Nagpuri buffalo calves (22.41%) [16] and Gir calves (6.18%) was due to gastroenteritis, followed by pneumonia, which was bacterial or viral infections or due to delayed feeding of colostrum [17]. Gastroenteritis (7.30%) was a major cause of calf mortality, followed by pneumonia and other diseases [18]. The most common and frequently-occurring disease of calves on the farms was gastroenteritis, followed by ectoparasitic and endoparasite infestation [19]. The higher calf mortality occurred due to gastroenteritis/calf scours (43.26%) and respiratory illness (pneumonia) (22.74%) followed by congenital defects (10.87%), digestive disorders (*viz*. tympany, bloat) (6.04%), accidental fall/ injury (5.63%) and others (16.70%) in Jersey crossbred calves [5,20-22].

Major risk factors for calf mortality include

Mortality in dairy calves has a multi-factorial etiology resulting from interactions between the calf and dam, infectious agents, management, and environmental factors.

Sex of the calf

Several researchers have reported that morbidity and mortality rates differed between the sexes of calves. A significantly higher mortality rate was reported in males than female calves [19, 21, 23]. Similarly, the mortality of female calves was lower than that of male calves, and a higher percentage of male calves died (17.30%) than female calves (12.75%) [17]. The reason for this higher mortality might be that the absorption of colostral immunoglobulins is higher in females than in males [24]. In the male female's competition between microorganisms and immunoglobulins for a common intestinal receptor does occur in the early few hours of life. Due to this competition, male calves become more immunodeficient than female calves. Therefore, male calves are more prone to bacterial diseases than female calves [25]. It is also worth mentioning that male calves are not as valuable to the dairy operation as females and therefore may not receive the attention the heifers do, possibly accounting for the higher mortality in males.

Age of the calf

The age of the calf is the most important determinant factor affecting calf morbidity and mortality [21,23], Younger calves (below 1 month) had the highest mortality (21.53%), followed by older calves (9.35%) and adults (4.73%) [26,27]. Shivahre *et al*., (2014) [28] reported similar findings in Murrah buffalo calves where mortality was three times higher in calves from birth to 1 month of age as compared to those from 1 to 2 months of age. Mishra *et al*., (2015) [17] also supported a significant variation in the mortality rate in calves born in different birth periods. The highest mortality was recorded in the age groups of calves below three months (81.25%), 3-6 months (14.58%), and more than 6 months (4.17%) of age [29]. However, Shahi and Kumar (2014) [30] observed a non-significant effect period of mortality from 3-6 months and 6-12 months in Jersey × Sahiwal crosses. It might be due to the first month of the calf being very crucial for the calf during which environmental stress is high and the calf is highly susceptible to bacterial disease.

Season of birth

The season of birth is considered an important factor in determining the risk of mortality of calves. The season of birth played a significant influence on calf mortality at pre-and post-weaning stages in different purebred and crossbred cattle [16,31-33]. The highest mortality of calves was observed in the winter season in different cattle breeds [31, 34-36]. The increased mortality rate of calves in the winter season may be due to exposure to cold temperatures [31], production of lower-quality colostrum during the winter months, or due to impaired absorption of immunoglobulins from colostrum [37]. Kharkar *et al*. (2017) [16] observed the highest mortality in the winter season (40.30%) followed by the month of March (36.47%) and summer (11.32%) seasons. However, in Jersey crossbred [31], Karan Fries [38] and Jersey × Sahiwal crosses, a non-significant effect of season of birth was found on the mortality rate of calves.

Parity of dam

The parity of the dam was also important as a risk factor for calf mortality. Various published reports of Van *et al*., 2012 [39]; Gunawan *et al*., 2013 [40]; Norsberg *et al*., 2013 [41]; Mishra *et al*., 2015 [17]; Gupta *et al*., 2016 [42]; Kalam *et al*., 2016 [43] stated that the arity dams significantly affected the mortality of calves of different cattle breeds. Van *et al*., (2012) [39] noted the decreasing trend in calf mortality as an increasing parity number, reaching the lowest level at the ninth parity and higher. The mortality risk of calves increased with the increasing age (parity) of a dam in Jersey cattle [41] whereas maximum calf mortality was noted in 1st and second parities as compared to advanced parities [17]. So, parities affect calf mortality, and the result indicated that calves born to the first parity dam required more care and management than the calves born to multiparous cows. Gupta *et al*. (2016) [42] found the highest mortality in the first parity (22.44%) and the least mortality in the 10th parity (2.24%) in Marrah buffalo. This might be associated with the calving difficulty of young cows as a result of undeveloped reproductive systems and some genetic inheritance. The mortality rate was lower in the third parity as compared to the first parity in the Gir breed [43]. On the contrary, Kharkar *et al*. (2017) [16] observed higher mortality in the first parity as compared to the second parity but the non-significant effect of the parity of dam on calf mortality in Jersey × Sahiwal crossbred cattle.

Herd size

A marked increase in population density commonly increases the incidence of infectious diseases and mortality. Herd size is the most important risk factor for calf mortality [19,20,44,45]. The calf mortality rate was significantly higher in larger herd sizes than in small sizes. Buffalo calf mortality was higher in large herd sizes than in medium and small herd sizes. Tiwari *et al*., 2007[20]; Sreedhar and Sreenivas, 2015 [19]). Chowdhury *et al*. (2017) [45] also supported the previous finding of higher mortality in large sizes. The incidence risk of diarrhea and pneumonia was higher with the larger herd size. Herd size by itself has no biological effect on the calf's health; rather, it may be a measurement of other factors like the time available to observe and care for calves. Another possible reason for the apparent association between herd size and calf mortality could be that, in the case of small herd sizes, adequate time may elapse between successive births, which will decrease the concentration of infectious agents in the calf-rearing environment [44].

