The Pharma Innovation Journal 2023; 12(6): 4291-4295

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 4291-4295

www.thepharmajournal.com
Received: 01-03-2023
Accepted: 05-04-2023

Gorakshanath Raosaheb Antre
Ph.D. Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra, India

Dr. SD Mandakmale
Associate Professor, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra, India

Pranjali Bhaudas Meshram
Ph.D. Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra, India

Dr. US Gaikwad
Assistant Professor, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra, India

Dr. DK Deokar
Associate Professor, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra, India

Corresponding Author:
Gorakshanath Raosaheb Antre
Ph.D. Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra, India

Effect of genetic and non-genetic factors on first lactation reproduction traits in Phule Triveni crossbred cattle

Gorakshanath Raosaheb Antre, Dr. SD Mandakmale, Pranjali Bhaudas Meshram, Dr. US Gaikwad and Dr. DK Deokar

Abstract
The data of 250 Phule Triveni crossbred cattle born from 62 sires maintained at Research Cum Development Project (RCDP) on cattle, MPKV, Rahuri for a period of 33 years (1987 to 2020) were collected for present investigation. The overall least-squares means of age at first calving (AFC), first service period (FSP) and first calving interval (FCI) in Phule Triveni crossbred cattle were estimated as 1023.25±10.14, 198.38±9.83 and 477.52±09.82 days, respectively. The period of birth had significant effect on AFC (p<0.01) while the period of calving had significant effect on FSP (p<0.05) and FCI (p<0.05) in Phule Triveni crossbred cattle. The variations due to season of birth in AFC while the variations due to season of calving in FSP and FCI were non-significant in Phule Triveni crossbred cattle under study. There was non-significant effect of peak milk yield on FSP and FCI. The sire had significant effect (p<0.01) on AFC while non-significant effect on FSP and FCI in Phule Triveni crossbred cattle.

Keywords: Phule Triveni, age at first calving, first service period, first calving interval

Introduction
Livestock is a key component of Indian agriculture, which supports the country's economy and employs millions of people. India has 193.46 million cattle, ranking first in the world, according to the 20th Livestock Census (2019) [1]. In India, there are 51.36 million exotic/crossbred cattle and 142.11 million indigenous/non-descript cattle. The two most important aspects of the overall effectiveness and profitability of the dairy animals are milk production and reproductive performance. Unfortunately, for a long time, dairy cattle breeding programmes have focused primarily on enhancing the production traits and have not given the reproduction traits the weight they deserve. But over time, a decline in reproduction has overshadowed the increase in milk output. Additionally, it was discovered that the high-yielding cows were very sensitive to negative energy balance, excessive mobilisation of body reserves in early lactation, failure to recover body reserves during mid- to late-lactation and significantly reduced reproductive efficiency (Royal *et al*., 2000; Lucy 2001; Pyrce and Veerkamp, 2001; Pryce *et al*., 2004) [27, 15, 24]. Reproduction is also economically significant because its decline may result in more inseminations, more expensive veterinary care and a greater culling rate. According to Nehra (2011) [18] using data from Karan Fries, roughly 23 per cent of cows were culled before their first lactation because of reproductive issues.

It is extremely challenging to predict which breed, cross or generation will provide the highest economic returns over investment due to the wide variation in performance of crossbreds due to differences of exotic donor breed and the adaptability of the crossbred to the divergent climatic conditions of the tropics, despite the fact that exotic cattle and their crosses are being used more frequently to raise milk production in the hot climate of the Indian subcontinent (Patel and Dave, 1987) [20]. Therefore, determining and stabilizing the ideal level of exotic inheritance in a cross-breeding operation remains a moot topic (Dalal *et al*., 1991) [4]. For the creation and execution of long-term breeding programmes, it is imperative to evaluate the comparative performance of crossbreds of various generations under diverse agroclimatic environments (Prabhukumar *et al*.,1990) [22].

The profitability of the dairy sector depends on animal production, which is influenced by both genetic and non-genetic factors. Knowing how non-genetic factors affect an animal's ability to be exploited is crucial for maximizing its genetic potential. To assess the genetic and non-genetic factors that influence production and reproductive qualities, comparative research is absolutely necessary. Therefore, the present investigation was undertaken to evaluate the non-genetic and genetic parameters which affect the reproduction traits in Phule Triveni. The aim of present study was to study the reproductive performance in Phule Triveni crossbred cattle by using data records of period from 1987 to 2020.

