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Research Article

Incidences of and genetic parameters for some reproductive disorders of Jersey crossbred cattle

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Abstract

Data pertaining to reproductive disorders, viz., anestrus, repeat breeding and metritis, of Jersey crossbred cattle, maintained at the Eastern Regional Station of ICAR-National Dairy Research Institute, Kalyani, Nadia, West Bengal over a period of 40 years (1980 through 2019) were used to study the effect of genetic and non-genetic factors on these disorders and their genetic control. Least squares analysis of variance with fitting constant was applied to determine the effect of genetic and non-genetic factors on different reproductive disorders of animals. Heritabilities of these traits were estimated by paternal half sib method. The overall least squares means for occurrence of anestrus, repeat breeding and metritis in Jersey crossbred cattle were 38.62, 9.46 and 21.48 percent, respectively. The random effect of sire was highly significant for all the above reproductive disorders under study. In this study, the period of calving had a significant effect on the occurrence of all traits except metritis of animals. The significant effect of calving period may be due to the variations of management practices over the periods as well as wide fluctuations in environmental/climatic conditions like temperature, rainfall etc, prevailing in this herd over the years. Season of calving and parity had no significant influence on the occurrence of any of the above reproductive disorders of animals in this study. Low heritabilities estimates, ranging from 0.07 to 0.14, of different reproductive traits in our study indicate that slow genetic improvement may be possible for these traits through selection under prevalent management system.

Keywords: Cattle, Environmental effect, Heritability, Reproductive disorders

Highlights

- Sire significantly influenced the occurrence of anestrus, repeat breeding and metritis of cows.
- Birth year significantly influenced all the reproductive disorders considered for this study.
- Estimated heritabilities of the reproductive disorders were low (0.07 - 0.14) in magnitude.

INTRODUCTION

Generally, high producing animals are more prone to both pre and post-partum reproductive disorders (Deka *et al.*, 2021), which reduce the overall profitability of farms through increased culling rates, veterinary expenses, replacement costs, and decreased milk production (Pritchard *et al.*, 2013; Gaddis *et al.*, 2014). Reproductive disorders are the 2nd most frequent cause of involuntary culling in dairy animals besides mastitis (Lehenbauer, 1998). Premature culling of cows can force a huge negative impact on the economy of the herd due to losses in milk production, future progeny, possible selection differential and ultimately loss of possible genetic gain in the population. In order to improve the reproductive efficiency of the herd, understanding reproductive disorders (RDs) can offer practical solutions. Many reproductive disorders may affect the productivity of animals, but the disorder whose incidence rate is >1% will significantly affect the productivity of animals. Among the various reproductive disorders, anestrous, repeat breeding, retention of placenta and metritis are considered as the important livestock maladies affecting cattle and buffaloes. It was estimated that reproductive problems caused an annual economic cost of

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3963.1 million rupees in Assam and 30,500.0 million rupees in Bihar. The estimated cost of reproductive problems was 2424.9 rupees per dairy animal per year (of the total dairy animal population) which represented approximately 4.1% of the mean value loss of dairy animals (INR 58,966) per year (Deka *et al*., 2021).

Number of non-genetic factors affect reproductive disorders and directly obscure recognition of the genetic potential of the animals (Mahnani *et al*., 2015; Harichandan *et al*., 2018); therefore, to obtain reliable estimates of reproductive traits, adjustment of data for the fixed effects is necessary. Further, the involvement of genetic factors in the incidence of reproductive disorders is suspected because the incidence rates are higher among relatives of affected individuals than in the general population (Kirk *et al*., 1982; Martinez *et al*., 1983). Therefore the estimation of genetic and phenotypic parameters of reproductive disorders is of utmost importance not only for selecting the superior males for future breeding programs to reduce the occurrence of these reproductive disorders but also for animal welfare point of view. As scanty reports are available on reproductive disorders of crossbred cattle, therefore, the present study was undertaken to determine the prevalence rate of some reproductive disorders and their genetic control in Jersey crossbred cattle.

