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Research Article

Genetic studies on calving traits in Jersey crossbred cattle

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Abstract

Data on 1822 calving records of Jersey crossbred cows, maintained at the Eastern Regional Station of ICAR-NDRI, Kalyani, over the last 39 years (1980-2018) were collected to study the effect of genetic and non-genetic factors on different calving traits and to estimate the genetic parameters. Five calving traits viz., dystocia, stillbirth, abortion, premature birth and retention of placenta were considered for this study. Least squares analysis of variance with fitting constant was applied to analyze the data. The overall least-squares means for incidence of dystocia, stillbirth, abortion, premature birth and retention of placenta in Jersey crossbred cows were 7.97±1.63, 1.88±0.72, 12.02±1.28, 4.95±0.68 and 15.87±1.81 percent, respectively. Random effect of sire had a significant (P<0.01) effect on the occurrence of dystocia, stillbirth and abortion of animals. The period of calving had a significant (P<0.05) effect on dystocia and stillbirth of cows, whereas the season of calving significantly (P<0.05) affected the occurrence of abortion and premature birth of animals. The parity of animal had a highly significant (P<0.01) influence on the occurrence of abortion and premature birth. Primiparous animals had a higher occurrence of abortion and premature birth than multiparous cows. The birth weight of calves significantly (P<0.01) influenced the incidence of dystocia and retained placenta in animals. The estimates of heritability for the calving traits were low in magnitude, ranging from 0.03 - 0.08 under the paternal half-sib method of estimation. The study showed that as calving traits are lowly heritable; there is slow genetic improvement of these traits possible through selection.

Key words: Calving traits, Cattle, Environmental factors, Heritability

Highlights

- Random effect of sire had a significant influence on the incidence of dystocia, stillbirth and abortion of cows.
- Primiparous animals had a higher incidence of abortion and premature birth than multiparous cows.
- Calves' birth weight significantly (P<0.05) affected the incidence of dystocia and retained placenta in animals.
- Estimated heritabilities of the calving traits were low (0.03 - 0.08) in magnitude.

INTRODUCTION

Reproductive efficiency is one of the major determinants of the lifetime productivity of cattle, and reproductive disorders have been found to be a major reason for decreased reproductive efficiency in cattle. The reproductive disorders of crossbred dairy cattle remarkably reduce the overall performance of the animal, which is a great concern to dairy farmers worldwide because these adversely affect the future fertility of the animals. Hossein-Zadeh (2013) reported that reproductive issues of animals could considerably affect the reproductive efficiency of animals in any dairy cattle farm. Different calving traits, viz. abortion, dystocia, stillbirth and retained

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placenta etc. of dairy animals cause a considerable economic loss in any dairy herd due to reduced reproductive rate, prolonged inter-conception and calving interval, negative effect on fertility, increased cost of medication, drop in milk production, reduced calf crop and early depreciation of potentially used cows (Lobago *et al*., 2006).

In any dairy farm, the most important factor influencing calf health at birth is dystocia (calving difficulty), and the occurrence of dystocia generally affects the herd profitability (Dematawena and Berger, 1997). This condition arises due to the consequences of disproportion between the calf's size and the dam's pelvic area (Philipsson *et al*., 1979). Difficult calving can substantially increase the risk of infection as well as the death of the calf. Barrier and Haskell (2011) demonstrated that the incidence of dystocia affects the subsequent production, fertility, health, and survivability of dam and offspring, and increases the labour and treatment costs and workload of the farm. Reproductive failures due to stillbirth (SB) and abortion are other critical issues in cattle farming that causes substantial economic losses in a dairy herd. This reproductive disorder showed antagonistic relationships with the milk production of animals. Moreover, it may be associated with certain side effects such as lameness, mastitis, increased postpartum interval until first ovulation, reduced efficiency of the first insemination after calving and reduced fertility of animals.

