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CONTENTS

Evaluation of genetic and non-genetic factors affecting first lactation traits in crossbred cattle

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ABSTRACT: The present study was undertaken on crossbred cattle utilizing the records of 567 daughters of 57 sires, spread over a period of 30 years from 1990 to 2019, maintained at Instructional Dairy Farm of G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand to study the inheritance pattern of different economic traits. The least squares mean (LSM) along with their standard errors of age at first calving (AFC), first service period (FSP), first dry period (FDP), first lactation length (FLL), first calving interval (FCI), first lactation peak yield (FLPY), days to attend peak yield (DPY), first lactation milk yield (FLMY) and first lactation 305-day milk yield (FL305DMY) were observed as 1268.85 ±16.75 days, 267.51 ± 1.93 days, 91.56 ± 1.86 days, 369.41 ± 6.68 days, 465.80 ± 6.64 days, 13.88 ± 0.17 kg, 39.76 ± 0.78 days, 3294.64 ± 77.93 kg and 2570.74 ± 38.30 kg, respectively. Significant effects of sire were found on AFC, FLPY, DPY, FLMY and FL305DMY. Significant effect of period of calving was observed on AFC, FSP, DPY, FLMY, and FL305DMY while non-significant effect was found on FDP, FLL, and FCI. The effect of season of calving was found non-significant for all the first lactation traits under study. The heritability estimates for the traits under study AFC, FSP, FDP, FLL, FCI, FLPY, DPY, FLMY and FL305DMY were observed as 0.34 ± 0.21, 0.10 ± 0.1, 0.12 ± 0.11, 0.45 ± 0.16, 0.32 ± 0.17, 0.42 ± 0.22, 0.40 ± 0.20, 0.54±0.19 and 0.59±0.20, respectively. Thus, it can be asserted that sire and non-genetic factors have significant effect on the production and reproduction trait in crossbred cattle. It is pertinent to pre adjust the data of environmental factors for evaluating genetic parameters of economically important traits.

Key words: Crossbred cattle, first lactation traits, genetic and non-genetic factors

Enhancing dairy animal production can be accomplished through the improvement of environmental conditions, the enhancement of the population's average breeding values, or a combination of both approaches. The key to determining the actual progress achievable lies in partitioning the total phenotypic variance of economically important traits into genetic and non-genetic components. Accurate measurement of milk production per cow during lactation is of major interest in genetic improvement programmes. Using these measures, cumulative 305 days milk production is calculated and used not only in genetic evaluations but also in herd management as a decision-making tool (e.g., culling or feeding management).

The performance of a herd is determined by the animal's average milk and reproductive performance. The interaction of the cow's genetic composition and environmental factors at the specified time and age results in cow milk production (Yadav *et al*., 2018). It is, therefore, crucial to provide information on non-genetic factors throughout the genetic assessment of performance characteristics in milk-specified cows (Nyamushamba *et al*., 2013). Non-genetic factors comprise those environmental factors that have non-measurable effects, such as diseases as well as ecological factors that have measurable effects, such as lactation stage, cow age, parity, season, and year of calving, all of which are important when planning breeding programmes (Javed *et al.,* 2004).

The current study on crossbred cattle uses first lactation milk records as its primary data source. First lactation features are influenced by variety of genetic and non-genetic factors, therefore, accounting for these aspects is crucial for an objective assessment of an animal's genetic value.

MATERIALS AND METHODS

Source and collection of data

The present study was undertaken utilizing the records of 567 daughters of 55 sires, distributed over a period of 30 years from 1990 to 2019. The data were collected from cattle history sheets and milk record registers of crossbred cattle maintained at Instructional Dairy Farm of G.B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand.

Location and climatic condition of the farm

Pantnagar is located at the foothills of the Himalayas (Shiwalik range) and geographically falls in the humid sub-tropical climate zone. It is situated at 29o North latitude, 79.3o East longitudes and an altitude of 236.54 meters above the mean sea level. The region is popularly known as 'Tarai' due to its sub-tropical humid climate. The minimum temperature falls to 0.8°C (33.4°F) in January which is the coldest month whereas the maximum temperature goes up to 43.5°C (110.3°F) in May and June, which are the hottest months in this region. The average annual rainfall recorded in Pantnagar is 1699 mm. Most of the rainfall occurs in the months of July and August. The relative humidity ranges from 28% in the month of April to a high of 80% in the month of August.

