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RESEARCH ARTICLE

Genetic and non-genetic factors affecting calf survivability in Gir crossbreds

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Abstract: Data on survivability traits of Gir crossbred calves, maintained at RCDP on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra was collected for a period of 15 years (2005-2019) to study effect of genetic and non-genetic factors on survivability traits of calf. Traits studied were survivability at day 0-3, 4-15, 16-30, 3-90, 91-180 and 181-365 days. To determine the effects of genetic and non-genetic factors on survivability traits, least squares analysis of variance (Harvey, 1990) was applied, considering the fixed effects like genetic group, season and period of birth, parity of dam and birth weight of calves. The least square means of survivability per cent of Gir crossbred calves at 0-3, 4-15, 16-30, 31-90, 91-180 and 181-365 days were 96.17±0.80, 86.17±2.12, 89.23±2.03, 80.39±2.89, 83.41±3.02 and 95.61±1.79 per cent, respectively. The significant (P<0.05) effect of period of birth was found on calf survivability trait at different ages viz. days 31-90 and days 181-365. Parity of dam had non-significant effect on calf survivability traits of the Gir crossbred calves. Significant (P<0.05) effect of season of birth on calf survivability was observed only at 0-3 days age survivability trait. Significant (P<0.05) effect of sex of calves on survivability traits was recorded at 0-3, 4-15, 16-30 and 31-90 days. In the present study, birth weight of calf had significant (P<0.01) effect on calf survivability at 0-3 days after birth. The non-significant effect was reported among the survivability patterns of calves with different genetic groups.

Keywords: Calf survivability, Genetic factors, Non-genetic factors

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Introduction

Calves are the future progeny of livestock sector. Future of dairy herd solely depends upon successful rearing of new born calves and heifers. Healthy calves are not only required for sustenance of dairy herd but also necessary for preserving authenticated germplasm. In a dairy farm, a high survival rate aids in increasing selection pressure, which is one of the most important elements determining genetic gain and profitable returns (Sreedhar and Sreenivas, 2015). In rural dairy farms, the growth performance of calves revealed poor health condition, which indicates that lack of awareness among farmers on scientific management of calves (Tiwari et al. 2007). Dairy cattle mortality is important not only with regards to financial losses, but also in terms of animal health and welfare. For genetic improvement, efforts need to be increasing the intensity of selection, which becomes possible by increasing the herd size and the number of offspring reaching the milking herd in the next generation.

Although calf and heifer mortality reported to be relatively low, but they arise ethical issues and their economic impact on cattle breeding is substantial. Higher young stock or heifer mortality results in more replacement and veterinarian costs and reduced possibility for selection and genetic gain. As replacement costs increase with age, losses at higher ages up to first calving are even more economically important than early losses. Concerns related to animal health and welfare are increasing day by day, and hence these aspects should be considered in future animal breeding strategies. Thus, necessary measures can be taken by improving management practices and by studying the genetic factors deciding the ability of calf to survive. It is thus essential to make, calf survival traits as integral part in the definition of an overall breeding objective in cattle. In dairy cattle breeding, genetic improvement of survival traits and welfare of newborn calves have been not paid attention for a long time. The reason for this is that calves have traditionally been viewed as a cost rather than an investment by farmers. Time, labor, and money spent on raising healthy calves do not yield immediate results, but are only quantifiable over time. Calf health, welfare, and survival data are limited and not frequently collected, with the exception of features that can be linked to the dam of the calf, such as calving ease and stillbirth, which are included in routine

collection schemes. This results in newborn calves that have little information available at the time of birth and then disappear for two years only to come back after first calving. However, genetic studies regarding the losses from birth to calving are not enough and little information is available about survival traits of calves. Looking to this present study was planned to study the effect of genetic and non-genetic factors on calf survivability.