Generally, calving traits are influenced by the direct genetic effect of the calf and the maternal effect of the dam. Incidences of difficult calving in dairy herds can be reduced by proper selection and by differential use of sires over heifers and other females at risk. The efficacy of either approach will depend on the prediction of the genetic merit of sires, which in turn requires estimates of genetic parameters. Since genetic selection can improve calving performance, it is necessary to include calving traits in genetic evaluations. A number of environmental factors affecting the calving traits of dairy cows (McGuirk *et al.*, 1999; Atashi, 2011) need to be studied to obscure the genetic potentiality of animals. Further, estimating genetic parameters of calving traits is useful for developing appropriate mating schemes. Therefore, the present study was undertaken to determine the genetic and non-genetic factors affecting the calving traits and their genetic control in Jersey crossbred cattle.

MATERIALS AND METHODS

Study location and animals: Data on calving traits of Jersey crossbred cattle, maintained at the Eastern Regional Station of ICAR-National Dairy Research Institute, Kalyani, Nadia, West Bengal over a period of 39 years (1980-2018) were used to determine the effect of genetic and non-genetic factors on different calving traits of crossbred cattle, produced from the crossing of Jersey male with Tharparkar or Red Sindhi females. A detailed description of the experimental animals since the inception of this farm has been described by Kumar and Mandal (2021). Generally, animals were maintained in a loose housing system. Heifers were bred at the age of two years when they attained a body weight of approximately 220-230 kg. Heat detection was done visually every day from 06:00 to 08:00 h in the morning and from 17:00 to 18:00 h in the afternoon by trained inseminator and the herdsmen. Cows and heifers observed in heat were inseminated with frozen semen Jersey crossbred within 8-12 h after the onset of heat. The calves were born round the year, and they were separated from their dams at birth, weighed and fed colostrum from a milk feeding bottle twice a day for the first three days of life.

Data and traits considered: A total of 1822 calving records were included for the present study. Traits considered for the present investigation were dystocia (DYS), stillbirth (SB), abortion (AB), premature birth (PMB) and retention of placenta (ROP). The incidence rate (%) of each calving trait in each lactation or calving was calculated by the number of new

cases of occurrence/disorder in each lactation per number of animals in that lactation. Calving traits are binary traits and dichotomous in nature and follow a binomial distribution. The description of calving traits along with the coding has been presented in Table 1.

The total duration of the study was classified into 8 periods with 5-years intervals for the period of calving. Based on the prevalent climatic conditions of the study area, the season of calving was divided into 3 seasons- winter (November to February), summer (March to June) and rainy (July to October). The parities of animals were classified into 2 groups: primiparous and multiparous. The birth weights of calves were classified into 5 groups, viz. calves having birth weights of ≤ 15 kg, > 15 to ≤ 20 kg, >20 to ≤ 25 kg, >25 to ≤ 30 kg and > 30 kg. These animals were progenies of 67 sires, and sires having 3 or more progenies were considered in the study.

Statistical analyses: For characters that are expressed phenotypically as all-or-none values like all calving traits, the variance is dependent on the frequency, and the assumptions of ANOVA are violated. Transformations are generally used for the normalization of binomially distributed data, but studies on transformed and raw data showed a little/minor advantage of the transformation of data over raw data (Van Vleck, 1972). Further, Auran (1972) and Philipsson (1976) used least-squares procedures without any transformation for binary traits. Therefore, least-squares analysis of variance with fitting constant (Harvey, 1990) was applied to analyze the different calving traits of animals. The following mixed models were used:

1) Model for dystocia and retention of placenta

$Y_{ijklmn} = \mu + B_i + S_j + P_k + (Pa)_l + (BW)_m + e_{ijklmn}$

Where, Y_{ijklmn} is the observation on the n^{th} cow calving trait observation mated with i^{th} sire calved in j^{th} season born in the k^{th} period, l^{th} parity and m^{th} birth weight group of calf

μ is the overall mean

B_i is the effect of the i^{th} sire (i = 1, 2……, 67)

S_j is the effect of the j^{th} season of calving (j = 1, 2, 3)

P_k is the effect of the k^{th} period of calving (k = 1, 2, 3, 4, 5, 6, 7, 8)

$(Pa)_l$ is the effect of the l^{th} parity of dam (l = 1, 2)

$(BW)_m$ is the effect of the m^{th} birth weight group of calves (m = 1, 2, 3 ,4, 5)