MATERIALS AND METHODS

The present study was conducted on the Jersey crossbred cattle, produced from the crossing of Jersey male with Tharparkar or Red Sindhi females, maintained at the Eastern Regional Station (ERS) of Indian Council of Agricultural Research- National Dairy Research Institute (ICAR-NDRI), Kalyani, West Bengal, India. Data pertaining to reproductive disorders of Jersey crossbred cattle, maintained over a period of 40 years (1980 through 2019), were used to determine the prevalence rate of different RD and the effect of genetic and non-genetic factors on RD and to estimate genetic parameters for RD. The reproductive disorders, viz., anestrus (ANE), repeat breeding (RP) and metritis (MET), were considered for the present study (Table 1).

A total of 1733 records from 666 animals descended from 57 sires and 278 dams were used for the study. The incidence rate of any reproductive disorder in a particular lactation or calving is calculated by the number of cases of reproductive disorder/disease in the lactation per total number of animals in the lactation (Woodward, 1999). Least squares analysis of variance with fitting constant (Harvey, 1990) was applied to determine the effect of genetic and non-genetic factors on different reproductive disorders of animals. The following model was used:

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

Y_{ijkln} = Observation on the n^{th} cow with reproductive disorders mated with i^{th} sire, calved in j^{th} season, born in k^{th} period, l^{th} parity of calf

μ = Overall mean

Bi = Random effect of i^{th} sire

S_j = Fixed effects of j^{th} season of calving

P_k = Fixed effects of k^{th} period of calving

$(Pa)_l$ = Fixed effects of l^{th} parity

e_{ijkln} = Random error ~ NID (0, σ^2_e)

Table 1. Description of the reproductive disorders

Traits	Acronyms	Variable	Definition
Anestrus	ANE	Dichotomous	State of complete sexual inactivity with no manifestation of oestrus for more than two months
Repeat breeding	RB	Dichotomous	Cow that displays normal estrous cycles, has no clinically evident reproductive disease yet fails to become pregnant after 3 or more inseminations
Metritis	MET	Dichotomous	Inflammation of the uterus often characterized by fetid, red-brown, watery uterine discharge

The comparison of different sub-groups mean was carried out using Duncan's Multiple Range Test (DMRT) as described by Kramer (1957). Genetic parameter of different reproductive disorders was estimated by paternal half sib method (Becker, 1975).

RESULTS

Incidences of reproductive disorders: The overall incidence of different reproductive disorders of Jersey crossbred cattle in our study are presented in Table 2. The present study indicated that the average incidences of anestrus, repeat breeding and metritis of Jersey crossbred cattle were 35.8, 8.5 and 19.8 percent, respectively. Among the different reproductive disorders studied, the highest incidence was observed in anestrus, followed by metritis and repeat breeding.

Genetic and non-genetic factors affecting reproductive disorders: The least squares means of different reproductive disorders of Jersey crossbred cattle are depicted in Table 3. The present study revealed that the overall least squares means for occurrence of ANE, RB and MET in Jersey crossbred cattle were 38.62, 9.46 and 21.48 percent, respectively. The random effect of sire was highly significant ($P<0.01$) for all the RD considered for this study. Regarding the effect of non-genetic factors on different RD, it was observed that period of calving had a significant ($P<0.05$) effect on the occurrence of ANE and RB of animals. However, season of calving and parity had no significant ($P>0.05$) influence on the occurrence of any of the above RD in this study.

Table 2. Incidence of different reproductive disorders of Jersey crossbred cattle

Traits	No of calving	No of cases	Incidence (%)
Anestrus	1557	557	35.77
Repeat breeding	1734	148	8.54
Metritis	1733	344	19.84

Table 3. Least-squares means along with standard errors of different reproductive disorders in Jersey crossbred cattle

