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Genetic study on some of the production traits in Gir cows

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Milk yield is the basic and most important trait on which the economy of dairying is based. A high milk-producing cow is more economical to the farmer as compared to the low producing one. Lactation period is important in assessing production as it determines the total quantity of milk produced by a cow. An optimum dry period or period of rest is essential for the maximum production of milk in the subsequent lactation. These production traits, in addition to genetic causes, are influenced by some environmental factors. The present study was undertaken to study the genetic variation and co-variation present and to examine the effects of environmental factors on these traits in Gir cows.

The data for the present study were obtained from the Gir herd maintained at the Kasturba Gandhi Memorial National Trust Dairy Farm, Kasturbagram, Indore (MP), covering a period of 38 years from 1960 to 1997. The incomplete records, records with history of abnormalities, viz. abortion, premature and stillbirths, were discarded. Production traits, viz. lactation yield, lactation period and dry period were studied. The 38 years period was divided into 9 groups of 4-year duration except the last one, which consisted of 6 years. On the basis of temperature and humidity complex, the year was divided into 4 seasons, viz. summer (April to June), rainy (July to September), winter (October to January) and spring (February to March). Least-squares technique of fitting constants (Harvey 1979) using the following linear mathematical model was applied to study the effects of various non-genetic factors on the traits under study.

$$Y_{ijklm}=\mu+A_i+B_j+C_k+D_l+e_{ijklm}$$

Where,

Y_{ijklm} is the observation on the trait for mth cow in 1th parity that calved kth sex of calf in jth season of ith period, μ is the population mean, A_i is the effect of ith period, B_j is the effect of jth season, C_k is the effect of kth sex of calf, D_l is the random error associated with each observation and assumed to be normally and independently distributed with mean zero and variance, σ_e^2.

The significance of the differences between least squares means in each significant subclass was tested by Duncas's multiple range test. Least-squares constants were used to adjust the data to a common basis and the adjusted data were utilized to estimate heritabilities and genetic and phenotypic correlations by paternal halfsib correlation method.

The least-squares means with standard errors for different production traits are given in Table 1. The results of analysis of variance are presented in Table 2 and the estimates of heritabilities and genetic and phenotypic correlations are detailed in Table 3.

The overall least-squares mean for lactation yield was 1882.54±37.01 kg. This is close to the averages reported for Gir by Odedra *et al.* (1978) and Gajbhiye and Dhanda (1987). The mean lactation yield in this breed has been reported to be as low as 1255 to 1564 kg by Santos *et al.* (1990) and Umrikar *et al.* (1990) to as high as 2544 to 2944 kg by Mathur and Khosla (1994) and D'souza *et al.* (1996). This indicated for large herd variations in the breed and thus a possibility of genetic improvement in lactation yield by introducing genes from other herds with higher mean lactation yield.

Table 2 reveals the period of calving to be a highly significant ($P<0.01$) factor to affect the lactation yield, a finding similar to that reported by Odedra *et al.* (1978) and Nanavati and Khan (1997) in this breed. In general the trait showed an increasing trend over the periods (Table 1). The differences among the periods could be attributed to differential management, availability of feeds and fodders, and due to variation among sires. The season of calving also had highly significant effect ($P<0.01$) on lactation yield. This is in agreement with the findings of D'souza *et al.* (1996) and Nanavati and Khan (1997) in Gir cattle. Calvers in summer, winter and spring produced significantly larger yields than that of rainy season calvers. The lower lactation yield in rainy calvers could be due to significantly shorter lactation period

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Table 1. Least squares means and standard errors for various production traits along with Duncan's multiple range test in Gir cattle