Material and Methods

Source of data

The data pertaining to the reproduction traits of 250 Phule Triveni crossbred cattle born from 62 sires were collected from history-cum-pedigree sheets and daily milk yield records maintained at Research Cum Development Project (RCDP) on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (M.S.) for the period of 33 years (1987-2020) and utilized for the present investigation.

Standardization of data

Culling in middle of lactation, abortion, still-birth or any other pathological causes which affected the lactation yield were considered as abnormalities and thus, such records were not taken for the study. The outliers beyond two-standard deviation on both the tail ends of normal distribution were excluded from the data. The records of Phule Triveni of known pedigree and with normal lactation were included in the present study. Reproduction traits were normalized.

Classification of data

The data were classified according to period of birth/calving, season of birth/calving and peak milk yield for various first lactation reproduction traits.

Statistical Analysis

In order to overcome non orthogonality of the data resulting from unequal and disproportionate sub class frequencies, the least squares analysis method suggested by Harvey (1990) [10] was used for analysis of data. The following mathematical models were used to estimate least squares means of various traits by considering effects of different factors.

Model – I: The least squares mean of age at first calving was estimated by considering period of birth and season of birth effects.

$Y_{ijk} = \mu + P_i + S_j + e_{ijk}$

Where,

Y_{ijk} = k^{th} Observations of age at first calving in i^{th} period of birth and

j^{th} season of birth

μ = Population mean

P_i = Effect of i^{th} period of birth (i = 1, 2………11)

S_j= Effect of j^{th} season of birth (j = 1, 2 and 3)

e_{ijk} = Random error associated with NID ~ (0, σ^2e)

Model – II: The least squares mean of first service period, first calving interval were estimated by considering period of calving, season of calving and peak milk yield effects.

$Y_{ijkl} = \mu + P_i + S_j + A_k + e_{ijkl}$

Where,

Y_{ijkl} = 1^{th} Observations of reproductive traits in i^{th} period of calving, j^{th} season of calving and k^{th} peak milk yield.

μ = Population mean

P_i = Effect of i^{th} period of calving (i = 1, 2……..10)

S_j = Effect of j^{th} season of calving (j = 1, 2 and 3)

A_k = Effect of k^{th} peak milk yield (k = 1, 2 and 3)

e_{ijkl} = Random error associated with NID ~ (0, σ^2e)

Model – III: Least squares analysis of some reproduction traits as affected by sire was carried out by using following statistical model.

$Y_{ij} = \mu + S_i + e_{ij}$

Where,

Y_{ij} = j^{th} Observation on reproduction and production traits in i^{th} sire

μ = Population means

S_i = Effect of i^{th} sire (i = 1 to n)

e_{ij} = Random error associated with NID ~ (0, σ^2e)

Duncan's Multiple Range Test (DMRT)

Whenever the effects were significant the differences between means were tested for significance by Duncan's Multiple Range Test (DMRT) as modified by Kramer (1957) [13].

Results and Discussion

The data on first lactation reproduction traits consists of age at first calving (AFC), first service period (FSP) and first calving interval (FCI) were analyzed by least-squares technique to estimate the effect of non-genetic factors *viz.* period of birth/calving, season of birth/calving and peak milk yield on the traits under study. After correcting the data for the non-genetic factors, the least squares means of traits were estimated by considering the effects of sire.

First Lactation Reproduction Traits

The overall least-squares means of AFC, FSP and FCI in Phule Triveni were estimated as 1023.25±10.14, 198.38±9.83 and 477.52±09.82 days, respectively (Table 2). The observed age at first calving were in close agreement with Akhtar *et al.* (2003) [2] in 5/8 HF x 3/8 SW, Garudkar (2015) [9] in IFG, Ambhore *et al.* (2017) [3] in Phule Triveni, Jadhav *et al.* (2019) [12] and Sarwade (2021) [29] in HF x Gir halfbred. The lower AFC than the present results were reported by Garudkar (2015) [9] in FG and FJG genetic group. However, higher values of AFC were noticed by Jadhav (1990) [11] in HF x SW, Thombre *et al.* (2002) [34] in HF x Deoni and Dubey and Singh (2005) [8] in Crossbred Sahiwal.

The present results of FSP were resembled with Mukherjee (2005) [17] in Frieswal (164.51±2.51 days), Deokar *et al.* (2008) [6] in Phule Triveni (158±6 days), Garudkar (2015) [9] in IFJG (161.78±3.05 days), Rathee (2015) [26] in Frieswal (153.26±3.79 days) and Ambhore *et al.* (2017) [3] in Phule Triveni (151.07±5.10 days). However, Panja (1997) [19] and Saha (2001) in Karan Fries cattle reported shorter service period.