Effects	Anestrus (%)	Repeat breeding (%)	Metritis (%)
Overall mean	38.62±2.34 (1543)	9.46±1.14 (1719)	21.48±1.6 (1719)
Period of calving			
POC-1 (1985-1989)	50.87±9.30^{a} (123)	13.17±4.98^{a} (131)	30.88±7.10 (131)
POC-2 (1990-1994)	47.73±7.33^{a} (157)	8.91±3.91^{a} (176)	27.94±5.58 (176)
POC-3 (1995-1999)	49.32±5.40^{a} (212)	8.14±2.86^{b} (230)	21.00±4.08 (230)
POC-4 (2000-2004)	32.97±5.12^{ab} (221)	14.44±2.70^{a} (252)	24.68±3.84 (252)
POC-5 (2005-2009)	35.96±5.48^{ab} (249)	4.98±2.90^{b} (274)	11.79±4.13 (274)
POC-6 (2010-2014)	22.65±6.58^{b} (256)	10.06±3.52^{a} (287)	17.28±5.02 (287)

Cont. Table 3.

Table 3., Cont. ...

Effects	Anestrus (%)	Repeat breeding (%)	Metritis (%)
Overall mean	38.62±2.34 (1543)	9.46±1.14 (1719)	21.48±1.6 (1719)
POC-7 (2015-2019)	3$_{b}$0.82±7.85^{a} (325)	6.51±4.20^{b} (369)	16.77±5.99 (369)
Season of calving			
Winter (Nov-Feb)	39.53±2.96 (482)	8.39±1.51 (542)	21.50±2.14 (542)
Summer (Mar-Jun)	40.25±2.87 (533)	10.38±1.46 (589)	20.56±2.07 (589)
Rainy (July-Oct)	36.08±2.95 (528)	9.61±1.50 (588)	22.37±2.13 (588)
Parity of animals			
Primiparous	40.48±3.02 (468)	10.95±1.58 (487)	22.67±2.24 (487)
Multiparous	36.76±2.55 (1075)	7.97±1.25 (1232)	20.29±1.77 (1232)

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

Estimation of heritability of reproductive disorders by paternal half sib method: Estimates of the heritabilities of different RDs by parental half sib method have been depicted in Table 4. The heritabilities of the reproductive disorders in Jersey crossbred cattle were found to be low and within a range from 0.07-0.14.

Table 4. Estimates of heritability of reproductive disorders of cattle by paternal half sib method

Traits	Heritability (h^2)
Anestrus	0.14±0.05
Repeat breeding	0.08±0.04
Metritis	0.07±0.04

DISCUSSION

In the present study, the occurrence of anestrus was similar to the findings of Khan *et al*. (2016), Distl (1991) and Harichandan *et al*. (2018), who reported 31.8%, 31.8-34.6% and 36.9-38.2% of anestrus in cattle, respectively. On the contrary, a low incidence rate of anestrus 22.5% and 18.5% was observed by Balasundaram (2008) in first calver and all calvers, respectively in Karan Fries cattle. Koeck *et al*. (2010) and Dhami *et al*. (2018) also observed very low incidence (2.04-8.4% and 6.3%) of anestrus in HF crossbred and Austrian Fleckvieh dual-purpose cattle, respectively. Lower incidence of anestrus was also obtained by Ashoo *et al*. (2020), who found an incidence rate of 7.1% in crossbred cattle as compared to 6.8% in indigenous cattle.

Similar to the present findings, Gustafsson and Emanuelson (2002) also observed a low incidence rate of repeat breeding (2.4 to 15.4%) in their experimental herds. This finding was well comparable with the study of Balasundaram (2008), who reported an overall incidence rate of 10.74% and 11.67% repeat breeding in first calver and all calvers, respectively in Karan Fries cattle. However, higher incidences i.e., 8.17-16.39%, 17.57% and 24.61% were observed by Dhami *et al*. (2018), Khan *et al*. (2016) and Ashoo *et al*.

(2020) respectively in crossbred cattle. Similarly, Lim *et al.* (2015) and Harichandan *et al.* (2018) also observed very high (42.3 to 51.9%) incidence of repeat breeding in their study. The incidence of metritis (19.8%) in this study was in agreement of the findings of Stevenson and Call (1988), who observed an incidence of 21% in periparturient dairy cows. However, Balasundaram (2008) reported higher incidence of metritis in Karan Fries dairy cattle. On the contrary, VanDorp *et al.* (1998), Koeck *et al.* (2010), Dhakal *et al.* (2015), Khan *et al.* (2016), Guarini *et al.* (2019) and Ashoo *et al.* (2020) reported a lower incidence (4-10%) of metritis in different cattle breeds.

