

# GENETIC ANALYSIS OF PRODUCTION PERFORMANCE OF HOLSTEIN FRIESIAN × SAHIWAL COWS\*

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## ABSTRACT

*Data on 642 Holstein Friesian × Sahiwal cows, maintained at the Military Dairy Farm, Secunderabad, over a period of 19 years (1988-2006) were analyzed. The least squares means of total lactation milk yield (TLMY), 300-days lactation milk yield (300-Days LMY), lactation length (LL), peak yield (PY), milk yield per day of lactation (MYL) and milk yield per day of calving interval (MYCI) were 2864.32 kg, 2593.84 kg, 329.03 days, 13.30 kg, 8.69 kg and 6.40 kg, respectively. Genetic grades, period of calving and parity significantly affected all the production traits studied. Season of calving affected ( $P \leq 0.01$ ) all production traits except the lactation length. Heritability estimates were 0.20, 0.18, 0.06, 0.16, 0.27 and 0.17, respectively. The estimates of repeatability and correlations among the traits studied varied from 0.12 to 0.56 and 0.01 to 0.93, respectively.*

**Key words:** Heritability, Lactation milk yield, Holstein Friesian x Sahiwal, Most Probable Producing Ability

## INTRODUCTION

Crossbreeding has been in practice for several years as a tool to improve production performance of our native cattle breeds. Holstein Friesian and Jersey are the two breeds of choice for crossbreeding. The Ministry of Defence in collaboration with the Ministry of Agriculture launched a Cattle Breeding Project at Meerut in the year, 1985. This project aimed at developing breeds having about 62.5% Friesian and 37.5% Sahiwal inheritance with a production of 4000 kg milk/lactation. With progress in the breeding

programme, there currently exist cows with varying levels of Holstein Friesian inheritance. Hence, the present investigation was carried out to analyze the performance of cows of various genetic grades. The effect of period and season of calving was also studied.

## MATERIALS AND METHODS

The data for the present study were obtained on 2721 lactations from the pedigree and performance records of 642 Holstein Friesian x Sahiwal (Frieswal) cows maintained at Military Dairy Farm, Secunderabad during the period 1988–2006 and was grouped under

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seven genetic grades based on the Holstein Friesian inheritance in the crossbreds as G1 - 3/8 (35.9375% to 39.0625%), G2 - 7/16 (40.625% to 46.875%), G3 - 5/8 ( 53.125% to 68.75%), G4 - 3/4 (71.875% to 78.125%), G5 - 7/8 (81.25% to 87.50%), G6 - 15/16 (90.625% to 93.75%) and G7 - FS (about 55% to 75% - Sired by purebred bulls). The data were categorized into four periods as P1 (1988 - 1992), P2 (1993 - 1997), P3 (1998 - 2002) and P4 (2003 - 2006) and three seasons of calving as Summer (March - June), Rainy (July - October) and Winter (November - February).

Least squares technique (Harvey, 1979) was employed to study the influence of genetic grades, period and season of calving, parity and sex of calf on total lactation milk yield (TLMY), 300-days lactation milk yield (300 - Days LMY), peak yield (PY), milk yield per day of lactation (MYL) and milk yield per day of calving interval (MYCI). The least squares means were compared by Duncan's Multiple Range Test (Duncan, 1955) as modified by Kramer (1957). Heritability and genetic and phenotypic correlations were obtained by paternal half-sib correlation method as per Becker (1985), based on the data adjusted for effects of periods, seasons and parity. Data on sires having atleast three progeny only were included in the estimation of the genetic parameters. Most Probable Producing Ability (MPPA) was computed as per Lush (1945), based on total lactation milk yield and 300-days lactation milk yield.

