A STUDY OF PATTERN IN CALF MORTALITY AT AN ORGANIZED MURRAH BUFFALO HERD IN INDIA: A 24 YEAR REVIEW

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ABSTRACT

The Present study was conducted to retrospectively analyze the pattern of calf mortality (0 to 1 year age) from 1992 to 1993 to 2015 to 2016 in an organized Murrah buffalo herd maintained at Central Institute for Research on Buffaloes (CIRB), Hisar, Haryana. During the study period, highest calf mortality (8.35%) was observed inperiod P1 (1992 to 1995), while lowest mortality (2.64%) was observed in P7 (2010 to 2013) with an overall mortality rate of 4.94% from 1992 1993 to 2015 to 2016 over the period of twenty five years. The overallage-specific mortality (9.5%) was observed highest in Group I: birth to three months age, while lowest mortality (2.5%) was observed in Group 3: 6 to 12 months age. There was no significant difference in overall sex-specific mortality ($P \leq 0.01$) over the period of twenty four years. Highest proportionate mortality rate (37.6%) was observed during winter season and greatest losses in terms of proportionate mortality rate (30.7%) were attributed to gastrointestinal plus pneumonia causes of mortality. Chi square test depicted statistically significant association of period, age group, season and cause of deathwith the calf mortality at $P \leq 0.01$. Retrospective investigation indicates that overall calf mortality rate from birth to one year of age was much lesser during the recent period (P7: 2.6%, P8: 3.1%) possibly attributed to good husbandry conditions including routine vaccination schedule, optimum colostrum feeding and improved nutritional management as contributing factors here for a steady improvement in the management and health status of calves through time. Based on findings of the highest mortality up to 3 months age (9.5%) in the present study, proper hygienic conditions in calf sheds, adequate healthcare, appropriate colostrum feeding and good husbandry conditions during this critical period are recommended to minimise the calf exposure to new infections.

Keywords: *Bubalus bubalis*, buffaloes, Murrah buffalo, calf mortality, age, sex, season, cause of mortality

INTRODUCTION

Raising of healthy calves plays an imperative role in the economics and sustenanceof dairy enterprises. Calf mortality adversely affects replacement stock to maintain herd sizethereby causing financial liabilities to poor farmers.

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Various studies revealed that calf mortality was mainly attributed to conditions like diarrhea, pneumonia and septicemia which are hastened by faulty managemental practices including delayed and inadequatecolostrum feeding,unhygienic calf sheds, internal and external parasitic infestations andmeteorological factors of harsh weather conditions(Blood *et al*, 1994). It has been found that 20% cattle calf mortalityrate can decrease the net profit of a dairy enterprise by 38% in comparison with a goal of mortalityrate of 5% (Amuamutu *et al*., 2006). In a well-managed dairy farm, calf mortality should not be greater than 5% from birth to 1 month age (Radostits *et al*., 2006). From epidemiological point of view, study on the pattern of calf mortality proves an important guideline to assess risk factors associated with calf mortality thereby designing improved managemental practices to avoid excessive mortality in future.

The present study was thereforecarried outto retrospectively investigateoverall mortalityand mortality pattern of calvesand to analyze mortality in respect to period, age, sex, season and cause of death inan organizedMurrah buffalo herd maintained at CIRB where scientific calf management practices were adopted for management and improvement of buffaloes.

MATERIALS AND METHODS

Data collection

The study used raw data on the death of individual calftaken from the record books and annual reports maintained at CIRB over a period of 24 years between 1 April 1992 and 31 March 2016 excluding stillbirths.The collected data were entered and compiled in Microsoft excel spread sheet for descriptive analysis of calf mortality rate excluding uncertain or unverifiable data entries.