Similar result of FCI findings with Deokar *et al.* (2008) [6] in Phule Triveni (438±6.05 days), Ambhore *et al.* (2017) [3] in Phule Triveni (430.32±4.01 days), Kuchekar *et al.* (2021) [14] in Phule Triveni (421.63±5.65 days) and Sarwade (2021) [29] in HF x Gir halfbred (421.10±3.77 days). However, shorter calving interval was observed by Akhtar *et al.* (2003) [2] in 5/8 HF x 3/8 SW (386±7 days), Nehra (2011) [18] in Karan fries (328±5 days).

Table 1: ANOVA for first lactation reproduction traits in Phule Triveni crossbred cattle

Source of variation	Age at first calving (days)		First service period (days)		First calving interval (days)	
	d.f.	MSS	d.f.	MSS	d.f.	MSS
Period of Birth/Calving	10	224603.37**	9	38286.85*	9	38287.49*
Season of Birth/Calving	2	20560.46	2	42392.35	2	42198.52
Peak milk yield	-	-	2	12757.27	2	12779.71
Error	237	16536.97	236	17267.49	236	17254.91
Sire	61	52931.86**	61	20088.29	61	20061.76
Error	187	15187.57	187	16178.50	187	16170.14

*: $p<0.05$
**: $p<0.01$

Effect of period of birth/calving

The period of birth had significant effect on AFC ($p<0.01$) while the period of calving had significant effect on FSP ($p<0.05$) and FCI ($p<0.05$) in Phule Triveni crossbred cattle (Table 1). The DMRT confirmed in Phule Triveni that the cows born during period P_{11} had significantly shorter AFC (834.40±64.37 days), which was at par with the cows born during P_1 (884.54±19.72 days). These findings were in close agreement with Singh *et al*. (2014) in Frieswal, Ambhore *et al*. (2017) [3] and Kuchekar *et al*. (2021) [14] in Phule Triveni, Jadhav *et al*. (2019) [12], Shinde (2021) [30] and Sarwade (2021) [29] in HF x Gir halfbred.

In Phule Triveni, significantly lowest FSP was observed in cows those calved during period P_1 (131.35±18.47 days) than other periods. These results were in agreement with the findings of Divya (2012) [7] in Karan Fries, Rathee (2015) [26] in Frieswal cows and Kuchekar *et al*. (2021) [14] in Phule Triveni. While, non-significant effect of period of calving on service period was reported by Garudkar (2015) [9] in FG, IFG, FJG, IFJG crossbreds, Ambhore *et al*. (2017) [3] in Phule Triveni cattle, Jadhav *et al*. (2019) [12].

In Phule Triveni, significantly lowest FCI was observed in cows those calved during P_1 (410.43±18.47 days), while it was the highest in cows calved during P_8 (523.64±28.82 days) which was at par with cows calved during P_7 (511.29±26.28 days). The significant effect of period of calving on FCI was supported by Zol *et al*. (2009), Ambhore *et al*. (2017) [3] and Kuchekar *et al*. (2021) [14] in Phule Triveni cattle, Mukherjee (2005) [17] and Rathee (2015) [26] in Frieswal cows.

Table 2: Least squares means for first lactation reproduction traits in Phule Triveni crossbred cattle