Grouping of data

The data were classified according to the season and period of calving. The data spread over 30 years (1990-2019) for crossbred cattle was grouped into five periods. Each year has been divided into three seasons based on rainfall, temperature and humidity over the year's (Table 1).

Table 1: Distribution of observations according to period and season of calving

Period	Year of calving	Name of season	Group of months
1	1990-1995	Summer	March to June
2	1996-2001	Monsoon	July to October
3	2002-2007	Winter	November to February
4	2008-2013		
5	2014-2019		

Least squares analysis

Since the sub-class numbers were unequal and disproportionate, therefore, the data on various performance traits was subjected to Least-squares analysis by fitting constants to estimate magnitude of various genetic and non-genetic sources of variations on these traits. The analysis was carried out by using model-2 and model-8 of mixed model least-squares maximum likelihood (LSMLMW) computer programme designed by Harvey (1990). For estimation of genetic parameters and breeding values, the sire having progeny less than three were not included. The data was suitably classified to study the effects of non-genetic factors like period and season of birth. For this study the model was $Yijkl = \mu + S_i + G_j + P_k + e_{ijkl}$ the observation on l^{th} progeny of i^{th} sire of j^{th} season in K^{th} period where, μ = Population mean; S_i = Random effect of i^{th} sire (i=1,2,3,4……57); Gj = Fixed effect of j^{th} season of calving (j=1,2,3); P_k = Fixed effect of k^{th} period of calving (k=1,2….5); e_{ijkl} = Random error assumed to be normally and independently distributed with mean zero and constant variance i.e., NID $(0, \sigma^2)$

Duncan's Multiple Range Test (DMRT)

The statistical significance of various fixed effects (period and season of calving) in the least squares model was determined by 'F' test. For significant effects, the differences between pairs of levels of effects were tested by DMRT as modified by Kramer (1957).

Estimation of heritability

Heritability estimates for different traits were obtained from sire component of variances using paternal half-sib correlation method (Becker, 1975). The sires with three or more than three progenies were included for the estimation of heritability. The model used to estimate the heritability was: $Y_{ij} = \mu + s_i + e_{ij}$; Where, Y_{ij} =Observation of the j^{th} progeny of the i^{th} sire ; μ= Overall mean ; s_i= Effect of the i^{th} sire, e_{ij}= Random error NID $(0, \sigma^2_e)$; The s_i and e_{ij} were assumed to be independent of each other.

RESULTS AND DISCUSSION

The overall least squares mean along with standard

Table 2: Least squares means along with standard errors for first lactation traits

Effect		AFC	FSP	FDP	FLL	FCI	FLPY	DPY	FLMY	FL305DMY
Overall	567	1268.85±16.75	267.51±1.93	91.56±1.86	369.41±6.68	465.80±6.64	13.88±0.17	39.76±0.78	3294.64±77.93	2570.74±38.30
P 1(period)	68	1206.21±58.52^{a}	255.61±6.75^{ab}	90.36±6.51	385.89±23.34	512.17±23.20	11.69±0.60^{a}	40.42±2.72	2763.1±5272.24^{a}	1974.06±133.78^{a}
P 2	146	1236.73±47.68^{a}	274.37±5.50^{b}	83.25±5.30	391.17±19.02	496.51±18.90	13.40±0.49^{a}	42.51±2.21	3754.66±221.81^{b}	2788.65±109.00^{b}
P 3	160	1200.63±41.67^{b}	268.54±4.81^{b}	90.53±4.63	368.93±16.62	475.06±16.52	16.04±0.43^{b}	39.78±1.93	3575.36±193.83^{b}	2817.90±95.25^{b}
P 4	111	1267.16±51.09^{b}	274.61±5.89^{b}	94.02±5.68	363.43±20.38	482.24±20.25	14.84±0.53^{b}	38.94±2.37	3235.49±237.68^{b}	2647.66±116.80^{b}
P 5	82	1433.54±93.07^{b}	264.44±10.73^{a}	99.62±10.35	337.61±37.12	363.02±36.89	13.43±0.96^{b}	37.14±4.32	3144.52±432.95^{c}	2625.41±212.75^{c}
S 1 (season)	180	1225.25±24.91^{a}	270.04±2.87	92.40±2.77	367.86±9.94	465.43±9.88	13.66±0.26^{a}	38.53±1.16	3192.5±8115.90	2524.25±56.95
S 2	145	1282.07±26.57^{ab}	266.67±3.06	91.80±2.96	366.28±10.60	464.72±10.53	13.62±0.27^{a}	40.60±1.23	3346.71±123.60	2603.35±60.74
S 3	242	1299.24±22.74^{b}	265.83±2.62	90.47±2.53	374.08±9.07	467.24±9.01	14.36±0.23^{b}	40.15±1.06	3344.62±105.79	2584.61±51.98