Study area and Study design

The climatic conditions of this semi-arid belt of Haryana were distinctly seasonal in terms of an annual cycle of hot weather season (May to July), southwest monsoon season (July to September), autumn (October to November), cold weather (December to February) and spring season (March to April). The calf mortality was retrospectively analysed from 1 April 1992 to 31 March 2016 (twenty four years). Calves werecategorized into three age groups; Group 1 (G1): birth 3 month, Group 2 (G2): 3 to 6 months and Group 3 (G3): 6 to 12 months. The mortality rate was calculated as the number of deathsdue to all causes divided by the sum of all animals at risk of dyingin a defined population during a particular time period (Thrushfield *et al*., 2007) and this calculation was expressed as a percentage. Calves born from May to June, July to September, October to November, December to February and March to April were categorized as being born in summer, monsoon, autumn, winter and spring seasons respectively. To identify any pattern or trend in calf mortalityover 24 years between 1 April 1992 and 31 March 2016, the data were categorized into eight periods: P1 (1992 to 1995), P2 (1995 to 1998), P3 (1998 to 2001), P4 (2001 to 2004), P5 (2004 to 2007), P6 (2007 to 2010), P7 (2010 to 2013) and P8 (2013 to 2016).

Management practices

Artificial insemination (AI) with the frozen semen of progeny tested Murrah buffalo bulls was practiced. Calves were allowed to suckle the colostrum immediately after parturitionfor first three days followed by restricted suckling practice twice a daymorning and evening before

milking of damsthroughout the lactation. Weaning is delayed as buffalo has a strong maternal instinct. Calf starter/ concentrate with green fodder was introduced from two weeks of age onwards. Calves were kept in groups according to their age in calf sheds till the completion of dam's lactation. Regular prophylactic and therapeutic measures *viz*. deworming, vaccination, routine health checkup twice daily and treatment of sick calves were done efficiently and timely. Managemental practices adopted were clean dry calf sheds, protection from harsh weather conditions, clean and fresh drinking water ad libidum.

Statistical analysis

The association among calf mortality (the dependent variable) and the risk factors such as period, age, sex, season, causes of mortality (independent variables) were tested using Chi-square test. P-value of <0.01 was considered as statistical significant.

RESULTS AND DISCUSSION

A descriptive data of the results obtained in the study is shown in Table 1. Overall mortality: From the total 13575 calves up to 1 year age, a total of 671 calves died across the period P1 (1992 to 1993) to P8 (2015 to 2016) with an overall mortality rate of 4.94% over 24 years (Table 1).

Overall mortality rate steadily decreased from P1, 8.3% to P3, 4.0% showing a clear decliningpattern of mortalityacross the three periodswith percentage decrease between 32% and 31%.Thereafter, a trend ofcontinual increase in mortality could be identified in the next three periods from P4 to P6 where the mortality rate increased from 4.5% to 5.9% with a fairly uniform percentage increasevarying between 15% and 12%. The lowest mortality was observed in P7 (2.6%), about half that of P6 (55.1% decline) followed by P8 (3.1%) (Figure 1). Chi square test ($\chi 2 = 80.8$, $P<0.001$) depicted statistically highly significant association of periodwith the calf mortality at $P\leq0.01$ (Table 1).

Age-specific mortality rate: Over the period P1 (1992 to 1993) to P8 (2015 to 2016), 434, 124 and 113 calves died in G1, G2 and G3 age groups respectively from the total of 671 deaths. Highest overall mortality rate (9.5 %) accounted for 65% of total calf deathwas observed in calves of G1: birth 3 months age group followed by G2: 3 to 6 months (2.7%) and G3: 6 to 12 months (2.5%) (Table 1). In G1, mortality rate decreased by 50% from P1 (1992 to 1995 = 14.1) to P2 (1995 to 1998 = 7.1%) showing a clear declining pattern of mortality across the two periods. Following this, the mortality rate fluctuated between 8.9% and 12.6% in the next three periods from P3 to P5 (1998 to 1 = 8.9, 2001 to 2004 = 8.1, 2004 to 07 = 12.6%). Thereafter, a pattern of decrease in mortality could be identified in the next two periods from P6 to P7 where the mortality rate declinedby 44% from 11.0% to 6.2%. Mortality rate was lowest in the P7 (2010 to 2013 = 6.2 %) followed by P8 (2013 to 16 = 6.7%) period (Figure 2). A trend of declining mortality in P7 and P8 might be the result of better management and health control measures in CIRB herd.

Group 2: 3 to 6 months age had an overall mortality rate of 2.7%, which was about equal to that of Group 3: 6 to 12 months (2.5%). Mortality rate in Group 2 was highest in the P1, P2 and P4 (1992 to 1995 = 4.3%, 1995 to 1998 = 4.3%, 2001 to 2004 = 3.2) which accounted for 58.1% of the overall deaths in Group 2. Since P3 (1998 to 1901 = 2.0%), the mortality rate has been at or below the

Table 1. Demographic characteristics and relationship of risk factors age, sex, period, season and cause of death with Murrah buffalo calves mortality from 1992-2016: results of chi square test.