Table 1. Description of the calving traits and their coding

Traits (Acronym)	Definition	Coding
Ease of Calving/ Dystocia (DYS)	Prolonged or difficult parturition	Normal calving = 0 Difficult calving = 1
Stillbirth (SB)	Stillborn calves those born dead or dying within 48 hrs of birth or after at least 260 days of gestation.	Born alive = 0 Dead at birth or within 48 h = 1
Abortion (AB)	Abortion in dairy cattle is commonly defined as a loss of the fetus between the age of 42 days and approximately 260 days of pregnancy.	Non-abortion = 0 Abortion = 1
Premature birth (PMB)	Premature birth of a calf is defined as when an animal delivers a live calf before 270 days of gestation.	Non-occurrence of incidence = 0 Premature birth = 1
Retention of placenta (ROP)	Failure of the expulsion of the placenta without any assistance within 12 h after calving is called retained placenta.	Normal expulsion = 0 Retained placenta = 1

e_{ijklmn} is the residual error ~ NID (0, $ó^2_e$)

2) Model for still birth, abortion and premature birth

$Y_{ijklm} = \mu + B_i + S_j + P_k + (Pa)_l + e_{ijklm}$

Where, Y_{ijklm} is the observation on the n^{th} cow calving trait observation mated with i^{th} sire calved in j^{th} season born in the k^{th} period, l^{th} parity

μ is the overall mean

B_i is the effect of the i^{th} sire (i = 1, 2……, 67)

S_j is the effect of the j^{th} season of calving (j = 1, 2, 3)

P_k is the effect of the k^{th} period of calving (k = 1, 2, 3, 4, 5, 6, 7, 8)

$(Pa)_l$ is the effect of the l^{th} parity of dam (l = 1, 2)

e_{ijklm} is the residual error ~ NID (0, $ó^2_e$)

The comparison of different sub-groups mean was made by Duncan's Multiple Range Test (DMRT) as described by Kramer (1957). The heritability of calving traits was estimated by the paternal half-sib method. The sires having 3 or more progenies were considered in the study.

RESULTS

The overall least-squares means for incidence of dystocia, stillbirth, abortion, premature birth, and retained placenta in Jersey crossbred cow were 7.97±1.63, 1.88±0.72, 12.02±1.28, 4.95±0.68 and 15.87±1.81 percent, respectively over the study period (Table 2). In this study, the effect of sire had a significant (P<0.01) influence on the incidence of DYS, SB and AB in cows. Among non-genetic factors, the period of calving had a significant (P<0.05) effect on the occurrence of DYS and SB in cows, though no definite patterns of occurrence of DYS and SB in cows were observed over the study periods. Season of calving significantly (P<0.05) influenced the prevalence of abortion in crossbred animals, and the highest incidence of abortion was observed in winter (15.4%), followed by rainy (11.0%) and summer (9.67%) seasons. Further, the present study also revealed a highly significant (P<0.01) influence of calving season on the premature birth of calves. Animals calved in the rainy season had a maximum (6.19%) incidence of premature birth as compared to cows calved in summer (5.25%) and winter (3.42%) seasons. The parity of animal had a highly significant (P<0.01) influence on the occurrence of abortion and premature birth. In this study (Table 2), primiparous animals had higher AB (15.76%) and PMB (7.08%) than multiparous cows (AB- 8.28% and PMB-2.82%). The incidences of dystocia and retained placenta of cows were significantly (P<0.05) affected by birth weight groups of calves (Table 2). Cows with calves of higher birth weight groups had a significantly higher risk of dystocia than cows with lower birth weights. On the other hand, cows having a fetal birth weight of 15 kg or less had the highest incidence of the retained fetal membrane than cows with higher fetal birth weight in this study. Estimates of heritabilities of different calving traits (Table 3) of Jersey crossbred cattle ranged from 0.03- 0.08 in the present study.