errors of AFC, FSP, FDP, FLL, FCI, FLPY, DPY, FLMY and FL305DMY were observed as 1268.85 ±16.75 days, 267.51 ± 1.93 days, 91.56 ± 1.86 days, 369.41 ± 6.68 days, 465.80 ± 6.64 days, 13.88 ± 0.17 kg, 39.76 ± 0.78 days, 3294.64 ± 77.93 kg and 2570.74 ± 38.30 kg, respectively. The LSM and standard errors of production and reproduction traits in different classes of calving seasons, and periods are presented in Table 2. The similar findings were reported by Kumar *et al*. (2017) and Kumari *et al*. (2019) in crossbred cattle for AFC and for FSP very same estimates were reported by Shahi and Kumar (2010) in crossbred cattle.

Effect of Sire on First Lactation Traits

The least squares analysis of variance showed that sire had a highly significant impact on AFC, FLPY, DPY, FLMY and FL305DMY. However, in the present investigation, the effect of sire on FSP, FDP, FLL and FCI was found to be non-significant.

The genetic contribution of sires to their offspring can vary significantly. If the sires have diverse genetic backgrounds, this variation can lead to significant differences in traits like milk production, growth rate, fertility, and other reproductive traits. Environmental factors such as nutrition, housing, and management practices can influence production and reproduction traits. If these factors are not consistent across all sires' offspring, it might mask or amplify the genetic effects, leading to non-significant results. Traits with higher heritability are more likely to show significant sire effects because a larger portion of the trait variation is due to genetic factors. Traits with low heritability might not show significant sire effects because environmental factors play a major role in phenotypic expression. There could be interactions between sires and other factors such as dams, specific management practices, or even the specific environment. These interactions can complicate the interpretation of the significance of the sire effect. So, the significance of the sire effect on production and reproduction traits in cattle can be attributed to a combination of genetic variation, environmental consistency, trait's heritability, and potential interactions.

These results were consistent with those of Shahi and Kumar (2010), Lodhi *et al.* (2016), Jadhav *et al.* (2019) and Girimal *et al.* (2020) studied the effect of sire on production and reproduction traits in crossbred cattle.

Effect of period and season of calving on First Lactation Traits

Significant effect of period of calving was observed on AFC, FSP, DPY, FLMY, and FL305DMY while non-significant effect was found on FDP, FLL, and FCI. These results were consistent with those of Shahi and Kumar (2010), Puhle *et al.* (2015), Singh *et al.* (2015), Lodhi *et al.* (2016), Kokati *et al.* (2017), Gaikwad *et al.* (2018), Verma *et al.* (2018) and Girimal *et al.* (2020). However, the effect of season of calving was found non-significant for all the first lactation traits under study. Non-significant effect of season of calving on various first lactation traits were also reported by Tiwari *et* *al*. (2010), Divya *et al.* (2014), Gaikwad *et al.* (2018), Basak and Das (2018) and Jadhav *et al.* (2019). The reason for the significant and non-significant effects of the period and season of calving on first lactation traits could be due to variations in management practices, genetic traits of the cows, dietary consistency, and regional climate conditions.