Age[a]	Born (numbers)	Mortality (numbers)	Mortality (%)	chi square value	P-value
G1	4584	434	9.5	296.951	<0.001*
G2	4513	124	2.7		
G3	4478	113	2.5		
Overall	13575.0	671	4.94		
Sex					
Male	6648	335	5.04	0.001	0.969NS
Female	6927	336	4.9		
Overall	13575	671	4.94		
Periods[b]					
P1	1593	133	8.35	80.8	<0.001*
P2	1600	91	5.69		
P3	1948	77	3.95		
P4	2177	99	4.55		
P5	1929	101	5.24		
P6	1500	88	5.87		
P7	1366	36	2.64		
P8	1462	46	3.15		
Overall	13575	671	4.94		
Seasons[c]			Proportionate Mortality rate		
Hot		46	6.86	172.52	<0.001*
southwest monsoon		148	22.06		
Autumn		126	18.78		
Cold		252	37.56		
Spring		99	14.75		
Overall		671.00	100		

Table 1. Demographic characteristics and relationship of risk factors age, sex, period, season and cause of death with Murrah buffalo calves mortality from 1992-2016: results of chi square test. (Continue)

Age[a]	Born (numbers)	Mortality (numbers)	Mortality (%)	chi square value	P-value
Diseases[d]					
Gastrointestinal		170	25.34	21.39	<0.001*
Respiratory		173	25.78		
Respiratory plus Gastrointestinal		206	30.70		
Others		122	18.18		
Total		671	100		

[a]Age was categorized into three groups: G1 (birth to 3 month), G2 (3 to 6 months) and G3 (6 to 12 months).

[b]Periods were categorized as following: P1 (1992-1995), P2 (1995-1998), P3 (1998-1901), P4 (2001-1904), P5 2004-2007), P6 (2007-2010), P7 (2010-2013) and P8 (2013-2016).

[c]Seasons include hot weather (May to July), southwest monsoon (July to September), autumn (October to November), cold (December to February) and spring season (March to April).

[d]Diseases were defined as the following: Gastrointestinal, Respiratory (Pneumonia, bronchopneumonia), Respiratory plus Gastrointestinal (enteritis, gastritis), others (navel ill, ascariasis, septicemia, toxemia, accidents, strangulation of intestine, haemorrhages of visceral organs, hepatitis, peritonitis, pleuritis, and pericarditis)

*Significant at 1% level of significance (P≤0.01).

[NS]Nonsignificant

overall mortality rate of 2.7% in Group 2 except P4 (2001 to 2004 = 3.2) and P6 (2007 to 2010 = 2.8%). Mortality rate in Group 3 was highest in the P2, P1 and P6 (1995 to 1998 = 5.7%, 1992 to 95 = 5.5%, 2007 to 2010 = 3.5) which accounted for 61.1% of the overall deaths in Group 3. Following P3 (1998 to 1901 = 1.0%), the mortality rate has been below the overall mortality rate of 2.5% in Group 3 except P4 (2001 to 2004 = 2.6) and P6 (2007 to 2010 = 3.5 %). Among the risk factors assessed, there was statistically highly significant association ($\chi 2 = 296.951$, $P<0.001$) of age groups G1, G2 and G3 with the calf mortality at $P\leq0.01$ (Table 1 and Figure 2).

Sex specific calf mortality pattern: Sex wise overall mortality up to one year age for male and female calves across the period 1992 to 2016 was found to be 5.04 and 4.85%, respectively. For G1, G2 and G3, 52.1%, 50.8% and 40.7% calves that died were male respectively and 47.9%, 49.2 and 59.3% died calves were female in G1, G2 and G3 respectively over the period of 24 years. No statistically significant association of sexwith the calf mortality was found ($\chi 2 = 0.001$, P 0.969) at $P\leq0.01$ (Table 1 and Figure 3).

