

Original Research Article

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## Effect of Genetic and Non-Genetic Factors on First Lactation Production and Reproduction Traits in HF × Gir Cattle

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### ABSTRACT

The present investigation was carried out with the objective of performance appraisal of HF × Gir cattle with respect to production and reproduction traits. The performance records of 421 HF × Gir half breed cattle sired by 48 bulls were collected for production and reproduction traits spread over a period of 39 years (1977 to 2015) from Research-Cum Development Project on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri District Ahmednagar (Maharashtra). The overall least squares means for first lactation total milk yield (FLTMY), first lactation 300 days milk yield, first lactation length (FLL), First dry period (FDP), First service period (FSP), First calving interval (FCI) and Age at first calving were 2701.77±46.04, 2511.70 ±37.40, 320.43± 3.04, 88.40±2.58, 130.14±3.19, 409.17±3.25 and 990.69±6.53 days, respectively. Further, the least squares analysis revealed non significant effect of season of calving and age at first calving groups on all first lactation reproduction and milk production traits. Whereas, the effect of period of calving was found to be highly significant on FLTMY, FL300DMY and AFC and non-significant on FLL, FDP, FSP and FCI. However, the effect of sire was found to be significant on FLTMY, FL300DMY and AFC. The heritability of all traits except FCI and FSP were moderate in magnitude which indicated these traits are more influenced by additive genetic variability and hence there is more scope for improvement by selection. The highly significant genetic and phenotypic correlation was found between production and reproduction traits.

#### Keywords

HF × Gir cattle,  
Genetic parameter,  
First lactation traits

#### Article Info

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## **Introduction**

Livestock sector is an important subsector of the agriculture of Indian economy. It forms an important livelihood activity for most of the farmers, supporting agriculture in the form of critical inputs, contribute into the health and nutrition of the household, supplementing income, offering employment opportunities, and finally being a dependable “bank on hooves” in times of need. It acts as a supplementary and complementary enterprise. They further also play a significant role in generating gainful employment in the rural sector, particularly among the landless, small and marginal farmers and women, besides providing cheap and nutritious food to millions of people. Milk yield is an important economic trait in livestock species. It represents a major source of income in most dairy enterprises.

Economic traits are generally controlled by genetic factors but environmental influences like year, season and age at first calving have significant effects on milk yield. These environmental factors may suppress the animal's true genetic ability and create a bias in the selection of animals. Heritability is required to calculate genetic evaluations to predict response to selection and to help producers decide if it is more efficient to improve traits through management or through selection. Therefore, present study was aimed to evaluate first lactation traits and estimates their genetic parameters in HF × Gir half breed cattle.

## **Materials and Methods**

The data for the present investigation were collected for a period of 40 years (1974-2015) from History sheet of 421 HF × Gir half breed cows born from 48 sires maintained at Research cum Development Project (RCDP) on cattle, MPKV Rahuri, District-

Ahmednagar (Maharashtra State). Only the sires having records at least 3 daughters were included in the present study. The first lactation length less than 150 days was considered as abnormal and was not included in the analysis. The total duration of the present study was divided into 6 periods. Each year was divided into three seasons namely Rainy ( $S_1$ ), Winter ( $S_2$ ) and summer ( $S_3$ ) various first lactation traits were considered for the study which were age at first calving (AFC), First lactation total milk yield (FLTMY), first lactation 300 days milk yield. (FL300DMY), first lactation length (FLL), First service period (FSP) First Dry period (FDP) and First calving interval (FCI). For accurate estimation of genetic variation present in traits as well as to account for the effect of non-genetic factors, both the genetic and non genetic factors were considered.

## **Statistical analysis**

The mixed model analysis using least squares maximum likelihood (LSML) program (Harvey, 1990) was used for determining the influence of genetic and non-genetic factors on first lactation production and reproduction traits and estimation of genetic parameters, simultaneously. The model incorporated seasons, period's age at first calving as fixed effects and sires as random effects. The statistical significance of various fixed effects in the least squares model was determined by 'F' test for significant effects the difference between pairs of levels of effects were tested by Duncan's multiple range test as modified by Kramer (1957). The heritability, genetic and phenotypic correlations were obtained from the above LSML software.

## **Results and Discussion**

The overall least- squares means and coefficient of variation of productive and reproductive traits are presented in Table 1.

The overall least-squares mean of FLTMY, FL300days, FLL, FSP, FDP, FCI and AFC were  $2701.77 \pm 46.04$ ,  $2511.70 \pm 37.40$ ,  $320.43 \pm 3.04$ ,  $88.40 \pm 2.58$ ,  $130.14 \pm 3.19$ ,  $409.17 \pm 3.25$  and  $990.69 \pm 6.53$  respectively.