Source of variation	Age at first calving (days)			First service period (days)				First calving interval (days)			
	N	Mean	SE		N	Mean	SE		N	Mean	SE
μ	**250**	**1023.25**	**10.14**	**μ**	**250**	**198.38**	**9.83**	**μ**	**250**	**477.52**	**09.82**
Period of birth/calving											
P_1 (1987-89)	45	884.54^a	19.72	-	-	-	-	-	-	-	-
P_2 (1990-92)	36	961.41^{bc}	21.59	P_1 (1990-92)	54	131.35^a	18.47	P_1 (1990-92)	54	410.43^a	18.47
P_3 (1993-95)	11	1090.15^e	38.89	P_2 (1993-95)	28	192.27^{ab}	25.17	P_2 (1993-95)	28	471.34^{ab}	25.16
P_4 (1996-98)	13	1081.37^{de}	35.81	P_3 (1996-98)	9	192.19^{ab}	44.09	P_3 (1996-98)	9	471.41^{ab}	44.07
P_5 (1999-2001)	16	1151.10^e	32.21	P_4 (1999-2001)	15	160.00^a	34.26	P_4 (1999-2001)	15	439.14^a	34.25
P_6 (2002-04)	14	1018.03^d	34.38	P_5 (2002-04)	12	203.86^{ab}	38.42	P_5 (2002-04)	12	483.27^{ab}	38.40
P_7 (2005-07)	23	965.62^{bc}	26.88	P_6 (2005-07)	16	191.79^{ab}	33.20	P_6 (2005-07)	16	470.91^{ab}	33.19
P_8 (2008-10)	24	1009.50^{cd}	26.25	P_7 (2008-10)	26	232.23^b	26.29	P_7 (2008-10)	26	511.29^b	26.28
P_9 (2011-13)	30	1129.43^e	23.71	P_8 (2011-13)	21	244.55^b	28.83	P_8 (2011-13)	21	523.64^b	28.82
P_{10} (2014-16)	34	1130.16^e	22.30	P_9 (2014-16)	31	220.52^{ab}	24.46	P_9 (2014-16)	31	499.61^{ab}	24.45
P_{11} (2017-20)	4	834.40^a	64.37	P_{10} (2017-20)	38	215.08^{ab}	22.49	P_{10} (2017-20)	38	494.15^{ab}	22.49
Season of birth/calving											
S_1: Rainy	68	1032.66	16.58	S_1: Rainy	63	189.84	17.66	S_1: Rainy	63	468.98	17.65
S_2: Winter	101	1032.67	14.85	S_2: Winter	98	181.51	14.20	S_2: Winter	98	460.68	14.20
S_3: Summer	81	1004.41	15.61	S_3: Summer	89	223.81	15.25	S_3: Summer	89	502.89	15.24
Peak milk yield											
Y_1: < 12.00	-	-	-	Y_1: < 12.00	108	207.53	14.03	Y_1: < 12.00	108	486.68	14.02
Y_2: 12.00-14.00	-	-	-	Y_2: 12.00-14.00	80	183.76	16.11	Y_2: 12.00-14.00	80	462.88	16.11
Y_3: >14.00	-	-	-	Y_3: >14.00	62	203.87	18.01	Y_3: >14.00	62	483.00	18.01

Note: Means under each class in the same column with different superscripts differed significantly

Effect of season of birth/calving

The variations due to season of birth in AFC while the variations due to season of calving in FSP and FCI were non-significant in Phule Triveni crossbred cattle under study (Table 1). The non-significant effect of season of birth on AFC was in close agreement with Divya (2012) [7] in Karan Fries cattle, Singh *et al*. (2014) in Frieswal, Garudkar (2015) [9] in FG, IFG, FJG, IFJG crossbreds, Ambhore *et al*. (2017) [3] and Kuchekar *et al*. (2021) [14] in Phule Triveni, Jadhav *et al*. (2019) [12] and Sarwade (2021) [29] in HF x Gir halfbred. Whereas, contradictory results were reported by Akhtar *et al*. (2003) [2], PDC-AR (2003-04), Dubey and Singh (2005) [8] and Rathee (2015) [26] in different crossbred cows.

The non-significant effect of season of calving on FSP was reported by Divya (2012) [7] in Karan Fries cattle, Garudkar (2015) [9] in FG, IFG, FJG, IFJG crossbreds, Ambhore *et al*. (2017) [3] in Phule Triveni cattle, Jadhav *et al*. (2019) [12] and Sarwade (2021) [29] in HF x Gir halfbred. However, contradictory results were reported by Saha (2001) and Singh (2013) in KF, Mukherjee (2005) [17] in Frieswal, and Mhasade

(2010) in FG crossbreds.

The non-significant effect of season of calving on FCI was in accordance with Rathee (2015) [26] in Frieswal, Ambhore *et al.* (2017) [3] in Phule Triveni cows, Jadhav *et al.* (2019) [12], Shinde (2021) [30] and Sarwade (2021) [29] in HF x Gir halfbred. However, significant effect was reported by Akhtar *et al*. (2003) [2] in 5/8 HF x 3/8 SW crossbred and Mukherjee (2005) [17] in Frieswal.

Effect of peak milk yield

There was non-significant effect of peak milk yield on FSP and FCI in Phule Triveni crossbred cattle (Table 1). These results were in agreement with the findings of Deokar *et al*. (2015) [5] and Sarwade (2021) [29] in HF x Gir halfbreds.