DISCUSSION

The incidence of dystocia (7.97%) in this study was comparable with the findings of Steinbock *et al*. (2003) and Uematsu *et al*. (2013) in Swedish dairy Red and Japanese Black cattle, respectively. The occurrence of stillbirth (1.9%) in crossbred cattle in this study was in accordance with the findings of Islam and Nadroo (2006), Steinbock *et al*. (2006) and Uematsu *et al*. (2013), who observed the incidence of stillbirth ranged from 2.0 - 2.9% in different cattle breeds. Khan *et al*. (2016) observed the prevalence of abortion in crossbred cattle (11.25%), which was close to this study. Regarding the occurrence of premature birth, the findings of the present study were much higher than the findings of Sharma (2010) and Kumar *et al*. (2017), who reported the incidence of premature birth ranged from 0.01 to 1.8 percent in Karan Fries and Frieswal cattle, respectively. The incidence of retained placenta obtained in this study (15.9%) agreed with the findings of Hossain *et al*. (2015) and Khan *et al*. (2016) in crossbred cattle. In this study, the random effects of sire had a highly significant (P<0.01)

Table 2. Least-squares means of different calving traits (%) in Jersey crossbred cattle

Effects	DYS (%)	SB (%)	AB (%)	PMB (%)	ROP (%)
Overall mean	7.97±1.63 (1525)	1.88±0.72 (1721)	12.02±1.28 (1721)	4.95±0.68 (1721)	15.87±1.81 (1525)
Period of calving					
Pd 1 (1980-1984)	16.82±6. (23)	80[a]0.43±2.04[b] (31)	15.51±7.08[a] (31)	6.78±4.56[a] (31)	14.68±9.14[a] (23)
Pd 2 (1985-1989)	9.84±4.17[a] (116)	0.73±1.01[b] (133)	19.43±4.33[a] (133)	9.51±2.76[a] (133)	13.74±5.51[a] (116)
Pd 3 (1990-1994)	6.14±3.46[a] (151)	5.10±1.62[a] (182)	22.48±3.48[a] (182)	6.70±2.20[a] (182)	14.25±4.53[a] (151)
Pd 4 (1995-1999)	4.34±2.83[ab] (203)	3.66±1.54[a] (235)	13.65±2.79[a] (235)	6.85±1.74[a] (235)	24.54±3.62[a] (203)
Pd 5 (2000-2004)	0.15±0.09[b] (217)	1.68±1.58[a] (258)	12.15±2.87[a] (258)	3.74±1.79[a] (258)	21.17±3.73[a] (217)
Pd 6 (2005-2009)	6.07±3.20[a] (254)	1.25±0.48[b] (276)	7.13±3.25[a] (276)	2.45±2.05[a] (276)	11.28±4.15[a] (254)
Pd 7 (2010-2014)	12.69±3.70[a] (267)	1.11±0.62[b] (288)	3.47±2.88[a] (288)	1.13±1.47[a] (288)	15.09±4.85[a] (267)
Pd 8 (2015-2018)	7.78±4.26[a] (294)	1.06±0.92[b] (318)	2.35±4.57[a] (318)	2.44±1.92[a] (318)	12.23±5.64[a] (294)
Season of calving					
Winter	7.58±1.86[a] (471)	1.98±0.89[a] (551)	15.40±1.59[a] (551)	3.42±0.92[b] (551)	15.99±2.18[a] (471)
Summer	8.85±1.84[a] (537)	2.22±0.87[a] (602)	9.67±1.56[b] (602)	5.25±0.89[ab] (602)	16.74±2.14[a] (537)
Rainy	7.51±1.86[a] (517)	1.42±0.91[a] (568)	11.0±1.62[ab] (568)	6.19±0.94[a] (568)	14.89±2.18[a] (517)
Parity of animals					
Primiparous	8.36±1.94[a] (395)	1.80±0.93[a] (489)	15.76±1.66[a] (489)	7.08±0.97[a] (489)	15.34±2.30[a] (395)
Multiparous	7.60±1.69[a] (1130)	1.95±0.78[a] (1232)	8.28±1.38[b] (1232)	2.82±0.76[b] (1232)	16.40±1.90[a] (1130)
Birth weight of calves(kg)					
≤ 15	2.54±2.46[a] (94)				37.81±3.55[a] (94)
>15 to ≤ 20	4.82±1.82[a] (372)				15.16±2.11[b] (372)
>20 to ≤ 25	6.22±1.65[a] (695)				7.94±1.84[c] (695)
>25 to ≤ 30	12.34±1.95[b] (318)				9.54±2.32[bc] (318)
>30	13.96±3.79[b] (46)				8.93±4.98[bc] (46)