Subclass description	Number of observations	Lactation yield (kg)	Lactation period (days)	Dry period (days)
Overall mean (μ)	720	1882.54±37.01	292.43±4.35	137.94±4.04
Period				
P_1	51	1627.30^{a}±107.77	343.97^{e}±11.58	136.22±10.43
P_2	86	1807.91^{abc}±82.58	341.33^{e}±8.80	160.38±8.09
P_3	84	1741.74^{ab}±83.30	303.60^{cd}±8.96	157.50±8.57
P_4	89	1693.85^{a}±80.62	273.97^{ab}±8.56	139.41±8.15
P_5	90	1977.23^{bc}±80.07	290.86^{bc}±8.54	141.36±8.02
P_6	126	1934.71^{bc}±67.98	278.60^{ab}±7.28	135.58±6.85
P_7	154	1847.95^{abc}±61.17	260.77^{a}±6.73	134.63±6.43
P_8	21	.62.49^{c}±165.46	273.14^{abd}±18.32	121.86±16.33
P_9	19	2149.72^{bc}±173.80	265.66^{abd}±19.12	114.52±17.04
Seasons				
Summer	132	2035.80^{b}±69.59	305.40^{b}±7.58	137.22±7.05
Rainy	130	1635.93^{a}±71.51	273.88^{a}±791	131.36±7.53
Winter	266	1918.72^{b}±50.34	294.27^{b}±5.48	137.70±5.03
Spring	192	1939.72^{b}±59.73	296.18^{b}±6.79	145.48±6.34
Sex of calf				
Male	348	1747.56^{b}±47.68	297.29±5.43	131.92^{a}±5.10
Female	372	1817.53^{a}±45.62	287.58±5.16	143.96^{b}±4.75
Parity				
Pty1	291	1743.21^{a}±45.71	328.65^{b}±5.04	145.36±4.60
Pty2	178	1924.74^{b}±51.75	290.09^{a}±6.86	140.31±6.38
Pty3	143	1941.74^{b}±59.89	277.25^{a}±7.56	133.44±7.18
Pty4	108	19.20.47^{b}±64.78	273.74^{a}±8.59	132.64±8.12

Least squares means for a particular subclass having atleast one letter common as superscript are not significantly different from each other.

in these cows (Table 1) as compared to those calving in other seasons. Odedra *et al.* (1978) and Umrikar *et al.* (1990) observed the effect of season of calving to be non-significant.

The sex of calf born had a significant (P<0.05) effect on lactation yield (Table 2). However, Sharma *et al.* (1987) reported nonsignificant effect of sex of calf on this trait. The significant effect of parity on lactation yield obtained in this study is in agreement with the findings of Odedra *et al.* (1978), Gajbhiye and Dhanda (1987) and Nanavati and Khan (1997) in Gir cattle. It is evident from Table 1 that primipara had significantly lower lactation yield as compared to pluriparous animals. The major reason is that the primipara have not yet attained maturity, there is increase in size with advancing age and , therefore, further development and growth took place with successive freshening. The zebu breeds gradually increase their lactation yields from the time they first freshen until third or even fourth lactation; thereafter, senility begins and the quantity of milk produced during each lactation gradually declines.

The overall least-squares means of lactation period and dry period were 292.43±4.35 and 137.94±4.04 days, respectively, with coefficients of variation of 28.0 and 49.0%. The mean lactation period is close to estimates reported by Mathur and Khosla (1994), and Nanavati *et al.* (1996) in Gir cattle. Lower mean lactation period (ranging from 219.0 to 237.0 days) as compared to present value has been reported by Santos *et al.* (1990) in Gir and Tomar *et al.* (1994) in Nimari (admixture of Gir, and Khillari) cattle. However, Umrikar *et al.* (1990) reported higher estimate as compared to present value in this breed. The average dry period was closer to the values reported by Gajbhiye and Dhanda (1987) and Nanavati (1990) in Gir cows.

The least-squares analysis of variance revealed significant effect of period (P<0.01), season (P<0.05) and parity (P<0.01) on lactation period (Table 2). The effect of sex of calf born, however, was non-significant on this trait. The significant effect of period of calving on lactation period as obtained in this study was also reported by Nanavati *et al.* (1996) in Gir cows. Likewise, Santos *et al.* (1990) also reported significant effect of year on this trait in this breed. In general there was a

Table 2. The heritability estimates and genetic and phenotypic correlations among production traits in Gir cattle

Trait	Lactation yield	Lactation period	Dry period
Lactation yield	0.06±0.01	−0.47±0.34	−0.79±0.010**
Lactation period	0.58±0.03**	0.28±0.02	-0.44±0.13*
Dry period	−0.10±0.03*	−0.17±0.03**	0.06±0.01

