Genetic studies on first lactation traits and life time milk yield in crossbred cattle

ABSTRACT

Aims: To study the genetic studies on first lactation traits and life time milk yield in crossbred cattle.

Place and Duration of Study: Instructional Dairy Farm, G B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India, Between March 2021 and April, 2022.

Methodology: Data for this study were collected from the history sheets of crossbred cattle at the instructional dairy farm. The dataset included 976 crossbred cattle from 66 sires over 32 years (1988–2019). Cows with abnormal or incomplete records were excluded.

Results: The overall least squares mean of first lactation traits viz. age at first calving (AFC), first service period (FSP), first calving interval (FCI), first dry period (FDP), first lactation length (FLL), first lactation milk yield (FLMY) and lifetime milk yield (LTMY) were estimated to be 1153.20± 2.06 days, 192.95±4.90 days, 468.90±5.11days,129.50± 4.38 days, 339.41± 3.64 days, 3376.36±50.40 kg and 14930.60±167.65 kg, respectively. Season of calving did not significantly affect most traits except age at first calving. Period of calving significantly influenced all traits except first lactation milk yield and lifetime milk yield. Heritability estimates were low, with genetic and phenotypic correlations ranging from very low to high. Variations were mainly due to non-additive genetic variance, suggesting improvements can be achieved through better management and feeding practices.

Conclusion: Therefore, it can be concluded that there is limited scope for selecting cows based on lifetime traits. It is more advantageous to focus on selecting animals based on their performance in earlier lactation traits rather than traits that are expressed later in life.

Key words: *Crossbred cattle, First lactation milk yield, Life time traits, Least squares means and Heritability*

1. INTRODUCTION

The improvement in indigenous cattle breeds for milk production through the selection and grading-up has not been effective up to the desired levels due to low genetic potential for milk production, inadequate feeding and non-availability of nutrients, poor management, and prevalence of diseases combined with tropical climate. Another important reason of low production, in the recent past, has been rearing of cattle for dual or draught purposes.

Though the indigenous breeds of cattle in India are late maturing and poor milk producers but they possess disease resistance, have ability to utilize coarse fodders and also adapted to harsh tropical climate. Increase in production and productivity and simultaneously maintaining the diversity is the objectives of cattle breeding in India. Considering the need for the large and the rapid increase in milk production, crossbreeding of local cattle with exotic dairy breeds was therefore thought to be the only option. The potential for genetic improvement in a trait largely depends upon additive genetic variation existing in a population of interest. The variability for a particular trait in a population is measured by heritability estimates of traits under given environmental condition. Variance and covariance are of prime importance to the breeder for estimating the genetic parameters and then utilizing these estimates for selection of animals. Estimates of genetic parameters are needed for the prediction of breeding values and planning of selection strategies for desired genetic advancement. With this object in view, the present investigation was conducted for estimating the genetic and phenotypic parameters of first lactation and life time milk yield.

2. MATERIALS AND METHODS

2.1 Source of data and data editing

Data for this study were collected from the history sheets of crossbred cattle maintained at the instructional dairy farm of G B Pant University of Agriculture and Technology, Pantnagar. The dataset covered records on 976 cattle from 66 sires over 32 years (1988–2019). Records from cows with abnormalities or incomplete data were excluded. Only sires with at least five daughters and animals with known pedigrees and normal lactations were included. Lactation records shorter than 150 days were deemed abnormal and excluded. The study period was divided into six intervals: the first period of seven years, and the remaining five periods were five years each. Data were categorized by year

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into three seasons viz. Winter (November-February), Summer (March-June) and Rainy (July-October) to assess first lactation milk yield. The traits analyzed included age at first calving, first service period, first calving interval, first dry period, first lactation length, first lactation milk yield, and lifetime milk yield.

2.2 Statistical analysis

The data being non-orthogonal, with unequal subclass numbers, were analyzed using least squares analysis of variance without interactions [1]. The model assumed that different components fitted were linear, independent, and additive. Non-genetic factors~~,~~ including first lactation milk yield groups, periods~~,~~ and seasons of calving~~,~~ were considered as fixed effects. Duncan's multiple range test was used for pair-wise comparisons of least squares means. Before estimating genetic parameters, data were adjusted for significant non-genetic effects [2]. Heritability was estimated using the paternal half-sib correlation method along with the standard error [3, 4]. Genetic and phenotypic correlations among traits were derived from variance/covariance analysis using half-sib data and also standard errors for genetic and phenotypic correlations were estimated [3, 5, 6].