Materials and Methods

Data on mortality of Gir crossbred calves, maintained at the Research cum Development Project on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri were collected for a period of 15 years (2005-2019). Data were classified as period of birth, parity of dam, season of birth, sex of calf and birth weight group of calf and genetic group of calves. The year of birth was classified as 3 periods of birth, each period comprising of 5 years. Each year was divided into 3 seasons of birth viz. rainy (June to September), winter (October to January) and summer (February to May). Parity of dam was classified as 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and above. Sex of calf was grouped as male and female calves. The birth weight of calf has been grouped into 5 classes as d" 15 kg, > 15 kg tod" 20 kg, > 20 kg to d" 25 kg, > 25 kg to d" 30 kg and > 30 kg. On the basis of exotic inheritance of calves, the data was distributed into 5 genetic groups as G_1 (50% HF + 50% Gir), G_2 (50% HF + 25% Jersey + 25% Gir), G_3 (50% HF + 12.5% Jersey + 37.5% Gir), G_4 (50% Jersey + 50% Gir) and G_5 (75% HF + 25% Gir). The traits considered for the study were survivability from 0 to 3, 4 to 15, 16 to 30, 31 to 90, 91 to 180 and 181 to 365 days. The mean, standard error and coefficient of variation of all traits were estimated by using standard statistical procedures (Snedecor and Cochran, 1994). The data of all traits were normalized using mean and standard deviation of traits. To determine the effects of genetic and non-genetic factors on survivability traits, least squares analysis of variance (Harvey, 1990) was applied considering the fixed effects like genetic groups of calves, season and period of birth, parity of dam and birth weight of calves. The random effect of sire was also included in the model. The following model was used:

$$Yijklmno = \mu + Si + GGj + POBk + SOBl + PYm + BWn + eijklmno$$

Where,

$Y_{ijklmno}$ = o^{th} survivability observation of the calf which is progeny of i^{th} sire, having j^{th} genetic group, born in k^{th} period and l^{th} season, having m^{th} parity of dam, n^{th} birth weight of the calf.

μ = overall mean

S_i = random effect of i^{th} sire

GG_j = effect of j^{th} genetic group (j = 1, 2, 3, 4, 5)

POB_k = effect of k^{th} period of birth (k = 1, 2, 3)

SOB_l = effect of l^{th} season of birth (l = 1, 2, 3)

PY_m = effect of m^{th} parity of dam (m = 1, 2, 3, 4, 5, 6, 7)

BW_n = effect of n^{th} birth weight of calf (n = 1, 2, 3, 4, 5)

$e_{ijklmno}$ = random error associated with each observation assumed to be NID (0, ó$_e^2$)

Results and Discussion

Measurement of central tendency and dispersion of raw data

The mean values along with their standard deviations (S.D.) and coefficient of variation (C.V.) of calf survivability traits of Gir crossbred calves at different ages are presented in Table 1.

Causes of calf mortality

The highest (37.11%) mortality was reported due to gastroenteritis / diarrhoea followed by respiratory disease mainly pneumonia (25.76%), hepatitis (10.91%), pyrexia (8.87%), tympany / bloat (3.05%) and other causes were 14.26 per cent.

However, Kharkar et al. (2017) studied mortality percentage in Jersey and Sahiwal crosses, and found that highest mortality in calves were due to gastroenteritis (32.81%) followed by pneumonia (18.75%), septicaemia (12.50%) and other causes (15.63%). whereas, Mishra et al. (2015) reported that mortality in calves were mainly due to diarrhoea and respiratory diseases.

Table 1. Statistical analysis of calf survivability traits

Traits	Mean	S.D.	C.V.(%)
S_1	0.98	0.12	12.39
S_2	0.88	0.32	36.15
S_3	0.92	0.28	30.35
S_4	0.83	0.38	45.95
S_5	0.86	0.35	40.90
S_6	0.96	0.19	19.61

(Mean obtained based on 1389 observations)

Occurrence of calf survivability

The least square means of survivability per cent of Gir crossbred calves at days 0-3, 4-15, 16-30, 31-90, 91-180 and 181-365 were 96.17±0.80, 86.17±2.12, 89.23±2.03, 80.39±2.89, 83.41±3.02 and 95.61±1.79, per cent respectively (Table No. 2 and 3).

Effect of genetic and non-genetic factors on different calf survivability traits

The significant (P<0.05) effect of period of birth was found on calf survivability trait at different ages viz. D 31-90 and D 181-365. Significant effect of period of birth on calf survivability was also noticed by Singh and Gurnani (2003), Mishra et al. (2015) and Kharkar et al. (2017) in different breeds of cattle. The parity of dam had non-significant effect on calf survivability traits of the Gir crossbred calves. Similar to present findings, Hansen et al. (2003) and Gulliksen et al. (2009) observed that calf mortality was not influenced by parity of dam in different cattle breeds. Study in Jersey × Sahiwal crosses by Kharkar et al. (2017) also revealed that parity of dam not showed any significant effect on calf mortality. Conversely, Norberg et al. (2013) and Mishra et al. (2015) observed significant effect of parity on calf mortality at different ages after birth of crossbred calves. The significant (P<0.05) effect of season of birth on calf survivability was observed at D 0-3 age survivability trait. Findings of the present study showed that highest survivability was observed in calves born in winter (97.30%) followed by rainy (95.92%) and summer (95.28%) season at 0-3 days age period. Gulliksen et al. (2009) and Panmei et al. (2014) observed that the calf mortality was significantly (P<0.05) influenced by season of birth of calves in different breeds of cattle. Significant (P<0.05) effect of sex on survivability was recorded at 0-3, 4-15, 16-30 and 31-90 days. Similarly, several research workers Kulkarni and Bansod (2001), Kumar et al. (2002) and Mishra et al. (2015) reported that highest mortality was observed in male calves. Birth weight of calf had significant (P<0.01) effect on calf survivability at 0-3 days after birth. Calves having low birth weight (<15Kg) having more risk of mortality than calves with high birth weight. Survivability per cent increases with increasing birth weight at different ages of calves. These findings were supported by research workers like Riley et al. (2004), Henderson et al. (2011) and Bunter et al. (2014) revealed that low birth weight and poor vigor at the time of birth,