### **Effect of season of calving/ birth on first lactation production and reproduction traits**

The influence of season of calving was found to be non-significant on all production and reproduction traits of first lactation in HF  $\times$  Gir half breed cattle. The non-significant effect of season of calving on first lactation traits was also reported by many workers (Rashid, 2010; Nehra, 2011 and Divya, 2012) in KF cattle. Contradictory to the present study significant effect of season of calving of FL300DMY and FLTMY has been documented by Mukherjee (2005) and Rathee (2015) in frieswal cattle.

### **Effect of period of calving / birth on first lactation production and reproduction traits**

Period of calving have a highly significant effect on age at first calving, (AFC), FLTMY and FL 300 days milk yield. Whereas non-significant effect on FLL, FSP, FDP and FCI. The lowest AFC were found in period first (Table 1). Higher estimates for FLTMY and FL300 days were found in period first. Similar estimates were reported by Mukherjee (2005), Shelke (2012) and Ambhore (2017) in various crossbreeds. Reproduction traits were not significantly affected by period of calving. These non-significant finding were in accordance with Saha (2001) and Singh and Gurani (2004) in KF cattle.

### **Effect of sire on first lactation production and reproduction traits**

The sire had significant ( $P < 0.05$ ) effect on AFC, FLTMY and FL300DMY. Similar

results were reported by Akhtar *et al.*, (2003) in 5/8 HF  $\times$  3/8 SW cattle, Singh *et al.*, (2014) in frieswal and Divya (2012) in Karan fries cattle.

The non-significant effect of sire was found on FSP, FLL, FDP and FCI. The findings were in consonance with Akhtar *et al.*, (2013) and Ambhore *et al.*, (2017) in 5/8 HF  $\times$  3/8 SW and Phule Triveni cattle, respectively.

### **Effect of age at first calving on first lactation production and reproduction traits**

The non-significant effect of AFC groups was found on all first lactation production and reproduction traits. This finding was similar to the results reported by Singh (1995), Divya (2012) and Singh (2013) in Karan fries cattle. Whereas significant effect of age groups on FL300 DMY and FLL were reported by Ambhore (2017) in Phule Triveni cattle.

### **Heritability estimates of production and reproduction traits**

The heritability of AFC, FL300DMY, FLTMY and FDP & FLL were moderate. Which indicates that these traits were more influenced by additive genetic variability and could be improved by selection and improved management. Whereas, the heritability ( $h^2$ ) of FSP, and FCI were very low and associated with high standard error indicating that performance of this trait could be enhanced by improving management and environments factors. The higher heritability of AFC and FL 300 days milk yield in HF  $\times$  Gir half breed cattle. Indicates that selections based on these two traits are more desirable than other traits. The present results were in agreement with the finding reported by Mukherjee (2005) in Frieswal cattle, Nehra (2011) and Dash (2014) in KF cattle and Ambhore (2017) in Phule Triveni cattle.