*Significant (P<0.05); **significant (P<0.01); Diagonal elements are heritability estimates, upper diagonals are genetic correlations and lower diagonals are phenotypic correlations.

declining trend in this trait over the periods. This could be a reflection of efforts made at the farm for lowering down calving interval by applying selection pressure and improved mangemental practices as the results of calving interval in this herd have shown a significant declining trend (improvement) over the periods (Bhadoria 2000). The significant effect of season on lactation period observed in this study is in agreement with the findings of Saha and Khan (1987), Santos *et al.* (1990), Umrikar *et al.* (1990) and Nanavati *et al.* (1996) in Gir cattle. Significantly lower mean lactation period for rainy season calvers could be due to the fact that these animals experience lean period at the end of their lactation, when green fodder was not available at the farm.

The significant effect of parity on lactation period (Table 2) aligns well with the findings of Saha and Khan (1987) in this breed. Results indicate that the primipara had significantly longer lactation period (Table 1) as compared to other parities. This is in conformity with the findings of D'souza *et al.* (1995) who reported significantly longer lactations in young than in older cows. The finding suggests that as the cow grows older, her capacity to sustain longer lactation reduces. The non-significant effect of the sex of calf born on this trait was also reported by Tomar *et al.* (1994) in Nimari cows.

Table 2 reveals only sex of calf born to be a significant ($P<0.05$) factor to affect the dry period, while the effects of period, season and parity were nonsignificant. These observations are in agreement with the findings of Nanavati (1990) in Gir cows.

Heritability estimates: The estimates of heritability for lactation yield, lactation period and dry period were 0.06±0.01, 0.28±0.02 and 0.06±0.01 respectively (Table 3). The estimate for lactation yield is similar to those reported by Nanavati and Khan (1997) in Gir cows. For dry period and lactation period our estimates are close to those reported by D'souza *et al.* (1978, 1995), respectively, in this breed. Higher estimates for lactation yield were reported by Gajbhiye and Dhanda (1987), Santos *et al.* (1990) and D'souza *et al.* (1996). The low estimate of heritability for lactation yield in present study might be due to exhaustion of additive genetic variance for this trait as the herd under study was subjected to continuous selection pressure for improving lactation yield. Therefore, the improvement in this trait can be affected by introducing genes from other pedigreed herds (outcrossing) and by ameliorating the managerial and environmental conditions. The moderate estimate of heritability for lactation period in the present study suggested that this trait could be improved reasonably through mass selection.

Correlations: Phenotypic correlation of lactation yield with lactation period was significant and positive and with dry period it was significant and negative. The phenotypic correlation of lactation period with dry period was significant and negative (Table 3). Reports on correlations among these production traits in Gir cows do not appear to be readily available. However, our findings are in agreement with those of Deshpande and Singh (1977) in Deoni, and Chaturvedi (1991) in Malvi cows. The results indicated that higher lactation yield would simultaneously lengthen lactation period and shorten dry period, and thus, would increase the lifetime production as the phenotypic correlation between lactation period and first 3 lactations cumulative yield in this herd was highly significant and positive (Bhadoria 2000).

The genetic correlation of lactation yield with lactation period was non-significant and with dry period it was significant and negative which is in agreement with the findings of Mane *et al.* (1998) in Khillari cows. Genetic correlation of lactation period with dry period was significant and negative suggesting that improvement in lactation period through selection would bring about desirable improvement (reduction) in dry period.

SUMMARY

The effects of period, season, sex of calf born and parity were examined on total lactation yield, lactation period and dry period of Gir cows. The overall least-squares means were 1182.54±37.01 kg, 292.43±4.35 days and 137.94±4.04 days respectively. The effects of period, season, sex of calf and parity were all significant on lactation yield while on lactation period sex of calf had non-significant effect and all other factors had significant effect. Dry period was significatnly affected only by sex of calf. The heritability estimates for lactation yield and dry period were low (0.06±0.01), while the lactation period was moderately heritable (0.28±0.02). The phenotypic correlation of lactation yield with lactation period was positive and significant and with dry period it was negative and significant. The phenotypic correlation of lactation period with dry period was negative and significant. The genetic correlations of dry period with lactation yield and lactation period were significant and negative.

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