Table 2. Least squares means of calf survivability at 0-3, 4-15 and 16-30 days in Gir crossbreds

Parameters	Survivability per cent at D 0-3	Survivability per cent at D 4-15	Survivability per cent at D 16-30
Overall mean	96.17±0.80 (1389)	86.17±2.12 (1368)	89.23±2.03 (1210)
	Period of Birth (POB)		
P_1	96.22±1.23 (380)	88.61±3.22 (376)	92.58±3.03 (347)
P_2	95.94±1.01 (489)	88.67±2.65 (481)	90.79±2.53 (441)
P_3	96.35±1.42 (520)	81.23±3.69 (511)	84.31±3.53 (422)
	Parity of Dam (PY)		
PY_1	96.65±1.02 (315)	86.55±2.65 (310)	89.58±2.54 (270)
PY_2	95.19±1.07 (274)	85.03±2.82 (268)	90.67±2.69 (236)
PY_3	96.53±1.13 (210)	87.22±2.96 (208)	87.61±2.83 (187)
PY_4	95.99±1.18 (178)	84.81±3.08 (176)	89.61±2.97 (154)
PY_5	96.31±1.25 (150)	87.47±3.27 (148)	86.49±3.08 (134)
PY_6	96.61±1.38 (115)	82.99±3.60 (114)	90.25±3.45 (99)
PY_7	95.89±1.27 (147)	89.12±3.31 (144)	90.38±3.10 (130)
	Season of Birth (SOB)		
S_1	95.92^{b}±0.96 (397)	86.61±2.54 (390)	89.09±2.41 (350)
S_2	97.30^{a}±0.90 (536)	87.72±2.36 (532)	87.41±2.25 (467)
S_3	95.28^{b}±0.96 (456)	84.18±2.53 (446)	91.17±2.43 (393)
		Sex of Calf	
Male	95.35^{b}±0.90 (492)	81.55^{b}±2.38 (480)	85.62^{b}±2.31 (401)
Female	96.99^{a}±0.86 (897)	90.79^{a}±2.26 (888)	92.83^{a}±2.15 (809)
	Birth Weight (BW) of Calf		
B_1	86.53^{b}±1.95 (48)	75.95±5.36 (42)	83.41±5.52 (31)
B_2	97.81^{a}±0.90 (439)	86.99±2.35 (434)	90.92±2.22 (382)
B_3	98.10^{a}±0.87 (461)	90.12±2.26 (456)	90.18±2.10 (411)
B_4	98.61^{a}±0.96 (330)	89.88±2.50 (326)	92.00±2.35 (291)
B_5	99.79^{a}±1.38 (111)	87.92±3.56 (110)	89.63±3.41 (95)

(Means with different superscripts differ significantly (P<0.05) from each other, values in parenthesis are number of observations)

Table 3. Least squares means of calf survivability at 31-90, 91-180 and 181-365 days in Gir crossbreds