## RESULTS AND DISCUSSION

### Average performance

The overall least squares means for total lactation milk yield, 300-days lactation milk yield, lactation length, peak yield, milk yield per day of lactation and milk yield per day of calving interval were 2864.32 kg, 2593.84 kg, 329.03 days, 13.30 kg, 8.69 kg and 6.40 kg, respectively (Table 1), which were in agreement with the means reported

by Raheja (1997) and Sharma and Singh (1999) in Holstein Friesian × Sahiwal cows. However, means slightly higher than those in the present study were reported by Mudgal *et al.* (1986) in Holstein Friesian × Sahiwal cows and Kothekar (2004) in Holstein Friesian cows, while lower means were recorded by Gandhi *et al.* (1995) and Tomar *et al.* (1997) in Sahiwal cows and Das *et al.* (2006) in Holstein Friesian cows.

### Effect of Genetic Grades

Genetic grades significantly affected all production traits studied which was in agreement with the reports of Bhadauria and Katpatal (2003). Cows with Holstein inheritance of 5/8 and above had higher yields than cows of genetic grades 3/8 and 7/16. Cows of genetic grade 5/8 outperformed the cows of other grades in their overall performance. This significant difference among genetic grades could be assigned to variation in the genetic constitution of cows in the herd. However, non-significant influence of genetic grades on various production traits was found by Mudgal *et al.* (1985) in Holstein Friesian × Sahiwal cows.

### Effect of Period of Calving

Period of calving also significantly affected all the production traits studied and this was in fair agreement with the findings of Shrivastava *et al.* (1985) and Mudgal *et al.* (1986) in Holstein Friesian × Sahiwal cows. For all traits studied, except for the lactation length, the cows calved during periods 3 and 4 excelled the performance of cows calved during periods 1 and 2. The better performance of cows over periods could be ascribed to improvised managerial practices in the farm, as the periods advanced. Contrary to the present findings, Das *et al.* (2006) in Holstein Friesian × Sahiwal cows, observed no significant influence of period of calving on various production traits.

### Effect of Season of Calving

Season of calving significantly affected ( $P \leq 0.01$ ) all the production traits studied except for lactation length. Winter calvers outperformed rainy and summer calvers, probably on account of ample quality green fodder available during winter season. Mudgal *et al.* (1985) in Holstein Friesian  $\times$  Sahiwal cows also noticed significant influence of season of calving on various production traits, whereas Jadhav and Khan (1995) in Holstein Friesian  $\times$  Sahiwal cows and Kothekar (2004) in Holstein Friesian cows found that season of calving was not a significant source of variation in various production traits.

### Effect of parity

All production traits included in the present investigation were found to be affected significantly by parity, which might be due to variations in climatic and environmental factors to which the cows were exposed to during different parities. However, there existed no specific trend for the means of different traits in different parities. Significant influence of parity on various production traits was reported by Singh *et al.* (1997) in Sahiwal cows while contrary findings were recorded by Mudgal *et al.* (1985) in Holstein Friesian  $\times$  Sahiwal cows.

### Effect of sex of calf

Sex of calf had no significant influence on any of the production traits studied, which was in agreement with the reports of Shrivastava and Khan (1987) and Das *et al.* (2006) in Sahiwal cows.

### Genetic parameters

Heritability estimates (Table 2) for total lactation milk yield, 300-days lactation milk yield, lactation length and peak yield were 0.20, 0.18, 0.06 and 0.16, respectively, which were almost similar to the estimates reported by Singh *et al.* (1986).

However, estimates higher than those obtained in the present study was reported by Gaur *et al.* (1999) in Holstein Friesian  $\times$  Sahiwal cows. The low to moderate heritability estimates for various production traits observed in the present study presented scope for further improvement through selective breeding of sires coupled with optimum managerial conditions.

The genetic correlations among the traits were all positive and ranged from  $0.15 \pm 0.40$  (between lactation length and peak yield) to  $0.79 \pm 0.15$  (between total lactation milk yield and lactation length), while the phenotypic correlations ranged from 0.01 (between lactation length and peak yield) to 0.93 (total lactation milk yield and 300-days lactation milk yield). The results indicated that production traits in Holstein Friesian  $\times$  Sahiwal cows, in the present study were influenced by the same set of genes and selection for improvement in one trait would automatically improve the other production traits due to the correlated response to selection. Similar findings were also reported by Raheja (1994), Jadhav and Khan (1995) and Banerjee and Banerjee (2003).