Season specific mortality rate: Mortality rate in calves during four seasons of the year is presented in Table 1 and Figure 4. The maximum mortality observed was during cold weather followed bysouthwest monsoon, autumn, spring and hot weather season amounting to 37.6%, 22.1%, 18.8%, 14.8% and 6.9% of the total mortality respectively. Season ($\chi 2 = 296.951$, $P<0.001$) was found to be significantly associated with the calf mortality (Table 1).

Cause specific mortality rate: Diseaswise proportional mortality rate are presented in Table 1 and Figure 5. This reveals that greatest losses in calves were due to respiratory plus gastrointestinal diseases followed sequentially byrespiratory, gastro intestinal and other group constituting to 30.70, 25.78, 25.34 and 18.18% of total mortality respectively.

The annual steady patterns of increases and decreases in mortality rate between the years 1992 to 1993 to 2015 to 2016 made it difficult to identify a trend in overall mortality rate over 24 years so time period was categorized into eight periods. Retrospective investigation indicates that overall calf mortality rate from birth to one year of agewas higher during the initial periods (P1: 8.3%, P2: 5.7%) whereas it was much lesser during the recent period (P7: 2.6%, P8: 3.1%) when it attained significantly lower levels of calf mortality. There are many possible reasons whyrecent periods had consistently lower mortality rate than earlier periods, attributed to the better neonatal care including navel disinfection, protection from extreme climatic conditions, regular deworming, probiotic supplementation of calves, ensuring passive immunization of calves through downcalvers, vaccination and timely therapeutic support to sick animals. In addition, improved nutritional management with optimum colostrum feeding and good husbandry conditions are contributing factors here for a steady improvement in the management and health status of calves through time. The lowest mortality observed in P7 (2.6%), about half that of P6 (55.1% decline) followed by P8 (3.1%) helped to conserve and disseminate male germplasm through various agencies including state livestock development boards (MP LDB). The overall mortality from birth to one year of age across P1 to P8 was 4.9% which is in contrast with the findings of Patil *et al.* (1992); Sreedhar *et al*. (2010); Sharma *et al*. (1975); Verma *et al*. (1980); Ramakrishna *et al*. (2007); Tajane *et al.* (1983); Bhullar and Tiwana (1985);

Verma and Kalra (1974) in buffalo calves, Romha (2014) in cattle calves and Chaudhary (2013) in bovine calvesof up to one year age whose figures were 9.84%, 22%, 23.9%, 31.45%, 32.4%, 34.83%, 33.98 %, 37.3%, 11.6% and 21.53% respectively.

For age specific mortality rate, G1 had the highest overall mortality rate (9.5%) of the three age groups accounted for 65% of total calf death, both in terms of mortality rate by period and sex. However, a considerably high mortality corresponding to 34%, 25.24% and 38.85%, respectively for this age group has been reported earlier by Bhullar and Tiwana (1985) in buffalo calves, Kulkarni and Bansod (2001) in female cattle calves and Acharya (1988) in buffalo calves. The overall mortality rate for the remaining two groups, G2 (2.7%) and G3 (2.5%) were lower than G1 but were broadly similar to one another accounted for 18% and 17% of total calf death respectively with an annual trend of increases and decreases differed between the groups. The difference in mortality between birth to 3 months (G1) and up to 1 year age (G1 to G3) is also interesting, with the mortality rate of the G1 (9.5%) being higher than that of the G1 to G3 (4.9%) together .

This difference arose because although the G1 consistently had higher mortality rate, for G2 and G3, mortality rate was low. There are many possible reasons why GI had higher mortality than other two groups. First, the resilience of calves to disease differed between age groups. The retrospective study is in agreement with the established fact of decrease in mortality with increasing age. The findings of Sharma *et al.* (1975); Rao and Nagarcenkar (1980); Rana *et al.* (2010) also revealed decline in mortality with the advancement of age. As the calves grow, they acquire immunity to defend themselves from a wide variety of infections.The second major contributing factor to mortality is that of husbandry practices. Based on findings of the highest mortality up to 3 months age in the present study, it is recommended that the appropriate calf management measures such as maintenance of proper hygienic conditions in calf sheds, adequate healthcare and appropriate colostrum feeding during this critical period should always be in place to minimise the calf exposure to new infections.