Values in parenthesis represent the number of observations; Means with different superscripts differ significantly (P< 0.05) from each other

Table 3. Estimates of heritability of calving traits from the Paternal half-sib (PHS) method

Traits	Heritability
Dystocia	0.07±0.04 (1525)
Stillbirth	0.08±0.04 (1721)
Abortion	0.07±0.04 (1721)
Premature Birth	0.03±0.03 (1721)
Retention of placenta	0.03±0.03 (1525)

Figures in parenthesis represent the number of observations

influence on the incidence of dystocia, stillbirth and abortion of animals. Similar significant effects of sire on the prevalence of abnormal calving and stillbirth in cows were observed by Mukherjee and Tomar (2000) and Mee *et al*. (2014) in Karan Swiss and Holstein cattle, respectively. The significant effect of sire on the incidence of dystocia and stillbirth in this study suggests that superior sires could be used to lower the incidence of these calving traits in crossbred cattle. Similar to this investigation, several workers reported the significant effects of period/year of calving on the incidence of dystocia (Ghafariania *et al*., 2014; Boujenane, 2017) and stillbirth (Al-Samarai, 2008; Atashi *et al*., 2011) in different breeds of cattle. In this study, the significant differences in the incidence of dystocia/stillbirth among cows calved in different periods may be attributed to managemental differences, sire selection and different environmental conditions such as temperature, rainfall, humidity etc. As noticed in this study, significant variations in the prevalence rate of abortion among cows calved in different seasons were also reported by Yaqoob *et al*. (2016) and Tulu and Gebeyehu (2018) in other breeds of cattle. In this study, the higher incidence of abortion in the winter season could be due to the inclement weather and stress conditions that dams were subjected to during most of the pregnancy interval, that might be reflected in their newborn immunity. Kumar *et al*. (2017) obtained the significant effect of the calving season on the incidence of premature birth of cows, and they reported that the incidence of premature birth was higher in the rainy season (2.33%) than in other seasons. Similar to the present findings, a significant effect of parity of cows on abortion was noticed by Yaqoob *et al*. (2016) and Kumar *et al*. (2017) in Frieswal crossbred and dairy cattle, respectively. The higher incidence of abortion in primiparous cows i.e., heifers in this study, may be due to younger cows may have less acquired immunity and more susceptible to infectious agents than the older cows. Several workers (Ghafariania *et al*., 2014; Hohnholz *et al*., 2019) reported the significant effect of calves' birth weights on the occurrence of dystocia in cattle as observed in our study. Similar to the present findings, Kumari *et al*. (2015) also observed an increase in the retention of placenta with the decrease in fetal birth weight in crossbred and zebu cattle. In the present study, the higher incidence of retention of placenta with the lower fetal birth weight may be due to the fact that as fetus has less pressure on the fetal membrane, so there may be existence of weaker attachment between the fetal membranes and the cotyledons and ultimately it leads to difficulty in expulsion of the fetal membrane.

The direct heritability estimates for dystocia in this study were in consistent with the findings of other workers (Steinbock *et al*., 2003; Steinbock *et al*., 2006; Silvestre *et al*., 2019) in different breeds of cattle. The heritability estimate of stillbirth (0.08) obtained from this study was well within the range of the findings of other studies (Steinbock *et al*., 2003; Steinbock *et al.,* 2006) in different breeds of cattle. The heritability estimate of abortion in this study was well comparable with the findings of Gershoni *et al*. (2019) in Israeli dairy cattle. Pandey *et al*. (2016) estimated the heritability of abortion in crossbred cattle by the paternal half-sib method, and they found that the estimate was low (0.03) in crossbred

cattle. The estimate of heritability for retained placenta in this study was similar to the findings of various workers (Hansen *et al*., 2004; Steinbock *et al*., 2006) in different cattle breeds.