Effect of sire

The sire had significant effect (p<0.01) on AFC while non-significant effect on FSP and FCI in Phule Triveni crossbred cattle (Table 1). The significant effect of sire on AFC was also reported by Akhtar *et al*. (2003) [2] in 5/8 HF x 3/8 SW cattle, Singh *et al.* (2014) in Frieswal cattle, Ambhore *et al*. (2017) [3] in Phule Triveni cattle, Jadhav *et al.* (2019) [12], Shinde (2021) [30] in HF x Gir halfbred. Whereas, the non-significant effect of sire on AFC was reported by Garudkar (2015) [9] and Kuchekar *et al*. (2021) [14] in Phule Triveni.

The non-significant effect of sire on FSP was reported by Garudkar (2015) [9] in FG, IFG, FJG crossbreds, Ambhore *et al*. (2017) [3] in Phule Triveni cattle, Jadhav *et al*. (2019) [12].

The non-significant effect of sire on FCI was reported by Akhtar *et al*. (2003) [2] in 5/8 HF x 3/8 SW, Mukherjee (2005) [17] in Frieswal, Nehra (2011) [18] in KF cattle, Ambhore *et al*. (2017) [3] in Phule Triveni, Jadhav *et al*. (2019) [12] and Shinde (2021) [30] in HF x Gir halfbred.

Conclusion

The overall least-squares means of age at first calving (AFC), first service period (FSP) and first calving interval (FCI) in Phule Triveni crossbred cattle were estimated as 1023.25±10.14, 198.38±9.83 and 477.52±09.82 days, respectively. The influence of period of birth was found to be significant on AFC while the influence of period of calving was found to be significant on FSP and FCI in Phule Triveni crossbred cattle. The variations due to season of birth in AFC while the variations due to season of calving in FSP and FCI were non-significant in Phule Triveni crossbred cattle under study. There was non-significant effect of peak milk yield on FSP and FCI. The sire had significant effect on AFC while non-significant effect on FSP and FCI in Phule Triveni crossbred cattle.

References

1. 20th Livestock Census; c2019. https://dahd.nic.in/schemes/programmes/animal-husbandry-statistics
2. Akhtar J, Singh M, Kumar D, Sharma K. Factors affecting economic traits in crossbred cattle. Indian J Anim. Sci. 2003;73(4):464-465.
3. Ambhore GS, Singh A, Deokar DK, Gupta AK, Singh M, Ved Prakash. First lactation production and reproduction performance of Phule Triveni cattle in hot arid region of Maharashtra. Indian J Anim. Sci. 2017;87(1):105-108.
4. Dalal DS, Arora KC, Rathi SS. Evaluation of performance traits in halfbred cattle. Indian J Dairy Sci. 1991;44(2):401-405.
5. Deokar DK, Birari DR, Deshmukh AR, Dengare RS. Studies on first lactation reproduction traits of HF× Gir halfbreds. BIOINFOLET-A Quarterly Journal of Life Sciences. 2015;12(3a):576-581.
6. Deokar DK. Desale RJ, Kale SV, Kalhapure SP, Fulpagare YG. Source of variation in production traits of Phule Triveni crossbred cattle. Indian J. Anim. Prod. And Management. 2008;24(1/2):15-17.
7. Divya P. Single versus multi-trait models for genetic evaluation of fertility traits in Karan Fries cattle. M.V.Sc. Thesis, National Dairy Research Institute, Karnal, India. 2012.
8. Dubey PP, Singh CV. Estimates of genetic and phenotypic parameters considering first lactation and lifetime performance traits in Sahiwal and crossbreed cattle. Indian J. Anim. Sci. 2005;75(2):1289-1294.
9. Garudkar SR. Lifetime comparison of fertility and milk production in halfbred and three breed crosses of Gir. Ph.D. Thesis submitted to MPKV, Rahuri. 2015.
10. Harvey WR. Guide for LSMLMW, PC-1 Version, mixed model least squares and maximum likelihood computer programme, January 1990. Mimeograph Ohio State Univ., USA; c1990.
11. Jadhav KL. Evaluation of various Holstein grades for economic efficiency and health costs. Ph.D. Thesis, National Dairy Research Institute (Deemed University), Karnal, India; c1990.
12. Jadhav SS, Deokar DK, Fulpagare YG, Bhoite UV, Mandakmale SD, Nimbalkar CA. Effects of genetic and non-genetic factors on first lactation production and reproduction traits in HF x Gir cattle. International Journal of Current Microbiology and Applied Sciences, 2019;8(1):45-51.
13. Kramer CV. Extension of multiple range test to group correlated adjusted mean. Biometric. 1957;13:13-20.
14. Kuchekar HD, Bhoite UY, Bhoite SU, Gaikwad US, Shinde KP. Effect of genetic and non-genetic factors on first lactation reproduction and production traits in Phule Triveni cattle. Journal of Pharmacognosy and Phytochemistry. 2021;10(2):13-16.
15. Lucy MC. Reproductive loss in high-producing dairy cattle: Where will it end? J Dairy Sci. 2001;84:1277-1293.
16. Mhasade BS. Effect of age and weight at first calving on production performance of HF x Gir crossbreds. M.Sc. (Agri.) Thesis submitted to MPKV, Rahuri; c2010.
17. Mukherjee S. Genetic evaluation of Frieswal cattle. Ph.D. Thesis, National Dairy Research Institute (Deemed University) Karnal, (India); c2005.
18. Nehra M. Genetic analysis of performance trends in Karan Fries cattle. M.V.Sc. Thesis. NDRI (Deemed University) Karnal, India; c2011.
19. Panja P. Optimization of economic traits in Karan Fries cattle. M.Sc. Thesis, National Dairy Research Institute (Deemed University), Karnal, India; c1997.
20. Patel JM, Dave AD. Body weight changes and growth pattern in Jersey x Kankrej and Holstein x Kankrej F1 crossbreds. Indian J Anim. Res. 1987;21(2):97-101.
21. PDC-AR 2003-04. Project Directorate on Cattle, Annual Report (2003-04), Meerut.
22. Prabhukumar V, Rao CH, Venkatramaian A, Naidu KM. Genetic group differences in the performance of the