The estimates of repeatability obtained in the present investigation for total lactation milk yield, 300-days lactation milk yield, lactation length and peak yield were  $0.13 \pm 0.04$ ,  $0.56 \pm 0.04$ ,  $0.50 \pm 0.04$  and  $0.12 \pm 0.04$ , respectively. The high repeatability estimates for 300-days lactation milk yield and lactation length implied the higher probability of repetition of lactation milk yield and lactation length and offered a scope for preliminary selection of cows based on early lactation records.

### Most Probable Producing Ability

The Most Probable Producing Ability (MPPA) was computed based on the total lactation milk yield and 300-days lactation milk yield. The highest and lowest MPPA estimates based on the total lactation milk yield were 7911.31 kg and 5713.42 kg, respectively, while for MPPA based

on 300-days lactation milk yield, the highest and lowest estimates were 4635.70 kg and 2270.0 kg, respectively.

The present study revealed that the Frieswal cows of G3 genetic grade (53.125 to 68.75% Holstein Friesian), with the highest 300-days lactation milk yield (2893.60 kg), peak yield (14.81 kg), milk yield per day of lactation (9.50 kg) and milk yield per day of calving interval (7.08 kg) outperformed the other grades with respect to the production traits. The existence of low to medium genetic variation among production traits offered good scope for further genetic improvement through selection of the sires coupled with better management.

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**Table 2. Estimates of heritabilities (on diagonal) and genetic (above diagonal), phenotypic (below diagonal) and environmental (below diagonal within parentheses) correlations among various production traits**

	Total lactation milk yield	300-days lactation milk yield	Lactation length	Peak yield
Total lactation milk yield	<b>0.20 ± 0.08</b>	>1	0.79 ± 0.15	0.25 ± 0.28
300-days lactation milk yield	0.93 (0.95)	<b>0.18 ± 0.07</b>	0.67 ± 0.23	0.26 ± 0.28
Lactation length	0.66 (0.66)	0.56 (0.56)	<b>0.06 ± 0.05</b>	0.15 ± 0.40
Peak yield	0.03 (-0.02)	0.03 (-0.02)	0.01 (-0.01)	<b>0.16 ± 0.07</b>