No significant difference was observed in overall sex specific mortality over the period of twenty five years. Calves are reared without any bias at the institute. The male calves always remain on high demand from various states and national developmental agencies whereas female calves remain crucial for future herd replacement, progeny testing and elite bull production. All India Coordinated Research Project on buffaloes (AICRPB) was started in the year 1970 to 1971 with objective to enhance milk production of buffaloes by means of evaluating genetic merit of sires to produce proven superior bulls and by breeding, feeding and management. The erstwhile AICRP was renamed as Network Project on Buffalo Improvement (NPBI) since 1993, CIRB as a nodal centre with the aim to establish elite buffaloes herd for genetically superior young bulls production, select young bull calves on the basis of their pedigree performance, evaluate sires through progeny testing and to conserve male germplasm and its dissemination. (Sethi and Kaushik, 1996). Emphasis for maintaining health of male calves is equally important for this herd since inception of NPBI. The female calf mortality rate directly affects farms own requirement of replacement heifers and objective of sire evaluation. Contrary to this, sex-biased mortality pattern has been reported by Sharma *et al.* (1984) with high female calf mortality. Rao and Nagarcenkar (1980)

reported high mortality in male calves while Khan and Khan (1995), conversely, observed no sex-wise difference on rate of mortality in young buffalo calves.

Highest proportional season-specific mortality rate was observed during cold weather followed by southwest monsoon, autumn, spring and hot weather season. Increased mortality rate during cold season might be attributed to environmental stress associated with cold inclement weather wherein sudden climatic changes make calves prone to conditions like pneumonia and diarrhoea. High relative humidity and less bright hours lead to unhygienic calf sheds and wet beddings that make young calves more susceptible to infections. Therefore high mortality in cold season is an indicative of scope for further improvement in health of buffalo calves by preventing them from exposure to cold through adoption of weather forecast data, housing hygieneand individual housing, especially during early stage of calf hood. Similar high pattern of mortality during winter season was reported by Dhanda and Khera (1957); Singh and Singh (1971); Mishra (1977); Tomar (1973); Jain and Sharma (1982). Srivastva *et al.* (1973); Roy *et al.* (1977) contrarily reported a high mortality rate during monsoon season.

Cause-specific proportional mortality rate was highest due to respiratory plus gastrointestinal diseases followed sequentially by respiratory, gastro intestinal and other group respectively. During 2011 to 2012, calves of this herd suffering from diarrhea were diagnosed for etiology under the ongoing Pfizer project at NRCE, 2011 to 2012 and found positive for Rotavirus, *Coronavirus*, *Salmonella* and *E. coli* (unpublished data from Pfizer project at NRCE, 2011 to 2012). Dam vaccination against Rota virus may reduce mortality and morbidity but there is no alternative of good colostrum program or good housing/ hygiene. To minimize the economic and germplasm losses due to calf mortality, it becomes essential to maintain calf records for birth weight, colostrum intake and disease diagnosis including cause based necropsy examination to assist in identifying problems and updating management protocol. These findings are in consonance with Rana *et al.* (2010) who reported pneumoenteritis, pneumonia and enteritis to be the principal causes of mortality in that order. Contrarily, Dhanda and Khera (1957); Damodaran and Sundararaj (1974); Sharma *et al.* (1975); Verma *et al.* (1980); Raoand (1980); Bhullar and Tiwana (1985); Roy *et al*. (1997); Kulkarni and Bansod (2001) reported gastro intestinal followed by respiratory as the major cause of mortality in calves.

Interestingly, we found that after the introduction of FMD + HS Oil Adjuvant vaccine regime against haemorrhagic septicaemia and FMD in calves at CIRB herd with a vaccination schedule of twice a year along with a booster dose at an interval of 2 weeks after primary vaccination at three months age has decreased pneumonia mortality cases suspected for haemorrhagic septicaemia in calves since 2011. Before year 2011, alum precipitated vaccine against HS was used and HS suspected cases were more depicting the importance of considering selection of product and timing of vaccination. It is possible that change in design of vaccination programme against HS from alum precipitated vaccine annually to oil adjuvant vaccine twice a yearwithadoption of a strict vaccine regime since 2011 and low mortality cases of pneumonia thereafter might have made finding an association between vaccination and calf mortality at CIRB herd.Based on findings in the present study, it is recommended that early