3. RESULTS AND DISCUSSION

3.1 Least squares means and effect of season, period of birth and FLMY groups on economic traits in crossbred cattle

Mean and standard errors for first lactation traits and life time milk yield are presented in table 1. The overall least squares mean of first lactation traits viz. AFC, FSP, FCI, FDP, FLL and FLMY were estimated to be 1153.20± 2.06 days, 192.95±4.90 days, 468.90±5.11days, 129.50± 4.38 days, 339.41± 3.64 days, and 3376.36±50.40 kg, respectively. These estimates were in close agreement with those reported by [7, 8, 9, 10, 11, 12, 13, 14, 15]. The lifetime milk yield was estimated as 14930.60±167.65 kg. Various researchers have also reported similar results in crossbred cattle [13,16, 17, 14, 15].

The least squares analysis of variance to estimate different non-genetic effects are presented in table 2. The effect of season was found to have non-significant influence on all the traits except age at first calving. The cows calved in summer season (March–June), had lower values for the~~.~~ AFC, FSP, FCI, and FDP traits than the cows calved in another season. They, however, had higher values for the FLL, FLMY and LTMY. It was found that cows calved in rainy season (July – October) had higher ~~AFC,~~ FSP, FCI, and FDP traits than the cows calved in other seasons. The cows calved in winter (November-February), had highest age at first calving. These findings corroborated with the findings of [8, 13, 16, 17, 14, 15, 18, 26]. However, [7, 9, 10, 11, 12] reported significant effect of season.

The period of calving significantly influenced all first lactation traits except FLMY and LTMY. The mean performance of age at first calving was observed lowest in period 4 (2005-09) and highest in period 6 (2019-19). The mean performance of the first service period was observed highest in period 3 (2000-04) and it was lowest in period 6 (2015-19) of calving. The mean performance of the first calving interval and first dry period were observed highest in period 3 (2000-04) and it was lowest in period 6 (2015-19) of calving. The mean performance of FLL was observed highest in period 2 (1995-99) and it was lowest in period 3 (2000-04) of calving. The mean value of first lactation yield was observed highest for the period 2 (1995-99) and it was lowest in period 4 (2005-09) of calving. The mean value of life time lactation yield was observed highest for the period 5 (2010-14) it was lowest in period 6 (2015-19) of calving. These results were in close agreement with the findings of [8, 13, 15, 18, 26]. However, [7, 9, 10, 11, 12] reported non-significant effect of period.

However, no consistent trend was found, fluctuations being observed over the period of calving. The variability in all the traits over the periods might be due to differences in managemental practices followed during different periods of time.

The first lactation milk yield group significantly influenced all first lactation traits except age at first calving. The mean performance of AFC was observed lowest in group-2 and highest in group-4. The mean performance of FSP was observed highest in group-6 and it was lowest in group-1. The mean performance of the first calving interval was observed highest in group-6 and it was lowest in group-2 and FDP were observed highest in group-1 and it was lowest in group-2. The mean performance of the FLL was observed highest in group-6 and it was lowest in group-1. The mean value of FLL was observed highest for the group-6, and it was lowest in group-1. The mean value of LTMY was observed highest for the group-6 and it was lowest in group-1.

Table 1: Least squares means for the effect of season, period of birth and FLMY groups on economic traits in crossbred cattle

Source	No.	AFC(Days)	FSP (Days)	FCI (Days)	FDP (Days)	FLL (Days)	FLMY (kg)	LTMY (Kg)

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Comment [PC5]: Contradictory with the table. AFC is higher in winter calver

Comment [PC6]: Contradictory with the table. In table 1 period shows highly significant influence on LTMY.