Geographic location

Geographic location is considered an important factor in determining the risk of mortality of calves. Several studies have been conducted in the country from different study sites and have documented data sources for major causes of calf mortality.

Table-1 *Geographic location for major causes of calf mortality*

Location	Breed	N	Death	Mortality %	References
NDRI, Karnal	Karan Swiss, Karan Fries, Tharparkar	-	-	14.17	Prasad *et al*., 2004[46]
Saurashtra, Gujarat	Non-descript	524	84	16.03	Patbandha *et al*., 2017[47]
Central India	Non-descript	92	5	5.40	Singh *et al*., 2009[2]
	Cross Bred	94	6	6.30	
Lucknow, U. P	Sahiwal	1435	81	5.64	Shahi and Kumar, 2014[30]
		286	19	6.64	
Indore, M. P	Gir	1528	61	3.99	Mishra *et al*., 2015[13]

Housing

Animal housing conditions greatly affect health and productivity. The cleanliness of the barn influences calf health as calves housed in unclean barns are at higher risk of diseases than calves housed in clean barns. Mortality was higher in dirty barns [44]. The cleanness of the calf house was found to be significantly associated with calf morbidity and diarrhea, i.e., the health of the calves [48].

Birth weight of calves

The size of calves at birth is the main factor for calving ease of the dams and neonatal survival of the calves [49]. The increased birth weight of calves is related to calving problems like dystocia and stillbirths, and ultimately it leads to calf mortality. Johanson and Berger (2003) [49] reported that the higher birth weight of calves was associated with increased calf mortality and dystocia in dairy cattle. However, the mortality rate declines as the birth weight increases in calves, and it was found to be higher in the lower-weight group [50]. McCorquodale *et al*. (2013) [35] reported that the calf weight at 0 to 8 days of age had a significant ($p<0.05$) effect on calf mortality. Lower birth weight of calves was associated with higher calf mortality. Calf mortality decreases gradually with an increase in birth weight and was lowest in calves weighing 41 kg and above at birth in HF calves. Bunter *et al*. (2013) [51] observed the highest calf mortality (14.5%) when calf birth weight was lower (<29 kg) and lower calf mortality (5.8%) for calves with higher birth weight (>39 kg).

Species and breeds of calves

Species and Breed were also identified as risk factors for calf mortality. Calf mortality was higher in buffalo calves [52,53]. Irrespective of sex, mortality was higher in buffalo calves (22.37%) as compared to cattle calves (18.74%) Jain *et al*. (2008) [53] also reported that buffalo calves (30.5%) had 3 times higher mortality than cattle calves (9%). Higher calf mortality has been reported in exotic breeds and crossbred calves than the indigenous/zebu calves [46,54]. Parasad *et al*. (2004) [46] reported that mortality was higher in Tharparkar (7.21) than in Karan Swiss (17.12%) and Karan Fries (14.17%) breeds. Esubalew and Debeb (2017) [54] also observed a higher rate of calf mortality in exotic breeds (37.5%) than in crossbred (21.51%) and indigenous (9.18%) breeds. Sharma *et al*. (1984) [35] observed higher mortality in Brown Swiss (22.23%) calves as compared to indigenous breeds like Sahiwal (17.70%) and Red Sindhi (16.62%) calves. High exotic blood level was found to have a significant effect on increased calf mortality rate. This might be due to the susceptibility of B. Taurus breeds to climatic and disease stress in tropical environments [57].

Farmer's status

Farmer's status was also identified as a risk factor for calf mortality. Calf mortality among landless or marginal farmers was higher than that of medium and large farmers. The mortality rate was higher in landless (52.5%) and marginal (22.5%) farmers than in the small (15.00%) and large farmers (10.00%) [55]. This might be due to the farmer's status providing good housing facilities and good nutritive feed to calves.

Time to ingestion of first colostrum

Calving management has a key effect on calf performance and health. In the calf, any delay in the time of colostrum feeding after birth reduces absorptive capacity. The complete loss of the ability to absorb Ig across the intestinal wall occurs 24 to 36 hours after birth [56]. Other than induced separation, the length of time after birth to first feeding can be increased due to dystocia and perinatal asphyxia. In artificial feeding systems, maximal Ig absorption is accomplished by feeding as soon after birth as possible. The method of feeding colostrum is worth considering because this can influence the time to first feeding, volume ingested, and efficiency of passive Ig absorption. The amount of colostrum and its method of provision was found to be significantly associated with calf mortality. Those calves with a history of partial colostrum feeding were at a higher risk of mortality than those calves with complete colostrum feeding [54]. They also suggested that hand feeding was better than suckling. Recent studies have found 46-61% of calves that failed to suckle in the first 6 hours after birth. Reasons for this delay include a low pendulous udder, large teats, poor mothering ability, calves born in very cold weather, or those experiencing difficulty in birth/dystocia.

Conclusion

Calf mortality is one of the major problems on dairy farms worldwide. The first three months of calving are the most crucial for survivability on any dairy farm. Different environmental factors play a significant role in most of the survivability traits of calves, which indicates the need for optimum standardization of calf rearing and management practices on the farm for better survivability of calves. These may include proper housing and hygiene, adequate provision of high-quality colostrum during the first 6 hours, allocation of adequate feed and close notice to animals to minimize the transfer of diseases, disease prevention and control measures such as regular vaccinations, chemotherapeutic measures, and awareness creation on good record-keeping and animal health practices.

Application of research

These traits can be improved genetically through the selection of superior sires. Low heritability estimates of survivability traits indicate very slow genetic progress by the selection, and thus the survivability of calves could be improved by better management practices.

Research Category: Animal Science

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