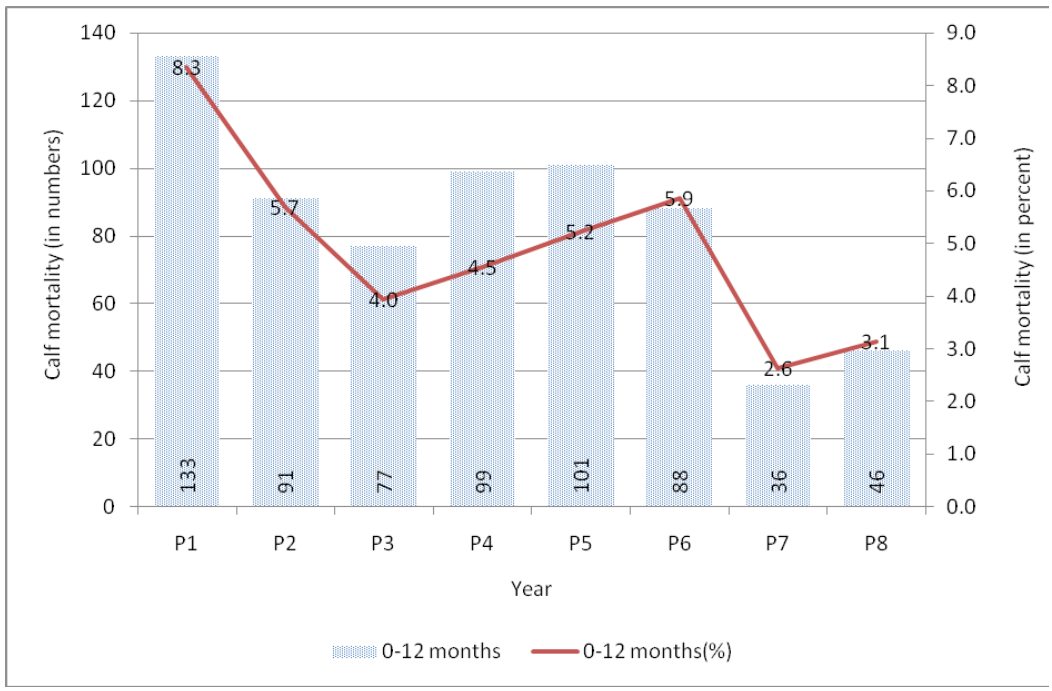

Figure 1. Overall mortality rate trend of Murrah buffalo calves up to one year age across the period P1 (1992-1993) to P8 (2015-2016).