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Overall	976	1153.20 ±2.06	192.95± 4.90	468.90 ±5.11	129.50±4.38	339.41± 3.64	3376.36±50.40	14930.60±167.65
Season	976	*	NS	NS	NS	NS	NS	NS
Winter	283	1160.27 ±2.98	206.26± 6.34	487.86 ±6.48	128.44±5.81	350.42± 3.90	3602.40±17.80	15455±226
Summer	293	1150.12 ±2.96	202.56± 6.29	480.30 ±6.43	122.72±5.76	357.58± 3.87	3641.90±17.70	15293±224
Rainy	400	1152.39 ±2.58	214.51± 5.48	490.45 ±5.60	135.70±5.02	354.75± 3.37	3594.60±15.40	15442±196
Period	976	**	**	**	**	*	NS	**
1988-1994	218	1116.48 ±3.82	207.61± 8.11	482.93 ±8.29	132.19±7.43	350.74± 5.00	3587.40±22.80	14136±289
1995-1999	168	1162.29 ±3.88	221.56± 8.24	497.64 ±8.42	129.06±7.55	368.58± 5.07	3663.10±23.20	15225±294
2000-2004	162	1162.66 ±3.98	239.25± 8.47	512.32 ±8.65	168.58±7.76	343.74± 5.21	3608.80±23.80	15274±302
2005-2009	167	1155.48 ±3.87	217.13± 8.23	492.36 ±8.41	142.15±7.54	350.21± 5.07	3584.60±23.20	16771±294
2010-2014	160	1161.95 ±3.95	185.00± 8.39	459.75 ±8.58	108.26±7.69	351.49± 5.17	3605.30±23.60	17492±299
2015-2019	101	1166.71 ±4.97	176.10± 10.60	454.20 ±10.80	93.49±9.68	360.72± 6.50	3628.60±29.70	13481±377
FLMY Groups	976	NS	**	**	*	**	**	**
≤ 2400	193	1157.98 ±3.80	148.70± 8.07	425.33 ±8.25	148.19±7.39	277.14± 4.97	2039.70±22.70	12794±288
2401-2900	230	1147.85 ±3.40	150.38± 7.22	422.92 ±7.38	118.12±6.62	304.80± 4.45	2666.90±20.30	14314±258
2901-3400	190	1152.19 ±3.60	174.18± 7.65	451.21 ±7.82	124.35±7.01	326.86± 4.71	3148.50±21.50	14698±273
3401-3900	153	1160.71 ±4.08	211.90± 8.67	487.17 ±8.86	125.02±7.94	362.16± 5.34	3611.10±24.40	15074±309
3901-4400	127	1149.30 ±4.40	237.00± 9.36	512.67 ±9.57	126.89±8.57	385.78± 5.76	4379.30±26.30	17169±334
≥4401	83	1157.56 ±5.54	324.50± 11.80	599.90 ±12.00	131.20±10.80	468.75± 7.25	5832.30±33.20	18330±420

** P ≤ 0.01; * P ≤ 0.05; NS= not significant

AFC=Age at First Calving, FSP=First Service Period,
FCI=First Calving Interval, FDP=First ~~dry~~ Dry ~~period~~Period,
FLL=First Lactation length, FLMY=First Lactation Milk Yield,
LTMY=Lifetime Milk Yield

3.2 Heritability estimates of economic traits in crossbred cattle

The heritability estimates for AFC, FSP, FCI, FDP, FLL, FLMY and LTMY, were 0.137±0.07, 0.156±0.07, 0.172±0.07, 0.207±0.08, 0.198±0.07, 0.294±0.09 and 0.138±0.171 respectively. In general, the heritability estimates of first lactation traits and lifetime milk yield traits under the present study were observed low, which revealed that non-genetic variability for these traits is existing and these traits can be improved through better feeding and management practices. Similar estimate of heritability was reported by [7] in FxS, [20] in FxT and BSxS, [9, 10, 11, 12, 13, 15] for crossbred cattle. However, higher estimates of heritability than the present study were reported by [8, 19, 22, 24, 25] in crossbreds.

The genotypic and phenotypic correlations among these traits are presented in table ~~3~~4. The genetic correlations of AFC with FSP, FCI, FLL, FLMY and LTMY were positive. However, negative genetic correlation was observed with FDP.

