

Genetic evaluation of first lactation production and reproduction traits in Sahiwal cattle

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ABSTRACT

The present study was conducted on first lactation production and reproduction performance of Sahiwal cattle from NDRI, Karnal and Government Livestock Farm, Chakganjaria, Lucknow. First lactation records of 894 Sahiwal cows born to 60 sires, spread over a period of 33 years from 1973 to 2005 were utilized for the present study. The overall least squares mean of first lactation traits viz. AFC, FLL, FLMY, FL305DMY, FSP, FDP and FCI were estimated to be 1234.97±16.3 days, 322.21±6.82 days, 1785.32±49.49 kg, 1526.11±34.97 kg, 239.74±11.98 days, 201.63±11.05 days and 523.84±11.99 days respectively. The estimates of first lactation production traits, except FLL, were significantly higher in Karnal herd while all the first lactation reproduction traits were significantly higher in Lucknow herd. Season effect was not significant on most of the first lactation traits except first dry period. In contrast, different periods of calving were found to have significant influence on all the traits except first calving interval and first service period. Similarly, interaction of herd and period was found to have significant effect on all the first lactation traits while herd x season and period x season interactions were not found to have any significant influence for most of the traits. The heritability estimates of different first lactation production traits were moderate while the estimates for different reproduction traits were low except for age at first calving. In conclusion, the mean performance of different first lactation production and reproduction traits was comparatively better in Karnal than that of Lucknow herd. However, there seems to be a decreasing trend in production performance of both the herds.

Key words: Sahiwal, least squares, genetic parameters, first lactation traits

INTRODUCTION

Sahiwal, one of the best sub-continental milch breeds of zebu cattle (Maule, 1990), is known for its endurance to hot climate of tropics, resistance to tropical diseases, low cost of maintenance and having higher percentage of milk constituents. The original breeding tract of Sahiwal cattle lies in the Montgomery district of Pakistan and true to the type animals are available in the bordering districts of Punjab and Rajasthan in India. Additionally, about 1200 breedable females with good production potential are maintained at various organized farms located in different parts of the country (Joshi *et al.*, 2001). The objectives of the present study were (i) to evaluate performance of Sahiwal cattle with respect to first lactation production and reproduction traits in organized herds (ii) to estimate the effects of different non-genetic factors and their interaction on first lactation traits and (iii) to estimate genetic parameters viz. heritability and genetic correlations among different first lactation traits.

MATERIAL AND METHODS

First lactation records of 894 Sahiwal cows born to 60 sires spread over a period of 33 years from 1973 to 2005, maintained at National Dairy Research Institute, Karnal and Government Livestock Farm, Chakganjaria, Lucknow were utilized for the present study. Only the sires having records on at least 5 daughters were included in the present study. The records of only those animals with known pedigree and normal lactation were considered. The lactation records of less than 100 days were considered as abnormal and were not included in the analysis. Expression of different traits varied in different periods due to change in managerial practices over time. The total duration of the present study was divided into six equal periods of five years

each. Each year was divided into four seasons namely winter (December-March), summer (April-June), rainy (July-September) and autumn (October-November). In order to classify the data for different periods and seasons, year and season of birth was considered for age at first calving, while year and season of calving was considered for other first lactation traits. The traits considered in the present study were age at first calving (AFC in days), first lactation length (FLL in days), first lactation total milk yield (FLMY in kg), first lactation 305 days milk yield (FL305DMY in kg), first service period (FSP in days), first dry period (FDP in days) and first calving interval (FCI in days).

Statistical Analysis: The influence of non-genetic factors on different traits were studied by least squares analysis of variance for non-orthogonal data using the technique described by Harvey (1987). The model for the least squares analysis of variance to estimate the influence of non-genetic factors on different first lactation traits included the effects of herd, seasons, periods and interaction among them. Prior to estimation of genetic parameters, the data were adjusted for different significant non-genetic factors (herd, season, period and their interaction effects). The data after adjustment for different significant non-genetic factors were utilized for estimation of genetic parameters. Paternal half-sib correlation (intra-sire correlation among daughters) method was used to estimate heritability of different traits (Becker, 1975). The standard error of heritability was estimated by the formula given by Swiger *et al.* (1964). The genetic and phenotypic correlations among different traits were estimated from the analysis of variance/covariance using half sib data as suggested by Becker (1975). The genetic correlation was calculated from sire component of variance and covariance.