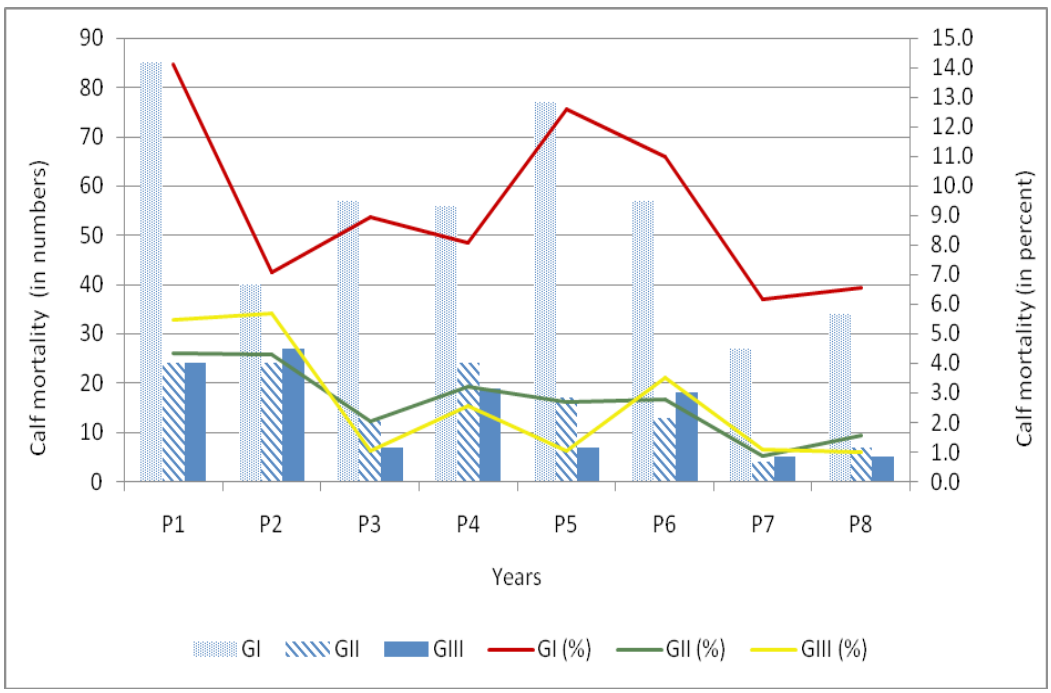

Figure 2. Age-specific mortality of Murrah buffalo calves from period P1 (1992 to 1995) to P8 (2013 to 2016).

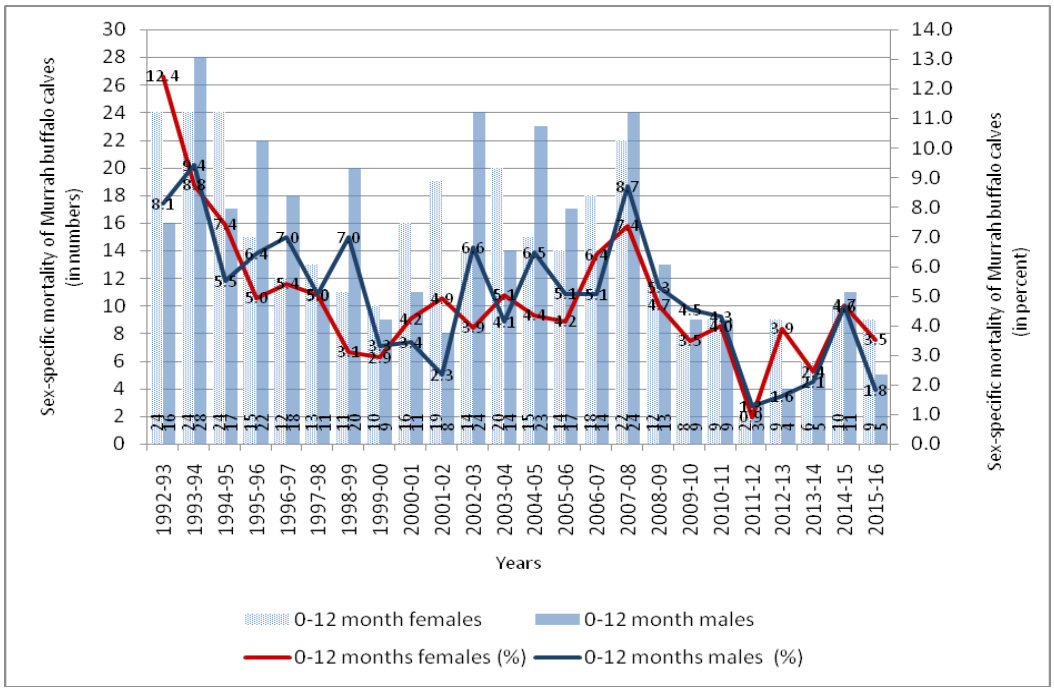

Figure 3. Sex-specific mortality of Murrah buffalo calves from 1992 to 2016.