**Table 1. Least squares means of various production traits**

	Total lactation milk yield (kg)			300-day lactation milk yield (kg)			Lactation length (days)			Peak yield (kg)			Milk yield per day of lactation (kg)			Milk yield per day of calving interval (kg)		
	n	Mean	S.E.	n	Mean	S.E.	n	Mean	S.E.	n	Mean	S.E.	n	Mean	S.E.	n	Mean	S.E.
Overall	2393	2864.32	102.04	2393	2593.84	90.26	2393	329.03	5.36	2371	13.30	0.35	2393	8.69	0.27	2125	6.40	0.24
<b>Genetic grades:</b>	**			**			**			**			**			**		
G1 (3/8)	76	2594.12 <sup>ab</sup>	135.60	76	2413.75 <sup>c</sup>	119.95	76	319.16 <sup>ab</sup>	7.12	67	13.40 <sup>ab</sup>	0.49	76	8.24 <sup>b</sup>	0.35	71	6.32 <sup>b</sup>	0.31
G2 (7/16)	122	2673.40 <sup>ab</sup>	132.57	122	2452.44 <sup>c</sup>	117.27	122	317.06 <sup>b</sup>	6.96	120	12.81 <sup>bc</sup>	0.46	122	8.50 <sup>b</sup>	0.35	117	6.10 <sup>b</sup>	0.30
G3 (5/8)	601	3166.81 <sup>a</sup>	102.67	601	2893.60 <sup>a</sup>	90.82	601	333.28 <sup>a</sup>	5.39	601	14.81 <sup>a</sup>	0.35	601	9.50 <sup>a</sup>	0.27	548	7.08 <sup>a</sup>	0.23
G4 (3/4)	256	2870.20 <sup>a</sup>	120.72	256	2611.54 <sup>b</sup>	106.78	256	328.29 <sup>a</sup>	6.34	255	13.54 <sup>ab</sup>	0.42	256	8.69 <sup>b</sup>	0.31	225	6.34 <sup>b</sup>	0.27
G5 (7/8)	240	3070.62 <sup>a</sup>	115.35	240	2731.31 <sup>b</sup>	102.03	240	340.95 <sup>a</sup>	6.05	239	13.94 <sup>a</sup>	0.40	240	8.96 <sup>b</sup>	0.30	224	6.83 <sup>a</sup>	0.26
G6 (15/16)	13	3202.80 <sup>a</sup>	321.50	13	2815.36 <sup>ab</sup>	284.39	13	343.97 <sup>a</sup>	16.87	13	12.20 <sup>c</sup>	1.10	13	9.31 <sup>ab</sup>	0.84	10	6.42 <sup>ab</sup>	0.78
G7 (FS)	1085	2472.33 <sup>b</sup>	115.18	1085	2238.86 <sup>c</sup>	101.88	1085	320.50 <sup>ab</sup>	6.04	1076	12.40 <sup>bc</sup>	0.40	1085	7.62 <sup>b</sup>	0.30	930	5.70 <sup>b</sup>	0.26
<b>Period of calving:</b>	**			**			**			**			**			**		
P1 (1988-1992)	39	2476.66 <sup>c</sup>	207.17	39	2107.70 <sup>c</sup>	183.25	39	358.22 <sup>a</sup>	10.87	39	11.72 <sup>b</sup>	0.71	39	6.73 <sup>d</sup>	0.54	39	5.08 <sup>d</sup>	0.46
P2 (1993-1997)	326	2709.58 <sup>c</sup>	114.11	326	2347.62 <sup>c</sup>	100.93	326	344.33 <sup>a</sup>	5.99	318	12.19 <sup>b</sup>	0.39	326	7.74 <sup>c</sup>	0.30	325	5.80 <sup>c</sup>	0.26
P3 (1998-2002)	1354	3413.52 <sup>a</sup>	90.53	1354	3220.44 <sup>a</sup>	80.08	1354	306.32 <sup>b</sup>	4.75	1348	16.63 <sup>a</sup>	0.31	1354	11.10 <sup>a</sup>	0.24	1275	8.23 <sup>a</sup>	0.21
P4 (2003-2006)	674	2857.53 <sup>b</sup>	95.18	674	2699.59 <sup>b</sup>	84.19	674	307.24 <sup>b</sup>	5.00	666	12.66 <sup>b</sup>	0.33	674	9.19 <sup>b</sup>	0.25	486	6.49 <sup>b</sup>	0.23
<b>Season of calving:</b>	**			**			**			**			**			**		
Summer	794	2754.74 <sup>b</sup>	108.63	794	2477.03 <sup>b</sup>	96.09	794	329.85	5.70	788	13.10 <sup>b</sup>	0.37	794	8.29 <sup>b</sup>	0.28	697	6.13 <sup>b</sup>	0.25