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RESULTS AND DISCUSSION

The least squares analysis of variance to estimate different non-genetic effects are presented in Table 1. The effect of herd was highly significant ($P < 0.01$) on all the first lactation traits except first lactation length. The mean first lactation production traits viz. FLMY and FL305DMY were significantly higher ($P < 0.01$) in Karnal herd (2093.67±81.47 kg and 1797.43±57.56 kg respectively). The respective means in Lucknow farm for these traits were 1476.97±45.76 kg and 1254.78±32.33 kg. However, the mean first lactation length was slightly higher in Lucknow farm (322.47±6.31 days) than that of Karnal farm (321.95±11.23 days) (Table 2). Similarly, the mean first lactation reproduction traits

were significantly ($P < 0.01$) lower in Karnal herd compared to that of Lucknow herd. The mean AFC, FSP, FDP and FCI were 1177.49±25.38 days, 204.49±19.72 days, 168.52±18.19 days and 490.47±19.73 days respectively in Karnal herd while they were 1292.46±20.00 days, 274.98±11.08 days, 234.74±10.22 days and 557.21±11.08 days respectively in Lucknow herd (Table 2). Thus the mean values of different first lactation production and reproduction traits revealed the better performance level suggestive of better managerial practices followed in Karnal farm as compared to Lucknow farm. Highly significant influence of herd on different first lactation production and reproduction traits observed in the present study is consistent with the findings of Banik (2004) and Kumar (2007) in Sahiwal cattle.

Table 1. Least squares analysis of variance to estimate effect of non-genetic factors on first lactation traits in Sahiwal cattle

Traits	Mean squares					
	Herd	Season	Period	Herd x Season	Herd x Period	Period x Season
AFC	1029147**	9481 ^{NS}	731877**	126683 ^{NS}	381194**	65266 ^{NS}
FL305DMY	15699315**	407836 ^{NS}	1381835**	89690 ^{NS}	2561216**	204224 ^{NS}
FLMY	20276626**	701108 ^{NS}	2337231**	298246 ^{NS}	4612893**	386743 ^{NS}
FLL	14.21 ^{NS}	5695 ^{NS}	52219**	NA	65450**	9131 ^{NS}
FSP	264897**	36851 ^{NS}	16405 ^{NS}	59411 ^{NS}	72729**	NA
FDP	233829**	66224*	72250**	43172 ^{NS}	74814**	17750 ^{NS}
FCI	237488**	36090 ^{NS}	14205 ^{NS}	63715*	69335*	NA

**Highly significant ($P < 0.01$); *Significant ($P < 0.05$); NS Not Significant; NA-Interaction effect not analyzed as both the main effects were not significant

Table 2. Least squares means of different first lactation production and reproduction traits in Sahiwal cattle