various crosses of angole with Friesian, Brown Swiss and Jersey breeds. Indian J Dairy. Sci. 1990;43(1):46-50.
23. Pryce JE, Royal MD, Garnsworthy PC, Mao IL. Fertility in the high yielding dairy cow. Liv. Prod. Sci. 2004;86:125-135.
24. Pyrce JE, Veerkamp RF. The incorporation of fertility indices in genetic improvement programmes. BSAS Occasional Publication. 2001;26:237-250.
25. Rana PS. A note on the performance of crossbred cows at military dairy farms. Cherion. 1991;20:1-5.
26. Rathee SK. Genetic evaluation of Frieswal cattle for life time traits. Ph.D. Thesis submitted to ICAR National Dairy Research Institute, Deemed University, Karnal (Haryana), India; c2015.
27. Royal MD, Darwash AO, Flint APF, Webb R, Woolliams JA, Lamming GE. Declining fertility in dairy cattle: Changes in traditional and endocrine parameters. Anim. Sci. 2000;70:487.
28. Saha. Generation wise genetic evaluation of Karan Swiss and Karan Fries cattle. M.Sc. Thesis. NDRI Deemed University, Karnal, India; c2001.
29. Sarwade DD. Genetic gain in economic traits through selection indices in HF×Gir halfbreds. Ph.D. Thesis submitted to MPKV, Rahuri; c2021.
30. Shinde OV. Genetic evaluation of sires of HF x Gir halfbred using fertility and milk production traits. Ph.D. Thesis submitted to MPKV, Rahuri; c2021.
31. Singh RK. Genetic evaluation of Karan Fries sires using multiple trait models. Ph.D. thesis submitted to NDRI, Karnal (Haryana); c2013.
32. Singh S, Das AK, Chakraborty D, Taggar RK, Kumar N, Gupta P. Studies on genetic and non-genetic factors affecting performance traits of Frieswal cows. Indian J. Anim. Res. 2014;48(6):537-540.
33. Sinha S. Studies on level of heterozygosity of Karan Fries animals. M.Sc. Thesis, National Dairy Research Institute (Deemed University) Karnal, India; c1999.
34. Thombre BM, Mitkari KR, Padghan PV, Shaikh FG, Chavan KR. Studies on age at first calving and first lactation performance in Holstein Friesian x Deoni straight breds. Indian J Anim. Res. 2002;36(2):144-146.
35. Zol SR, Bhoite UY, Pachpute ST, Deokar DK. Reproduction and production performance and breeding efficiency of Phule Triveni crossbred cows. J. Maha. Agric. Univ. 2009;34(2):208-210.