Rainy	750	2815.52 <sup>b</sup>	107.08	750	2554.57 <sup>b</sup>	94.72	750	327.43	5.62	742	12.99 <sup>b</sup>	0.37	750	8.58 <sup>b</sup>	0.28	673	6.43 <sup>a</sup>	0.25
Winter	849	3022.71 <sup>a</sup>	105.33	849	2749.91 <sup>a</sup>	93.17	849	329.81	5.53	841	13.81 <sup>a</sup>	0.36	849	9.19 <sup>a</sup>	0.27	755	6.64 <sup>a</sup>	0.24
<b>Parity:</b>	**			**			*			**			**			**		
1	605	2592.14 <sup>d</sup>	76.45	605	2362.27 <sup>d</sup>	67.63	605	321.88 <sup>ab</sup>	4.01	600	11.46 <sup>c</sup>	0.35	605	8.05 <sup>c</sup>	0.20	574	5.45 <sup>c</sup>	0.17
2	479	3157.95 <sup>a</sup>	79.82	479	2920.02 <sup>ab</sup>	70.60	479	330.16 <sup>a</sup>	4.19	474	14.08 <sup>ab</sup>	0.36	479	9.69 <sup>ab</sup>	0.21	442	7.08 <sup>a</sup>	0.18
3	387	3159.42 <sup>a</sup>	85.51	387	2918.89 <sup>ab</sup>	75.64	387	326.09 <sup>ab</sup>	4.49	383	14.75 <sup>a</sup>	0.37	387	9.78 <sup>ab</sup>	0.22	339	7.22 <sup>a</sup>	0.20
4	303	3142.09 <sup>a</sup>	90.14	303	2886.93 <sup>ab</sup>	79.73	303	330.82 <sup>a</sup>	4.73	301	14.60 <sup>a</sup>	0.39	303	9.56 <sup>ab</sup>	0.23	266	7.16 <sup>a</sup>	0.21
5	235	3268.35 <sup>a</sup>	97.25	235	2994.35 <sup>a</sup>	86.02	235	327.36 <sup>ab</sup>	5.10	233	14.67 <sup>a</sup>	0.41	235	10.01 <sup>a</sup>	0.25	196	7.51 <sup>a</sup>	0.23
6	157	3185.68 <sup>a</sup>	111.54	157	2923.51 <sup>ab</sup>	98.66	157	327.07 <sup>ab</sup>	5.85	156	14.21 <sup>ab</sup>	0.45	157	9.76 <sup>ab</sup>	0.29	126	7.37 <sup>a</sup>	0.27
7	105	2869.89 <sup>b</sup>	128.80	105	2668.86 <sup>bc</sup>	113.93	105	317.63 <sup>ab</sup>	6.76	105	13.48 <sup>b</sup>	0.50	105	9.10 <sup>bc</sup>	0.34	88	7.06 <sup>ab</sup>	0.30
8	66	2559.40 <sup>e</sup>	153.40	66	2370.05 <sup>cd</sup>	135.69	66	309.65 <sup>b</sup>	8.05	65	12.84 <sup>bc</sup>	0.57	66	8.37 <sup>c</sup>	0.40	53	6.28 <sup>bc</sup>	0.36
9	37	2615.09 <sup>c</sup>	194.38	37	2312.57 <sup>d</sup>	171.94	37	323.50 <sup>ab</sup>	10.20	36	12.86 <sup>bc</sup>	0.70	37	7.95 <sup>c</sup>	0.51	27	5.10 <sup>c</sup>	0.49
10	11	2307.28 <sup>f</sup>	342.86	11	2088.93 <sup>d</sup>	303.28	11	328.65 <sup>ab</sup>	17.99	10	11.28 <sup>c</sup>	1.25	11	6.70 <sup>d</sup>	0.89	7	4.26 <sup>c</sup>	0.91
11	5	3255.63 <sup>a</sup>	504.98	5	2598.30 <sup>bcd</sup>	446.69	5	399.38 <sup>a</sup>	26.50	5	14.99 <sup>a</sup>	1.76	5	8.05 <sup>c</sup>	1.32	4	6.58 <sup>abc</sup>	1.21
12	3	2258.96 <sup>a</sup>	654.15	3	2081.37 <sup>d</sup>	578.63	3	306.16 <sup>b</sup>	34.33	3	10.37 <sup>d</sup>	2.28	3	7.23 <sup>c</sup>	1.70	3	5.73 <sup>bc</sup>	1.41
<b>Sex of calf:</b>																		
Male	1281	2879.46	104.60	1281	2594.18	92.52	1281	330.60	5.49	1268	13.29	0.43	1281	8.67	0.27	1129	6.38	0.24
Female	1112	2849.19	104.47	1112	2593.49	92.41	1112	327.46	5.48	1103	13.32	0.43	1112	8.71	0.27	996	6.42	0.24