Effects	FL305DMY (kg)	FLMY (kg)	FLL (days)	AFC (days)*	FSP (days)	FDP (days)	FCI (days)
Overall	1526.1±34.97	1785.3±49.49	322.2±6.82	1234.9±16.3	239.7±11.98	201.6±11.05	523.8±11.99
Herd							
Lucknow	1254.8±32.33 ^a	1476.9±45.76 ^a	322.47±6.31	1292.5±20.00 ^a	274.9±11.08 ^a	234.7±10.22 ^a	557.2±11.08 ^a
Karnal	1797.4±57.56 ^b	2093.7±81.47 ^b	321.9±11.23	1177.5±25.38 ^b	204.5±19.72 ^b	168.5±18.19 ^b	490.5±19.73 ^b
Season							
Winter	1573.8±28.03	1840.9±39.66	332.39±5.47	1223.9±19.32	218.7±9.6	169.9±8.86 ^b	502.3±9.61
Summer	1476.0±36.94	1705.4±52.28	325.9±7.21	1236.1±31.98	216.7±12.66	175.8±11.68 ^b	501.8±12.66
Rainy	1581.2±55.38	1831.1±78.37	330.03±10.8	1240.8±29.04	217.3±18.97	171.7±17.50 ^b	501.7±18.98
Autumn	1473.4±117.75	1763.8±166.65	300.4±22.97	1239.2±36.49	306.2±40.34	289.1±37.22 ^a	589.6±40.35
Period							
1976-80	1642.6±88.16 ^b	2134.4±124.77 ^a	383.6±17.20 ^a	1231.8±50.99 ^{bc}	245.93±30.2	147.1±27.87 ^d	530.7±30.21
1981-85	1585.7±50.70 ^f	1888.9±71.76 ^{bc}	353.7±9.89 ^b	1394.7±26.90 ^a	235.2±17.37	164.4±16.03 ^d	518.1±17.38
1986-90	1665.1±48.65 ^b	1865.6±68.86 ^c	322.5±9.49 ^c	1199.7±24.41 ^{cd}	214.4±16.67	178.7±15.38 ^e	501.2±16.67
1991-95	1725.5±55.75 ^e	1950.6±78.91 ^b	312.4±10.88 ^{cd}	115.56±31.95 ^e	254.2±19.1	226.4±17.62 ^b	538.8±19.11
1996-2000	1433.9±52.70 ^d	1613.1±74.58 ^d	306.4±10.28 ^d	1259.7±29.57 ^b	239.7±18.05	215.6±16.66 ^b	522.0±18.06
2001-05	1103.78±128.53 ^e	1259.5±181.9 ^f	254.5±25.07 ^e	1169.4±60.85 ^{de}	249.0±44.03	277.7±40.62 ^a	532.3±44.05

Means bearing different superscripts within a column for an effect differ significantly.

* Periods for AFC in order are 1973-77, 1978-82, 1983-87, 1988-1992, 1993-97, 1998-2002 and season indicate season of birth.

Although season was found to have non-significant influence on all the first lactation production traits, it was found that cows calved in winter and rainy season had higher milk yields as compared to that of cows that calved during summer and autumn seasons. These findings are consistent with the results of Mohanty (2001), Kumar (2003) and Kumar (2007). This is understandable as the level of green fodder production normally goes down during the summer and autumn seasons. Although silage and hay are provided during lean seasons in both the farms, season seems to exert certain influence on the production of Sahiwal cows. Moreover, several other factors like stress due to adverse environmental conditions is bound to affect the production of dairy animals. Among the various first lactation reproduction traits, FDP was found to be significantly influenced by the seasonal effects. Cows that calved during autumn season had significantly higher FDP than those that calved during other seasons. Similarly, all the other first lactation reproduction traits (FSP and FCI) were comparatively higher in cows that calved during autumn season although they were statistically non-significant ($P>0.05$). Non-significant influence of different seasons on various first lactation reproduction traits had been reported earlier by Sahota and Gill (1994), Kuralkar *et al.* (1996) and Kumar (2003). Mohanty (2001) reported that the animals calved in autumn had highest FDP among different seasons of calving, which is in agreement with the findings of the present study. However, Kumar (2007) reported significant seasonal influence on first service period and first calving interval.