The present study revealed that different non-genetic factors significantly affected the calving traits, so better management practices should be adopted to improve these traits in this herd. Estimates of low heritability (0.03-0.08) for all calving traits in the present study indicate that slow genetic improvement may be possible through selection under prevalent management system.

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REFERENCES

Al-Samarai FR, 2008. Genetic evaluation of sires for stillbirths in a herd of Holstein cattle in Iraq. Life Sci Int J, 2(2): 652-659

Atashi H, 2011. Factors affecting stillbirth and effects of stillbirth on subsequent lactation performance in a Holstein dairy herd in Isfahan. Iran J Vet Res, 12(1): 24-30

Atashi H, Zamiri MJ and Sayyadnejad MB, 2011. Non-genetic factors affecting stillbirth and its effects on longevity, production, and reproductive performance in Holstein cows of Iran. Iran Agri Res, 30(1, 2): 73-82, doi: 10.22099/iar.2012.503

Auran T, 1972. Factors affecting the frequency of stillbirths in Norwegian cattle. Acta Agric Scan, 22(3): 178-182, doi: 10.1080/00015127209433479

Barrier AC and Haskell MJ, 2011. Calving difficulty in dairy cows has a longer effect on saleable milk yield than on estimated milk production. J Dairy Sci, 94(4): 1804-1812, doi: 10.3168/jds.2010-3641

Boujenane I, 2017. Non-genetic factors affecting dystocia and its effects on milk production of Holstein dairy cows in Morocco. Livest Res Rural Dev, 29: 8

Dematawena CMB and Berger PJ, 1997. Effect of dystocia on yield, fertility, and cow losses and an economic evaluation of dystocia scores for Holsteins. J Dairy Sci, 80: 754-761, doi: 10.3168/jds.s0022-0302(97)75995-2

Gershoni M, Ezra E and Weller JI, 2019. Genetic and genomic analysis of early abortions in Israeli dairy cattle. BioRxiv: 557306, doi: 10.1101/557306

Ghafariania Y, Babaiee M and Vatankhah M, 2014. Factors affecting calving difficulty on Holstein dairy cattle. Indian J Fundam Appl Life Sci, 4(S4): 1148-1155

Hansen M, Lund MS, Pedersen J and Christensen LG, 2004. Genetic parameters of calving traits at first and second calving in Danish Holsteins. Annual Meeting of the European Association for Animal Production (EAAP), Bled, Slovenia, pp12, https://sp.landbrugsinfo.dk/Kvaeg/Avl/Filer/eaap_mxh_2004.pdf

Harvey WR, 1990. User's Guide for LSMLMW PC-2 Version, mixed model least squares and maximum likelihood computer programme, Mimeograph. Ohio State University Press; Columbus, OH, USA

Hohnholz T, Volkmann N, Gillandt K, Waßmuth R and Kemper N, 2019. Risk factors for dystocia and perinatal mortality in extensively kept Angus Suckler cows in Germany. Agriculture, 9(4): 85, doi: 10.3390/agriculture9040085

Hossain MK, Billah MN, Aziz SA, Rahman MA, Islam MN *et al*., 2015. Factors affecting retained fetal membrane and its therapeutic management in dairy cows. Int J Nat Sci, 5(2): 93-97, doi: 10.3329/ijns.v5i2.28632

Hossein-Zadeh NG, 2013. Effects of main reproductive and health problems on the performance of dairy cows: A review. Spanish J Agric Res, (3): 718-735, doi: 10.5424/sjar/2013113-4140

Islam R and Nadroo GA, 2006. Incidence of abortion and still birth in cattle in an organized farm of Kashmir valley. Indian Vet J, 83(10): 1127-1128

Khan MH, Manoj K and Pramod S, 2016. Reproductive disorders in dairy cattle under semi-intensive

system of rearing in North-Eastern India. Vet World, 9(5): 512-518, doi: 10.14202/vetworld.2016.512-518

Kramer CY, 1957. Extension of multiple range tests to group correlated adjusted means. Biometrics, 13(1): 13-18, doi: 10.2307/3001898