Table 2: Analysis of variance (ANOVA) for economic traits in crossbred cattle

Source of Variation	DF	Mean Sum of Squares (MSS Values)						
		AFC(Days)	FSP (Days)	FCI (Days)	FDP (Days)	FLL (Days)	FLMY (~~kg~~Kg)	LTMY (Kg)

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Season	2	7972*	12871^{NS}	13648^{NS}	14356^{NS}	3628^{NS}	202259^{NS}	2427148^{NS}
PERIOD	5	58058**	71874**	66060**	88388**	12288*	139616^{NS}	324798268^{NS}
FLMY Groups	5	4552^{NS}	437312**	441906**	20330*	461827**	181060551**	428776750**
ERROR	963	2420	10935	11425	9179	4147	86645	13917380

** $P \leq 0.01$; * $P \leq 0.05$; NS= not significant

Table 3: Heritability estimates of economic traits in crossbred cattle

Traits	Heritability
Age at first calving	0.137±0.07
First service period	0.156±0.07
First calving interval	0.172±0.07
First dry period	0.207±0.08
First lactation length	0.198±0.07
First lactation milk yield	0.294±0.09
Life time milk yield	0.138±0.171

3.3 Genetic and phenotypic correlations among economic traits in crossbred cattle

The genetic correlations of FSP with FCI, FDP, FLL, FLMY, and LTMY were observed positive. The genetic correlations of FCI with FDP, FLL, FLMY and LTMY were observed positive with medium to high magnitude. The genetic correlations of FDP with FLMY and LTMY were observed positive. However, negative genetic correlation was estimated with FLL.

The genetic correlations of FLL with FLMY and LTMY were observed positive. The genetic correlation of FLMY with LTMY was observed positive. The present findings were in close agreement with the reports of [9, 10, 11, 12, 20, 21, 22] in crossbred cattle. The present study for genetic correlations were conformed with [13, 15, 23] but did not agree with the reports of [8] in crossbred cattle. The phenotypic correlations were found to be positive from very low to high and agreed with the reports of [21] in crossbred and [20] in FxT and BSxS.

The phenotypic correlations of AFC with FSP, FCI, FDP, FLL, FLMY and LTMY and were positive. The phenotypic correlations of FSP with FCI, FDP, FLL, FLMY, and LTMY were observed positive. The phenotypic correlations of FCI with FDP, FLL, FLMY and LTMY were observed positive with very low to high magnitude. The phenotypic correlations of FDP with FLL, FLMY and LTMY were observed negative. The phenotypic correlations of FLL with FLMY and LTMY were observed positive. The phenotypic correlation of FLMY with LTMY was observed positive. The finding in the present study were in close agreement with the reports of [21] in crossbred and [20] in FxT and BSXS, [9, 10, 11, 12, 22]. The present study corroborated with the [13, 15, 23] but did not agree with the reports of [8] in crossbred cattle.

Table 4: Genetic (above diagonal) and phenotypic (below diagonal) correlations among economic traits in crossbred cattle

Traits	AFC	FSP	FCI	FDP	FLL	FLMY	LTMY
AFC	-	0.407±0.35	0.391±0.34	-0.132±33	0.689±0.31	0.464±0.29	0.224±0.38
FSP	0.071±0.03	-	0.995±0.01	0.678±0.16	0.516±0.23	0.789±0.18	0.523±0.34
FCI	0.078±0.03	0.984±0.01	-	0.701±0.15	0.495±0.23	0.758±0.17	0.494±0.32
FDP	0.037±0.02	0.719±0.02	0.729±0.02	-	-0.273±0.30	0.241±0.26	0.048±0.33
FLL	0.068±0.03	0.569±0.02	0.579±0.03	-0.136±0.03	-	0.728±0.14	0.607±0.28
FLMY	0.007±0.03	0.414±0.03	0.407±0.02	-0.029±0.03	0.623±0.02	-	0.594±0.22
LTMY	0.008±0.02	0.097±0.03	0.096±0.03	-0.074±0.02	0.228±0.03	0.373±0.03	-

4. CONCLUSION

The genetic analysis of first lactation traits and lifetime milk yield in crossbred cattle provides valuable insights into the least squares means, heritability and genetic correlations of economically important traits. The present findings highlight the complex interaction between genetic and non-genetic factors in shaping lactation performance and lifetime productivity in crossbred cattle and moreover, these findings are crucial for developing breeding strategies and management practices that enhance the efficiency and sustainability of crossbred dairy cattle populations. On the basis of this study, it might be concluded that very little opportunity exists for selection of cows for life time traits. It is desirable to select the animals on the performance of earlier lactation traits rather than traits express later in life.

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