Cows that calved in different periods had significant differences ($P<0.01$) with respect to their lactation length and milk yields. The mean performance of all the three first lactation production traits viz. FLL, FLMY and FL305DMY decreased over the period of time and it was lowest in the last period of calving that spread between 2001 and 2005. The mean FLMY and FL305DMY increased slightly during the early 1990s, but subsequently decreased drastically till 2005. Similarly, there was deterioration in different first lactation reproduction traits except AFC with mean values being the highest for the period 2001-2005. Significant influence of different periods ($P<0.01$) was observed in AFC and FDP. However, no consistent trend was found, with fluctuations being observed over the period of calving in case of first service period and first calving interval. The fluctuation in FSP could be due to differences in managerial practices followed during different periods of time. The variability in FCI over periods might be due to its high association with FSP, since similar trend was observed for both these traits. These findings are in agreement with Chaudhary *et al.* (1995) and Singh and Gurnani (2003). The interaction between herd and period was found to be significant on all the first lactation traits while period x season interaction had significant influence on none of the traits under study. The effect of herd x season interaction was not found to be significant for most of the traits except FCI. Among the herd x period interactions of different traits, it was found that there was consistent decreasing trend in milk yield of Lucknow herd over the period of time while there was fluctuation in milk yields of Karnal herd. Most of the significant differences in different reproduction traits due to the interaction of herd and period can be attributed to lower performance level of the Lucknow herd.

The data on different traits were adjusted for significant effects using least squares constant before estimating the genetic parameters viz. heritability and genetic correlations. The estimates of heritability, phenotypic and genetic correlations are presented in Table 3. The heritability estimates ranged from 0.061 ± 0.06 (FDP) to 0.31 ± 0.10 (AFC). The heritability estimates for different first lactation production traits viz. FLL, FLMY and FL305DMY were 0.180 ± 0.08 , 0.091 ± 0.07 and 0.180 ± 0.08 respectively. Among these estimates, except for FLMY, the other two were found to be moderately heritable and significant ($P<0.01$). The heritability estimates of the production traits observed in the present study are comparable to that of Banik (2004) and Kumar (2007) while higher estimates were reported by Mohanty (2001) and Singh *et al.* (2005). The heritability estimates for different first lactation reproduction traits viz. AFC, FSP, FDP and FCI were 0.310 ± 0.10 , 0.086 ± 0.07 , 0.061 ± 0.06 and 0.065 ± 0.06 respectively. With the exception of AFC, all the other reproduction traits were found to be lowly heritable and the heritability estimates were not statistically significant ($P>0.05$). This is consistent with the reports of Banik (2004) and Kumar (2007) while Mohanty (2001) reported marginally higher estimates but with large standard error.

The genetic correlation between age at first calving and first lactation milk yield was negative (-0.171 ± 0.361) and non-significant. The genetic correlation of AFC with FLL, FSP, FDP and FCI were also negative but significant ($P<0.01$) with the 'r' values of -0.511 ± 0.268 , -0.540 ± 0.382 , and -0.315 ± 0.446 and -0.690 ± 0.464 respectively. Positive genetic correlation was observed between AFC and FL-305D-MY which is contradictory to the report of Kumar (2007). However, genetic correlation estimates of similar range between these two traits had been reported earlier (Singh, 1981; Mohiuddin *et al.*, 1991). The first lactation 305 days or less milk yield was having

positive genetic correlation with traits like FLL, FSP and FCI with 'r' values of 0.335 ± 0.293 , 0.096 ± 0.436 and 0.001 ± 0.491 . However, with the exception of FLL, estimates of genetic correlation of FL305DMY with the other traits were found to have high standard error. First lactation length was found to have significant positive genetic correlation with all the first lactation traits except FDP. The negative genetic correlation between FLL and FDP was significant (-0.335 ± 0.293) and is understandable, as higher number of days in lactation will reduce the subsequent dry period before next calving. Highly significant ($P<0.01$) positive genetic correlation (0.964 ± 0.054) was found to exist between first service period and first calving interval. This is expected as the calving interval is bound to increase if the number of days for successful insemination increases.