Heritability Estimates of Different First Lactation Traits

The heritability estimates for the traits under study, AFC, FSP, FDP, FLL, FCI, FLPY, DPY, FLMY and FL305DMY were observed as 0.34 ± 0.21, 0.10 ± 0.1, 0.12 ± 0.11, 0.45 ± 0.16, 0.32 ± 0.17, 0.42 ± 0.22, 0.40 ± 0.20, 0.54±0.19 and 0.59±0.20, respectively. Heritability estimates for the first lactation traits in the present study were found to be low to medium except for FLMY and FL305DMY which were on higher side. The h^2 estimates were as expected according to the traits which indicated that traits with sufficient additive genetic variability can be improved by selection whereas those with low to medium h^2 can be improved by adopting better management practices.

The medium to high heritability for first lactation peak yield were reported by Kumar *et al.* (2017); for first lactation milk yield by Kumar *et al.* (2008) and Kharat *et al.* (2008); for first lactation 305 days milk yield by Singh and Gurnani (2004), Ambhore *et al.* (2017) and Girimal *et al.* (2020). Medium to low heritability for reproduction traits were reported by Lodhi *et al.* (2016), Kuchekar *et al.* (2021) and Rajeev and Kumar (2021) in cross bred cattle.

CONCLUSION

Productive and reproductive traits are affected by genetic and non-genetic factors. Evaluation of these factors provides the basic information for establishing sound breeding programmes for genetic improvement of the animal population. It helps in selecting animals with superior genetic merits based on their high breeding values. However, it assists in early prediction of genetic merit and reducing the generation interval which results in increasing the amount of genetic gain. The non-genetic factors have an important bearing on these traits and directly obscure recognition of genetic potential. Moreover, the performance records of an animal should be corrected for classifiable non-genetic sources of variation, which is essential for obtaining precise estimates of genetic parameters. The heritability of a trait plays an important role in formulating the genetic improvement programme and predicting genetic gain (response to selection).

REFERENCES

Ambhore, G.S., Singh, A., Deokar, D.K., Gupta, A.K., Singh, M. and Prakash, V. (2017). First lactation production and reproduction performance of Phule Triveni cattle in hot arid region of Maharashtra *Indian J Anim Sci*., 87(1): 105–108.

Basak, S. and Das, N.D. (2018). Effect of parity, period and season of calving on production and reproduction traits on Deoni Cattle. *J Anim. Health Prod.,* 6: 1-4.

Becker, W.A. (1975). *Manual of Quantitative Genetics*. 3rd Edition, Washington State University, Washington, USA.

Divya, P., Singh, A., Gandhi, R.S. and Singh, R.K. (2014). Estimation of breeding values of first lactation 305-day milk yield from and multi-trait animal models in Karan Fries cattle. *Indian J. Anim. Sci.,* 84(10): 1085-1089.

Gaikwad, U., Dengre, R., Deokar, D. and Bhoite U. (2018). Studies on first lactation production traits of HF x Gir Halfbreds. *Journal of Animal and Veterinary Science,* 5(2): 12-15.

Girimal, D.G., Kumar, D., Shahi, B.N., Ghosh, A.K. and Kumar, S. (2020). Studies on some reproduction and first lactation milk yield traits in Sahiwal and crossbred cattle. *J. Vet. Med. Animal Sci*., 3(1): 1019.

Harvey, W.R. (1990). User's guide for LSMLMW and MIXMDL PC-2 version. Mixed model least-squares and maximum likelihood computer program, Ohio State University, Columbus, Ohio, USA.

Jadhav, S.S., Deokar, D.K., Fulpagare, Y.G., Bhoite, U.Y., Mandkmale, S.D. and C.V. Nimbalker

(2019). Effect of genetic and non-genetic factors on first lactation production and reproduction traits in HF × Gir cattle. *Int. J. Curr. Microbiol. App. Sci.,* 8(1): 45-51.

Javed, K., Afzal, M., Sattar, A. and Mirza, R.H. (2004). Environmental factors affecting milk yield in Friesian cows in Punjab. *Pak Vet J.*, 24(2): 58– 61.

