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Estimates of genetic parameters for first lactation performances in Tharparkar cattle

S. B. BASU[1], D. S. BHATNAGAR[2] and V. K. TANEJA[3]

National Dairy Research Institute, Karnal, Haryana 132 001

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ABSTRACT

Genetic parameters were estimated, and alternative selection models for age at first calving, milk yield and lactation length examined using 759 first lactation records from Tharparkar cows. Heritability estimates by half-sib correlations were 0.24, 0.37, 0.03 and 0.0 for age at first calving, 305–day milk yields, lactation length and calving interval respectively. Within period phenotypic correlations of lactation length with milk yields and calving interval were strongly positive. Genetic correlations were —0.43 between milk yield and age at first calving, 0.56 between milk yield and lactation length, —0.38 between age at first calving and lactation length, and zero among others.

Direct selection for milk yield or age at first calving would result in correlated change in lactation length more than direct selection for the trait. Direct selection for milk yield would result in moderate decline (improvement) in age at first calving and vice-versa. The index involving age at first calving, first lactation milk yield and lactation length ($R_{IH} = 0.69$) would give an expected genetic change of +257.74 kg as against 255.19 kg from direct selection for milk yield.

After nearly 2 decades of cross-breeding, renewed interest has been created in India to preserve and improve some of its elite pure breeds of cattle. Tharparkar is one such breed which has been chosen for selective breeding. A knowledge of the influence of heredity and environment on the economic traits is required to develop breeding programmes designed to increase the net merit.

The environmental factors influencing production traits in Tharparkar have been identified and investigated by Singh *et al.* (1962), Dass *et al.* (1971), Sharma *et al.* (1972) and Nagpaul and Bhatnagar (1971). However, most of the genetic estimates reported are biased because of inappropriate models accounting for confounding of sire with period in these data. The present study was undertaken to obtain reliable estimates of heritability and genetic correlations for first lactation traits, and to examine the direct and correlated responses to selection for these traits.

MATERIALS AND METHODS

First lactation performance records of 759 Tharparkar cows of this Institute spread over a period from 1932 to 1972 were utilized. The years were classified into 4 periods according to the distribution of sires avoiding overlapping of sires in 2 consecutive periods as far as possible. Sires with minimum of 2 records were considered. The traits studied were : age at first calving, 305 or less days milk yield, lactation length and calving interval. A standard least-squares analysis of variance (Harvey, 1966) was utilized to study the effects of periods, sire, month of calving and dams' parity. The following mathematical mixed model was used :

$$Y_{ijklm} = u + P_i + S_{ij} + m_k + d_l + e_{ijklm}$$

where Y_{ijklm} is the actual lactation record;
u is the overall mean;

Present address : [1]Head, Eastern Regional Station of the National Dairy Research Institute, Kalyani 741 235, [2]Head, [3]Scientist S-2, Division of Dairy Cattle Genetics.

P_i is the effect of the ith period;
S_{ij} is the effect of the jth sire in the ith period;
m_k is the effect of kth month;
d_l is the effect of the lth parity of calving of the dams; and
e_{ijklm} is the random error.

The sires were considered as random while other main effects were treated as fixed. Heritabilities and genetic correlations were obtained from sire components of variances and covariances.

Assuming a selection differential of one standard deviation, the expected genetic change from single trait selection was calculated as :

$\triangle G_x = h_x P_x$

where h^2 represents the heritability of the trait. The expected correlated genetic change in trait Y was expressed as :

$\triangle CG_Y = h_x . h_y . vg_{xy} . \sigma p_y .$

The change produced in each individual as a result of selection on the index was calculated as the regression of each genotypic value (G_i) on the index :

$\triangle G = i. \; b'G_i / \sqrt{b'p^b}$ units of change in each trait.

where G_i is ith column of genotypic variance-covariance matrix;
b is vector of weighting factors for each traits in the index; and
P is the matrix of phenotypic variances and covariances.

RESULTS AND DISCUSSION

The mean performances along with standard deviation and coefficient of variation for the 4 traits are presented in Table 1. The average milk yield was 2,011 .16 kg with a coefficient of variability of 32.87%. The milk yield in the present study was much higher than those reported by Amble *et al.* (1958), Singh *et al.* (1962), Sharma *et al.* (1972) and Taneja (1974) for Tharparkar breed.

The average age at first calving of 39.03 months was lower than in other herds. The comparatively lower age at calving was negative because of genetic correlation between milk production and age at first calving in this herd.