In order to evaluate the performance of the two Sahiwal herds under study over time, the mean performances of both the herds for different first lactation production and reproduction traits were plotted against different periods of calving (Figure). The mean first lactation milk yield and first lactation 305 days or less milk yield were found to decrease consistently in the Lucknow herd. The mean FLMY of 1903.57 kg in 1976-80 reduced to 1506.66 kg in 2001-06, while the mean FL305DMY

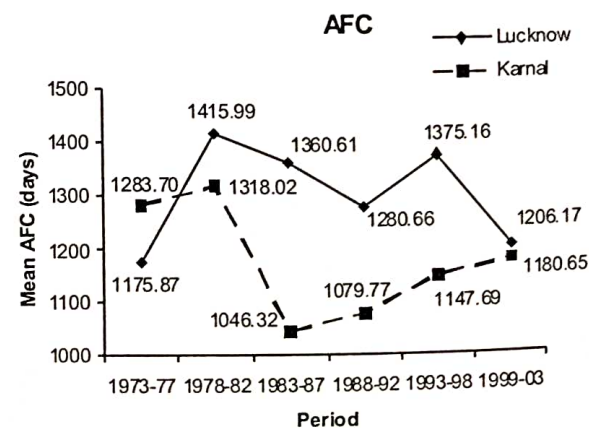
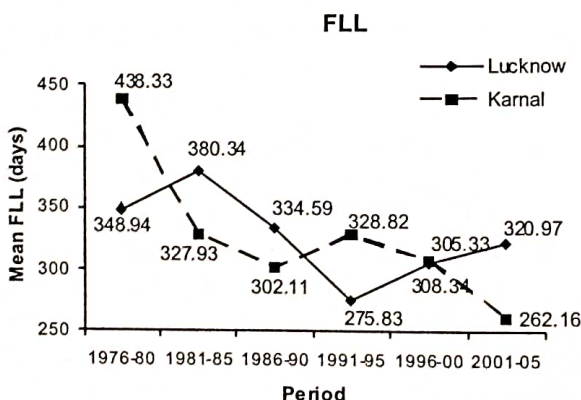
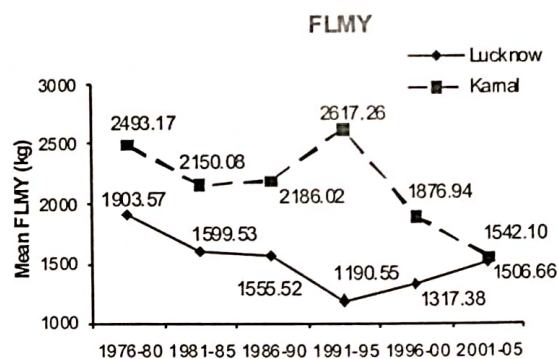
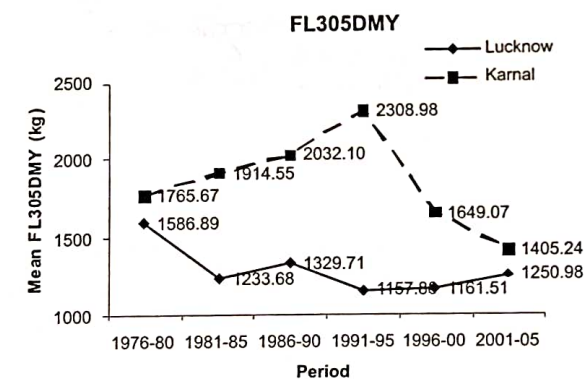
decreased from 1586.89 kg to 1250.98 kg. The mean FLMY and FL305DMY were consistently higher in Karnal herd compared to that of Lucknow herd over different periods of calving. However, the decreasing trend in Karnal herd for both these traits is evident, especially from 1996 to 2005. The decrease in mean milk yield (FLMY) was quite drastic from 2617.26 kg (1991-95) to 1542.10 kg (2001-05) and is almost on par with that of

Lucknow herd. With respect to different first lactation reproduction traits, the mean AFC and FDP were almost similar in both herds during the last period of calving (2001-05) although there were fluctuations during earlier periods of calving. The mean FSP and FCI were higher in Lucknow herd compared to that of Karnal herd. Although there were fluctuations in these two

Table 3. Heritability estimates, genetic and phenotypic correlations of different first lactation traits in Sahiwal cattle