Kharat, A.S., Kuralkar, S.V. and Ali, S.Z. (2008). Genetic studies on first lactation and lifetime traits in Holstein Friesian crossbred cows. *Ind. J. Anim. Res*., 42: 261-263.

Kokati, P., Panchal, B.D., Patel, A.C., Bahuguna, P.K., Joshi, R.S. and Rank, D.N. (2017). Genetic parameters of production and reproduction traits and factors affecting it in Frieswal cattle. *Int. J Livestock Res*., 7.

Kramer, C.R. (1957). Extension of multiple range tests to group correlated means. *Biometrics.,* 13: 13-18.

Kuchekar, H.D., Bhoite, U.Y., Bhoite, S.U., Shinde, K.P. and Pachpute, S.T. (2021). Effect of genetic and non-genetic factors on first lactation reproduction and production traits in HF x Gir Halfbred. *Int. J. Curr. Microbiol. App. Sci.,* 10(03): 927-932.

Kumar, A., Mandal, A., Gupta, A.K., Ratwan, P. and Kumar, N. (2017). Genetic evaluation of reproductive traits in Jersey crossbred heifers at an organized farm of eastern India. *Indian J Anim. Res*., 51: 619-624.

Kumar, S., Singh, Y.P. and Kumar, D. (2008). Genetic studies on performance traits in Frieswal cattle. *Ind. J. Anim. Sci.,* 78: 107-110.

Kumari, S., Narang, R., Malhotra, P., Sharma, N. and Mehrotra, A. (2019). Evaluation of reproductive performance of crossbred cattle maintained at an organized farm in Punjab. *The Pharma Innovation*, 8: 159-162.

Lodhi, G., Singh, C.V., Barwal, R.S. and Shahi, B.N. (2016). Genetic and phenotypic parameters of first lactation and lifetime traits in crossbred cattle, *Int. J. Agric. Pol. Res.,* 4 (8): 143-148.

Nyamushamba, G.B., Halimani, T.E., Imbayarwo-Chikosi V.E., Tavirimirwa, B. and Zishiri, O.T. (2013). Effect of within herd environmental factors on milk, fat and protein yields in Red Dane cattle in Zimbabwe. *Online J Anim Feed Res*., 3(5): 202–204.

Puhle, K.J., Mehla, R.K. and Intiwati Bhat, S.A. (2015). Effect of non-genetic factors on various economic traits in Karan Fries crossbred cattle. *Ind. J. of Dairy Sci.,* 68(2): 163-169.

Rajeev and Kumar, R. (2021). Genetics and phenotypic analysis of first lactation production, reproduction and part lactation traits in Frieswal cattle. *Agric. Sci. Digest.* 4: 252-255.

Shahi, B.N. and Kumar, D. (2010). Genetic variability in first lactation and herd life traits in Sahiwal and Jersey × Sahiwal cattle. *Indian Vet. J.,* 87 (11) :1168-1170.

Singh, A., Dubey, P.P., Kaur, S., Malhotra, P., Kumar, A. and Dash, S.K. (2015). Genetic analysis of first lactation traits in cattle. *Progressive Res. Int. J.,* 10(4): 2243-2246.

Singh, M.K. and Gurnani, M. (2004). Performance evaluation of Karan Fries and Karan Swiss cattle under closed breeding system. *Australasian J. Anim. Sci.*, 17(1): 1-6.

Tiwari, M., Kumar D., Singh, C.V., Singh, B. and Gupta, H.P. (2010). Estimation of genetic parameters of first lactation and lifetime traits in Sahiwal and its crossbreds. *Indian Vet. J.,* 87: 572-574.

Verma, U.K., Kumar, S., Yousuf, S., Ghosh, A.K. and Aswal, A.P.S. (2018). Genetic and phenotypic parameters of first lactation traits in red sindhi × jersey crossbred cattle. *J. Exp. Zool. India.,* 21(1): 201-204.

Yadav, A., Shukla, A.K. and Sharma, M.K. (2018). Prediction of future milk yield from early lactation traits in crossbred cattles using multiple linear regression models. *Plann. Prac.Res.,*13: 613-618.

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