**Table.1** Least squares means of first lactation reproduction and production traits of HF × Gir half bred

Source of variation	N	FSP (days)	FL300DMY (kg)	FLTMY (kg)	FLL (days)	FDP (days)	FCI (days)
		Mean ± S.E.	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.
<b>Overall mean (μ)</b>	421	130.14 ± 3.19	2511.70 ± 37.40	2701.77 ± 46.04	320.43 ± 3.04	88.40 ± 2.58	<b>409.17 ± 3.25</b>
Periods of calving							
<b>P<sub>1</sub> (1974-1980)</b>	156	127.51 ± 6.22	3238.74 ± 72 <sup>a</sup>	3388.09 ± 87 <sup>a</sup>	319.75 ± 86.72	86.01 ± 5.02	<b>405.5 ± 6.33</b>
<b>P<sub>2</sub> (1981-1987)</b>	61	124.88 ± 7.07	2752.06 ± 82 <sup>b</sup>	2953.71 ± 101 <sup>b</sup>	322.98 ± 7.69	80.19 ± 5.70	<b>401.37 ± 7.19</b>
<b>P<sub>3</sub> (1988-1994)</b>	47	133.5 ± 8.00	2350.84 ± 94 <sup>c</sup>	2539.17 ± 116 <sup>c</sup>	322.98 ± 7.69	88.49 ± 6.52	<b>413.94 ± 8.22</b>
<b>P<sub>4</sub> (1995-2000)</b>	77	135.77 ± 6.5	2242.12 ± 76 <sup>c</sup>	2510.84 ± 93 <sup>c</sup>	334.46 ± 6.19	80.51 ± 5.25	<b>415.93 ± 6.62</b>
<b>P<sub>5</sub> (2002-2008)</b>	50	126.69 ± 8.02	2188.89 ± 93 <sup>c</sup>	2334.08 ± 115 <sup>c</sup>	320.59 ± 7.63	86.45 ± 6.47	<b>407.60 ± 8.16</b>
<b>P<sub>6</sub> (2009-2015)</b>	30	132.51 ± 10.00	2297.58 ± 117 <sup>c</sup>	2484.74 ± 145 <sup>c</sup>	305.28 ± 9.59	108.76 ± 8.13	<b>410.63 ± 10.25</b>
Season of birth							
<b>S<sub>1</sub>: Rainy</b>	110	126.77 ± 5.55	2504.98 ± 64	2680.22 ± 79	322.92 ± 5.33	80.83 ± 4.47	<b>404.8 ± 5.64</b>
<b>S<sub>2</sub>: Winter</b>	146	127.47 ± 4.79	2507.35 ± 56	2672.76 ± 68	314.03 ± 4.56	93.43 ± 3.86	<b>407.3 ± 4.87</b>
<b>S<sub>3</sub>: Summer</b>	165	136.19 ± 4.57	2522.79 ± 53	2752.34 ± 65	324.35 ± 4.35	90.94 ± 3.69	<b>415.40 ± 4.65</b>
Age group							
<b>A<sub>1</sub>: &lt; 905 days</b>	232	127.78 ± 5.08	2462.58 ± 59	2671.02 ± 73	322.46 ± 4.83	83.89 ± 4.10	<b>406.87 ± 5.57</b>
<b>A<sub>2</sub>: 950-1050 days</b>	75	136.34 ± 6.47	2484.84 ± 75	2682.78 ± 93	328.70 ± 6.16	86.08 ± 5.22	<b>414.15 ± 6.59</b>
<b>A<sub>3</sub>: 1051 days and above</b>	<b>114</b>	<b>126.31 ± 5.66</b>	<b>2587.69 ± 66</b>	<b>2751.53 ± 81</b>	<b>310.14 ± 5.39</b>	<b>95.24 ± 4.57</b>	<b>406.49 ± 5.76</b>

Means under each class in the same column with different super scripts differ significantly

**Table.2** Estimates of heritability, phenotypic and genetic correlations among first lactation reproduction and production traits

Traits	AFC	FLL	FSP	FDP	FCI	FL300DMY	FLTMY
<b>AFC</b>	<b>0.20 ± 0.12</b>	-0.10 ± 0.42	0.05 ± 0.08	-0.03 ± 0.09	0.04 ± 0.15	0.07 ± 0.05	<b>0.08 ± 0.15*</b>
<b>FLL</b>	0.06 ± 0.02	<b>0.11 ± 0.10</b>	0.65 ± 0.87	-0.29 ± 0.56	0.65 ± 0.46*	0.48 ± 0.09**	<b>0.60 ± 0.08**</b>
<b>FSP</b>	0.72 ± 0.15*	0.20 ± 0.10	<b>0.02 ± 0.11</b>	0.70 ± 0.12	0.93 ± 0.16*	0.34 ± 0.03**	<b>0.34 ± 0.03</b>
<b>FDP</b>	0.72 ± 0.18*	0.10 ± 0.06	0.47 ± 0.34	<b>0.12 ± 0.12</b>	0.50 ± 0.23	-0.06 ± 0.61**	<b>-0.24 ± 0.02**</b>
<b>FCI</b>	0.53 ± 0.35	0.53 ± 0.11**	0.96 ± 0.56	0.47 ± 0.45	<b>0.02 ± 0.11</b>	0.80 ± 0.09	<b>0.34 ± 0.02**</b>
<b>FL300DMY</b>	-0.03 ± 0.48	0.48 ± 0.71**	0.21 ± 0.70	-0.26 ± 0.30	0.22 ± 0.42	<b>0.19 ± 0.14</b>	<b>0.87 ± 0.10**</b>
<b>FLTMY</b>	<b>-0.27 ± 0.64</b>	<b>0.69 ± 0.27</b>	<b>0.42 ± 0.55</b>	<b>-0.24 ± 0.06</b>	<b>0.42 ± 0.65</b>	<b>0.92 ± 0.05**</b>	0.18 ± 0.10

Estimates above the diagonal are the genetic correlations and below diagonal are phenotypic correlations. The diagonal values are the estimates of heritability; \*P < 0.05 and \*\* P < 0.01

**Table.3** Analysis of variance of various first lactation reproduction and milk production traits as affected by genetic and non genetic factors

Source of variation	Mean sum of squares						
	AFC	FSP	FL300DMY	FLTMY	FLL	FDP	FCI
Period of birth for AFC/ Period of calving	1112960.18**	1132.82	9931810.45**	9052380.68**	4002.76	3999.93	1754.27
Season of birth for AFC/ Season of calving	11308.48	4084.65	13726.15	293640.63	4540.21	5308.51	4396.26
Age at first calving group	-	2477.48	38445.12	163159.94	7603.45	3132.56	1573.53
Sire	19522.01*	2302.75	550409.00*	834083.86*	3343.02	2029.71	2470.59
Error	27008.67	2963.63	517003.44	711149.98	2732.24	1929.20	3068.27