Parameters	Survivability per cent at D 31-90	Survivability per cent at D 91-180	Survivability per cent at D 181-365
Overall mean	80.39±2.89 (1108)	83.41±3.02 (915)	95.61±1.79 (784)
	Period of Birth (POB)		
P_1	91.98[a]±4.21 (331)	85.36±4.40 (289)	97.55[a]±2.65 (246)
P_2	82.35[a]±3.56 (412)	85.60±3.75 (347)	98.97[a]±2.28 (301)
P_3	66.84[b]±5.01 (365)	79.26±5.46 (279)	90.32[b]±3.28 (237)
	Parity of Dam (PY)		
PY_1	79.42±3.57 (247)	82.31±3.73 (204)	95.78±2.22 (168)
PY_2	77.46±3.79 (221)	83.53±3.96 (179)	96.98±2.37 (154)
PY_3	78.71±3.98 (169)	84.88±4.17 (139)	95.12±2.48 (122)
PY_4	84.77±4.17 (142)	77.40±4.37 (122)	96.16±2.61 (100)
PY_5	78.84±4.39 (119)	80.85±4.65 (95)	93.88±2.80 (79)
PY_6	82.31±4.85 (91)	85.10±4.98 (78)	95.87±2.90 (69)
PY_7	81.22±4.37 (119)	89.79±4.56 (98)	95.48±2.64 (92)
	Season of Birth (SOB)		
S_1	79.72±3.41 (321)	84.08±3.59 (260)	96.50±2.13 (224)
S_2	79.02±3.20 (417)	84.16±3.36 (338)	95.26±1.99 (291)
S_3	82.43±3.42 (370)	81.27±3.57 (317)	95.07±2.13 (269)
	Sex of Calf		
Male	74.53[b]±3.32 (355)	83.44±3.51 (274)	95.90±2.1 (235)
Female	86.25[a]±3.02 (753)	83.38±3.17 (641)	95.32±1.88 (549)
	Birth Weight (BW) of Calf		
B_1	80.70±8.05 (26)	74.11±8.45 (21)	94.16±5.38 (16)
B_2	83.34±3.11 (353)	83.94±3.20 (300)	95.42±1.87 (259)
B_3	81.93±2.97 (375)	84.77±3.08 (313)	96.76±1.83 (268)
B_4	79.84±3.26 (269)	84.47±3.41 (217)	95.85±2.03 (184)
B_5	76.14±4.81 (85)	89.74±5.22 (64)	95.85±3.09 (57)

(Means with different superscripts differ significantly (P<0.05) from each other, values in parenthesis are number of observations)

correlated with occurrence of high mortality rates in different cattle breeds. The random effect of sire was significant (P<0.05) on calf survivability trait at 31-90 day. Similarly, Dechow et al. (2012) reported that effect of sire had significant effect on incidence of calf mortality and early lactation culling, particularly in herds with adverse cow survival environments. The significant effect of sire on calf survivability trait shows that this trait may be improved genetically by selection of sires.

Comparison of survivability patterns of calves with different genetic groups

The non-significant (P<0.05) effect was observed among the survivability patterns of calves in different ages with different genetic groups of Gir crossbred. However, the JG group had higher survivability per cent followed by FJG, F, FG and lower survival was noticed in R group. Similarly, Dhakal et al. (2013) found that genetic group had no significant effect on neonatal calf mortality in first or later parities in Holstein, Jersey and crossbred calves. Davis et al. (2020) conducted research in beef x dairy crossbred calves and studied the genetic parameters and sire breeding values for young stock survival.

Conclusions

The calf survivability was significantly influenced by the period of birth, season of birth, sex, birth weight and sire which indicated that the selection of sire and improvement in management could improve the survivability of calves in Gir crossbred cattle.

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Table 4. Least square means of calf survivability traits at different age periods as affected by genetic groups in Gir crossbreds

Parameters	No. of observations	Survivability per cent at D 0-3	Survivability per cent at D 4-15	Survivability per cent at D 16-30	Survivability per cent at D 31-90	Survivability per cent at D 91-180	Survivability per cent at D 181-365
Overall mean	1389	96.17±0.80 (1389)	86.17±2.12 (1368)	89.23±2.03 (1210)	80.39±2.89 (1108)	83.41±3.02 (915)	95.61±1.79 (784)
G_1(FG–50% HF + 50% Gir)	274	95.48±3.10 (274)	82.49±7.99 (271)	90.93±7.22 (244)	91.67±10.07 (232)	77.51±10.65 (192)	95.37±6.12 (168)
G_2(FJG – 50% HF + 25% J + 25% Gir)	573	98.69±1.71 (573)	94.13±4.43 (563)	88.08±4.07 (490)	74.70±5.73 (437)	86.38±6.38 (360)	93.84±3.52 (294)
G_3(R – 50% HF + 12.5% J + 37.5% Gir)	170	93.77±2.71 (170)	81.23±7.08 (168)	82.73±6.62 (153)	75.08±9.40 (141)	77.35±10.13 (125)	96.32±6.00 (109)
G_4(JG – 50% J + 50% Gir)	167	96.11±3.74 (167)	82.99±9.65 (165)	89.08±8.79 (149)	90.41±11.86 (134)	93.52±13.03 (106)	96.04±7.23 (101)
G_5 (F - 75% HF + 25% Gir)	205	96.79±1.91 (205)	90.01±4.96 (201)	95.31±4.62 (174)	70.09±6.60 (164)	82.28±7.49 (132)	96.47±4.27 (112)

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