	AFC	FLL	FLMY	FL305DMY	FSP	FDP	FCI
AFC	0.301±0.10**	0.132**	0.108**	0.136**	0.058 ^{NS}	-0.052 ^{NS}	-0.099**
FLL	-0.511**	0.180±0.08**	0.830**	0.997**	0.417**	0.074*	-0.174**
FLMY	-.171 ^{NS}	0.671*	0.091±0.07	0.825**	-0.161**	-0.335**	-0.381**
FL305DMY	0.239**	0.335*	0.962*	0.180±0.08**	0.418**	0.071*	-0.179**
FSP	-.540**	0.532*	0.445*	0.096**	0.086±0.07 ^{NS}	0.678**	0.313**
FDP	-.315**	-.377**	-.144 ^{NS}	-0.222*	0.489 ^{NS}	0.061±0.0 ^{NS}	0.870**
FCI	-.690**	0.552*	0.307 ^{NS}	0.001 ^{NS}	0.944**	0.473 ^{NS}	0.065±0.06 ^{NS}

Diagonal values - Heritability; Upper triangle - Phenotypic correlation; Lower triangle - Genetic correlation; ** Highly significant (P<0.01); * Significant (P<0.05); NS Not significant (P>0.05)



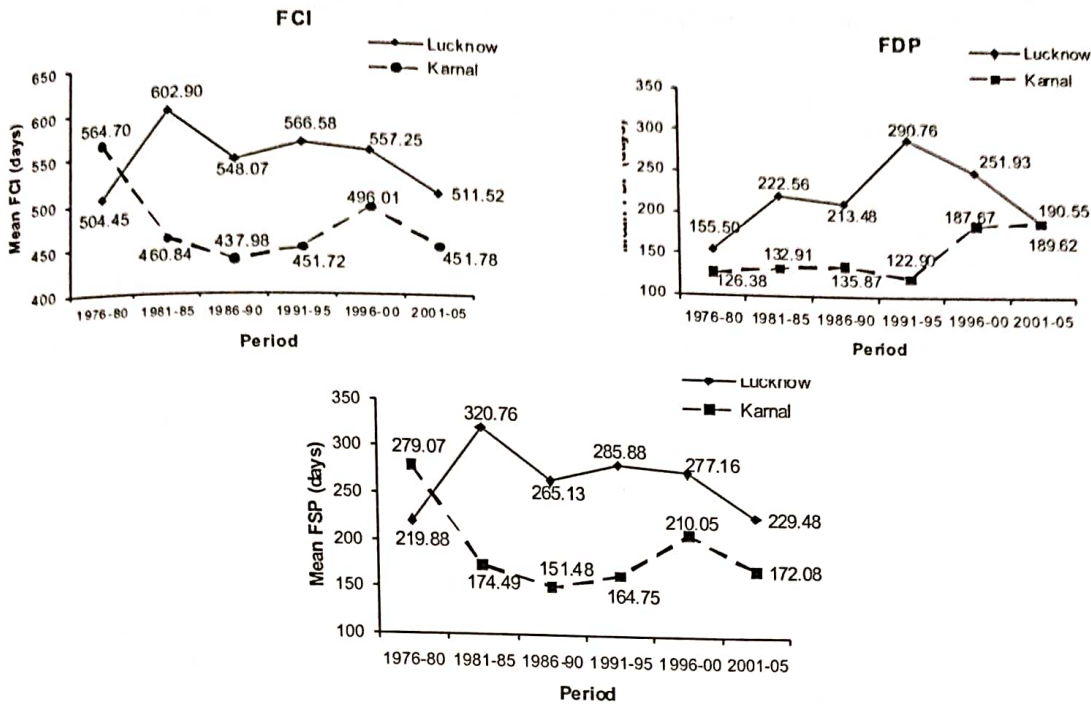


Figure 1. Comparative performance over different periods in the two herds of Sahiwal cattle for various first lactation traits

In conclusion, the mean performance of different first lactation production and reproduction traits was comparatively better in Karnal than that of Lucknow herd. However, there seems to be a decreasing trend in production performance of both the herds. The heritability estimates obtained in the present study were found to be low to medium for different production and reproduction traits respectively.

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