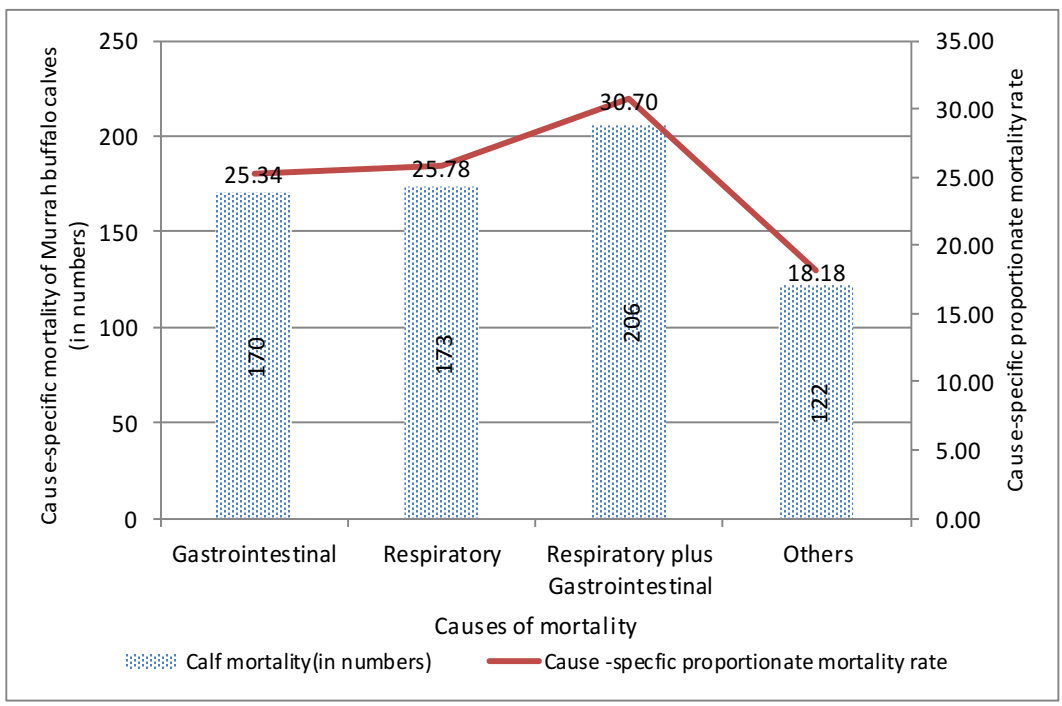

Figure 4. Season specific mortality of Murrah buffalo calves from 1992 to 2016.

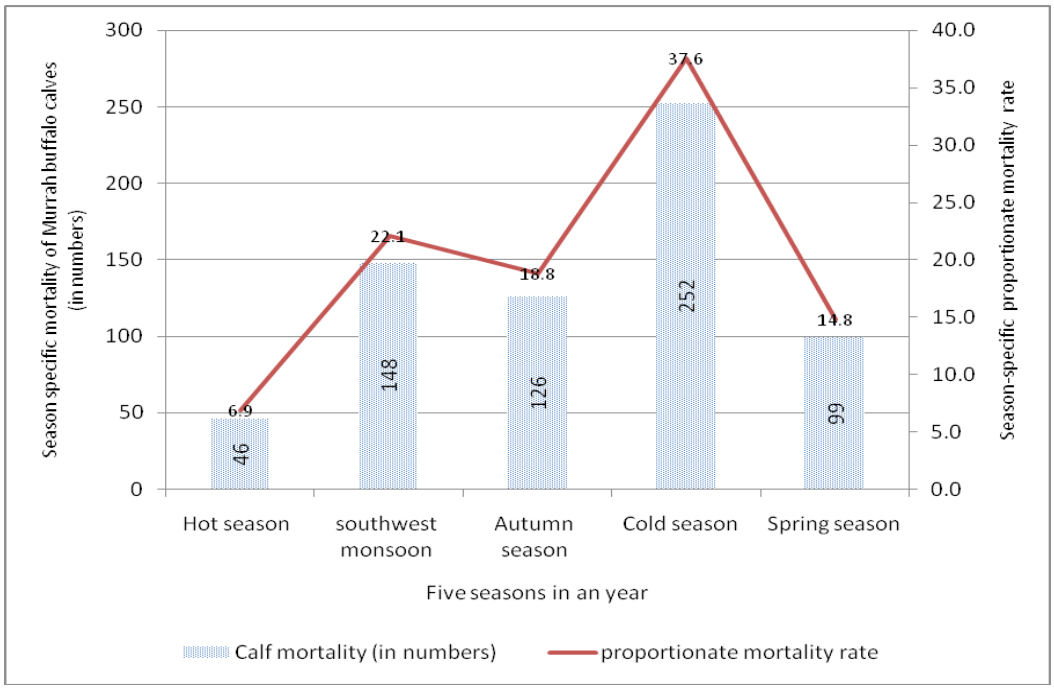

Figure 5. Cause specific mortality of Murrah buffalo calves from 1992 to 2016.

diagnosis of disease; good husbandry practices and isolation of causative agents from diarrheic and pneumonic calves for regular updating of therapeutic measures are needed.

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