Kumar A, Singh U, Alex R and Kumar S, 2017. Risk factors associated with abnormal parturition and their effects on production and reproductive performance in Frieswal cattle of India. Indian J Anim Res, 51(2): 242-246, doi: 10.18805/ijar.10272

KumarA and Mandal A, 2021. Evaluation of animal models to explore the influence of maternal genetic and maternal permanent environment effect on reproductive performance of Jersey crossbred cattle. Reprod Domest Anim, 56(3): 511-518, doi: 10.1111/rda.13889

Kumari S, Prasad S, Kumaresan A, Manimaran A, Patbandha TK *et al*., 2015. Risk factors and impact of retained fetal membranes on performance of dairy bovines reared under subtropical conditions. Trop Anim Health Prod, 47(2): 285-290, doi: 10.1007/s11250-014-0717-z

Lobago F, Bekana M, Gustafsson H and Kindahl H, 2006. Reproductive performances of dairy cows in smallholder production system in Selalle, Central Ethiopia. Trop Anim Health Prod, 38(4): 333-342, doi: 10.1007/s11250-006-4328-1

McGuirk BJ, Going I and Gilmour AR, 1999. The genetic evaluation of UK Holstein Friesian sires for calving ease and related traits. Anim Sci, 68(3): 413-422, doi: 10.1017/S1357729800050414

Mee JF, Sánchez-Miguel C and Doherty M, 2014. Influence of modifiable risk factors on the incidence of stillbirth/perinatal mortality in dairy cattle. Vet J, 199(1): 19-23, doi: 10.1016/j.tvjl.2013.08.004

Mukherjee K and Tomar SS, 2000. Genetic and non-genetic factors affecting abnormal births in Karan Swiss cattle. Indian J Anim Res, 34(1): 29-32

Pandey S, Singh CV and Barwal RS, 2016. Selective value, quantification and genetic parameters of components of replacement traits in crossbred cattle. Vet Med Open J, 1(1): 1-5, doi: 10.17140/VMOJ-1-101

Philipsson J, 1976. Studies on calving difficulty, stillbirth and associated factors in Swedish cattle breeds. II. Effects of non-genetic factors. Acta Agric Scand, 26: 165-174, doi: 10.1080/00015127609435084

Sharma PC, 2010. Genetic evaluation of Karan Fries cows for functional traits. PhD Thesis submitted to NDRI, Karnal, Haryana, India

Silvestre A, Martins Â, Santos V and Colaço J, 2019. Genetic parameters of calving ease in dairy cattle using threshold and linear models. Ital J Anim Sci, 18(1): 80-87, doi: 10.1080/1828051X.2018.1482801

Steinbock L, Johansson K, Näsholm A, Berglund B and Philipsson J, 2006. Genetic effects on stillbirth and calving difficulty in Swedish Red dairy cattle at first and second calving. Acta Agri Scand-Anim Sci, 56(2): 65-72, doi: 10.1080/09064700600836927

Steinbock L, Näsholm A, Berglund B, Johansson K and Philipsson J, 2003. Genetic effects on stillbirth and calving difficulty in Swedish Holsteins at first and second calving. J Dairy Sci, 86(6): 2228-2235, doi: 10.3168/jds.S0022-0302(03)73813-2

Tulu D and Gebeyehu S, 2018. Prevalence of major reproductive problem and associated risk factor in dairy cattle of Jimma Horro District in Kelem Wollega Zone, Western Ethiopia. J Vet Sci Technol, 9(5): 1000564, doi: 10.4172/2157-7579.1000564

Uematsu M, Sasaki Y, Kitahara G, Sameshima H and Osawa T, 2013. Risk factors for stillbirth and dystocia in Japanese Black cattle. Vet J, 198(1): 212-216, doi: 10.1016/j.tvjl.2013.07.016

VanVleck LD, 1972. Estimation of heritability of threshold characters. J Dairy Sci, 55(2): 218-225, doi: 10.3168/jds.S0022-0302(72)85463-8

Yaqoob B, Mridula S and Anoop S, 2016. Effect of parity of animal, season and sex of fetus on the rate of abortion in dairy cattle. Adv Anim Vet Sci, 4(11): 571-574, doi: 10.14737/journal.aavs/2016/4.11.571.574

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