\*P < 0.05 and \*\* P < 0.01

**Table.4** Least squares means of age at first calving as affected by various factors in HF × Gir halfbred

Source of variation	N	Mean ± S.E.
<b>Overall mean (μ)</b>	421	<b>990.69 ± 6.53</b>
Periods of birth		
<b>P<sub>1</sub> (1974-1980)</b>	157	<b>804.11 ± 9.52<sup>c</sup></b>
<b>P<sub>2</sub> (1981-1987)</b>	61	<b>968.18 ± 15.12<sup>b</sup></b>
<b>P<sub>3</sub> (1988-1994)</b>	54	<b>974.73 ± 16.20<sup>b</sup></b>
<b>P<sub>4</sub> (1995-2000)</b>	70	<b>1080.73 ± 14.11<sup>a</sup></b>
<b>P<sub>5</sub> (2002-2008)</b>	50	<b>1080.27 ± 16.77<sup>a</sup></b>
<b>P<sub>6</sub> (2009-2015)</b>	29	<b>1036.13 ± 22.01<sup>a</sup></b>
Season of birth		
<b>S<sub>1</sub>: Rainy</b>	137	<b>987.05 ± 10.82</b>
<b>S<sub>2</sub>: Winter</b>	157	<b>983.84 ± 10.05</b>
<b>S<sub>3</sub>: Summer</b>	<b>127</b>	<b>1001.18 ± 10.73</b>

Means under each class in the same column with different super scripts differ significantly

**Genetic and Phenotypic correlations of milk production and reproduction traits**

The genetic ( $r_g$ ) and the Phenotypic ( $r_p$ ) correlation of first lactation production and reproduction traits are presented in Table 2. The genetic and phenotypic correlations

between FLTMY and FL 300 DMY was  $0.87 \pm 0.10$  and  $0.92 \pm 0.05$  between FLTMY and FLL was  $0.60 \pm 0.08$  and  $0.69 \pm 0.27$  between FLTMY and FDP was  $0.24 \pm 0.02$  and  $0.24 \pm 0.06$  between FLTMY and AFC was  $0.08 \pm 0.15$  and  $0.27 \pm 0.64$  between FLTMY and FCI was  $0.34 \pm 0.03$  and  $0.42 \pm 0.65$  and

between FLTMY, FSP was  $0.134 \pm 0.02$  and  $0.42 \pm 0.55$ . The positively phenotypic correlation between FLTMY with FLL, FSP and FCI indicated that increase in first lactation FLTMY also tend to increase service period, Lactation length and calving interval (Table 3). However, genetic correlation of FLTMY and FL 300 DMY with FDP was negative and desirable indicating that cows producing more milk have shorter dry period. Similar to the present findings, Mukherjee (2005) also reported higher genetic correlation of FLTMY with FL 300 DMY and FLL in Frieswal cattle and the phenotypic correlation of milk Production with AFC was  $0.13 \pm 0.12$  and with FLL it was  $0.09 \pm 0.40$  in Karan Fries, cattle Nehra (2011).

### Impacts

The average least squares mean of first lactation were FLTMY  $2701.77 \pm 46.04$  kg, FL300DMY  $2511.70 \pm 37.40$  kg, FLL  $320.43 \pm 3.04$  days, FDP  $88.40 \pm 2.58$  days, AFC  $990.69 \pm 6.53$  days, FCI  $409.17 \pm 3.25$  days and FSP  $130.14 \pm 3.16$  days (Table 4).

Among the different genetic and non-genetic factors studied, period of calving had significant effect on FLTMY, FL300DMY and AFC and non significant effect on FLL, FDP, FCI and FSP. Season of calving and age at first calving group had non significant effect on all first lactation production and reproduction traits. The sire had significant effect on FLTMY, FL300DMY and AFC and non-significant effect on FLL, FDP, FCI and FSP.

The heritability estimates of FL300DMY, FLTMY, FLL, FDP, AFC, FCI and FSP were  $0.19 \pm 0.14$ ,  $0.18 \pm 0.10$ ,  $0.11 \pm 0.10$ ,  $0.12 \pm 0.12$ ,  $0.20 \pm 0.12$ ,  $0.02 \pm 0.11$  and  $0.02 \pm 0.11$ , respectively. The heritability of all traits except FCI and FSP from mixed model using LSML was moderate in magnitude which

indicated these traits are more influenced by additive genetic variability and hence there is more scope for improvement by selection. The low heritability estimate of FCI and FSP trait indicates that it is influenced more by managemental and environmental factors than by genetic factors.

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