The present study revealed a significant ($P<0.05$) effect of period of calving on the occurrences of ANE and RP in Jersey crossbred cattle. However, Balasundaram (2008) and Khan *et al.* (2011) reported period of calving had a non-significant effect on anestrus in Karan Fries cattle and Murrah buffaloes, respectively. Balasundaram (2008) also obtained a non-significant effect of period of calving on repeat breeding in Karan Fries cattle, which was contrary to our study. Regarding the effect of calving period on metritis, similar to this finding, Balasundaram (2008) also reported a non-significant effect of calving period on the incidence of metritis of animals in Karan Fries cattle. Further, Khan *et al.* (2011) observed a non-significant effect of period of calving on occurrence of metritis in Murrah buffaloes. On the contrary, Mahnani *et al.* (2015) found a significant ($P<0.001$) effect of period of calving on metritis in HF cattle. The significant effect of calving period on ANE and RB in our study may be due to the variations of management practices over the periods as well as wide fluctuations in environmental/climatic conditions like temperature, rainfall etc, prevailed in this herd over the years.

The non-significant effect of season of calving on anestrus in this present study was in agreement with the results of Khan *et al.* (2011) and Bartlett *et al.* (1986), who reported a non-significant effect of season of calving on anestrus in Murrah buffalo and Michigan Holstein-Friesian cattle respectively. Further, Balasundaram (2008) and Tolosa *et al.* (2021) also reported a similar non-significant effect of parity on anestrus in Karan Fries and dairy cattle, respectively, as we observed in our study. Similar to the present investigation, non-significant effects of season of calving (Bartlett *et al.*, 1986) and parity of animals (Brooks, 1998; Balasundaram, 2008) on occurrence of repeat breeding of animals were also observed in different breeds of cattle. Further, Balasundaram (2008) also reported non-significant effects of season of calving and parity of animals on incidences of metritis in Karan Fries, as we found in the present study. The random effect of sire was highly significant for all the reproductive disorders considered for this study. The significant sire effect suggests that as a long term effect, differential selection of sires can be useful in reducing the incidence of the various reproductive disorders in Jersey crossbred cows.

The low heritability estimates for anestrus (0.14) in Jersey crossbred in this study was in consistence with the findings of Balasundaram (2008) who reported estimate of 0.13-0.54 in Karan Fries cattle. However, Heringstad (2009), Koeck *et al.* (2010) and Distl (1991) obtained lower estimates of 0.06 ± 0.01, 0.006 ± 0.004 and 0.02-0.04 in Norwegian Red cattle, Austrian Fleckvieh dual-purpose cows and Holstein cattle, respectively. Similar to the heritability estimates for repeat breeding (0.08) in the present study, Balasundaram (2008) and Singh *et al.* (2019) reported heritability of 0.13 and 0.07 for repeat breeding in Karan Fries cattle and Murrah buffaloes, respectively. Estimate of heritability (0.07) for metritis in our study was within the range of estimates obtained by several workers (VanDorp *et al*., 1998; Lin *et al*., 1989; Poso and Mantysaari, 1996; Zwald *et al*., 2004; Dhakal *et al*., 2015) in different cattle breeds. Lower estimate of heritabilities for these reproductive disorder traits in this study, might be due to high influence of environmental effects and it clearly suggests that there is little scope for improving these traits through genetic selection of superior animals, and these traits are under the influence of environmental conditions, which is mainly due to the complex nature of reproductive disorder traits and other managemental and nutritional factors.

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

Conflict of interest: Authors have no conflict of interest in this study.

Author's contribution: SD: Involved with the investigation, data curation, formal analysis, writing-original draft; IG: Involved with methodology, investigation, formal analysis; MR: Data curation, formal analysis, review and editing of the draft; MK: Review and editing of the draft; SMD: Engaged in methodology, investigation, writing-review and editing; AM: Involved with conceptualization, methodology, investigation, formal analysis, writing-original draft, writing-review and editing.

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