The results of analysis of variance are given in Table 2. The effect of period of calving was significant for all the traits except first calving interval. The first lactation milk production decreased sharply over the periods though the lactation length increased. The fall in production was partly due to use of pedigree-selected bulls which proved to be inferior and partly due to increase in overall size of the herd. During the same period, the age at first calving increased from 32.58 to 39.81 months.

The effect of month of calving was not significant for all the traits except age at first calving, which agreed with the observations of Nagpaul and Bhatnagar (1971) and Sharma *et al.* (1972). Heifers calving in February had least age at first calving and those calving in November had highest age. Dam's parity of calving was a non-significant source of variation in the first lactation performance of the progeny.

The differences among sires were only significant for age at first calving and 305-day milk yield. The heritability estimate of milk yield was 0.37 ± 0.12. The present estimate was higher than the estimate of 0.08 ± 0.07 obtained by Gurnani *et al.* (1976) which was based on data corrected for period effects. As the period and sire effects were confounded, the correction for period effect simultaneously eliminated some of the sire differences in their data. The age at first calving had a heritability estimate of 0.24 ± 0.10. This was in agreement with the estimate of 0.21 obtained by Dass *et al.* (1971) but was lower than the value of 0.48 reported by Amble *et al.* (1958). However, it was higher than the estimate of 0.17 ± 0.10 reported by Gurnani *et al.* (1976) for Tharparkar animals. Singh (1957) obtained a very low estimate of 0.05, which was not significantly different from zero. The moderate estimate of heritability of age at first calving and milk yield in this study suggested that

Table 1. Least-squares means and standard errors for first lactation traits in Tharparkar cows

Traits	n	Age at first calving (months)	305-day lactation yield (kg)	Days in lactation	Calving interval (days)
Overall mean	753	39.0 ± 0.5	2011.2 ± 62.8	316.8 ± 4.5	447.5 ± 6.6
Period					
1	230	32.6 ± 0.7	2459.8 ± 84.6	294.5 ± 6.0	435.2 ± 8.7
2	190	43.2 ± 0.7	2090.5 ± 89.7	290.3 ± 6.6	443.3 ± 9.7
3	155	40.6 ± 0.8	1909.5 ± 96.6	345.0 ± 6.7	462.7 ± 9.6
4	178	39.8 ± 0.7	1585.0 ± 85.2	337.3 ± 6.5	447.1 ± 10.0
Months					
1	86	39.2 ± 0.8	2104.1 ± 88.0	308.8 ± 8.3	425.3 ± 12.7
2	95	36.9 ± 0.8	2121.2 ± 86.4	320.2 ± 8.1	459.0 ± 12·3
3	101	38.4 ± 0.7	2031.0 ± 84.5	312.0 ± 7.8	414.9 ± 11.4
4	103	38.1 ± 0.7	2011.5 ± 83.9	326.4 ± 7.7	463.5 ± 11.8
5	70	38.6 ± 0.8	1920.8 ± 94.0	311.1 ± 9.1	450.4 ± 13.9
6	45	39.4 ± 1.0	2042.6 ± 107.7	336.5 ± 10.8	452.9 ± 16.7
7	43	38.5 ± 1.0	1812.4 ± 112.9	298.1 ± 11.5	442.7 ± 17.7
8	50	39.6 ± 1.0	1942.7 ± 105.4	311.0 ± 10.5	439.8 ± 16.2
9	30	40.6 ± 1.2	1952.9 ± 126.0	313.7 ± 13.1	432.6 ± 20.3
10	32	39.1 ± 1.1	1966.5 ± 123.2	318.4 ± 12.8	476·4 ± 19.7
11	37	41.1 ± 1.1	2168.2 ± 117.8	336.2 ± 12.1	450.6 ± 18.7
12	61	39.1 ± 0.9	2060.4 ± 99.3	309.4 ± 9.8	426.0 ± 15.0
Dam's parity					
1	187	39.4 ± 0.6	2098.5 ± 70.3	325.4 ± 5.8	454·0 ± 8.6
2	152	39.7 ± 0.6	2008.4 ± 72.4	318.9 ± 6.1	460.5 ± 9.2
3	123	39.3 ± 0.7	2137.8 ± 76.9	326.1 ± 6.8	458.8 ± 10.2
4	74	39.5 ± 0.8	1999.5 ± 88.7	299.7 ± 8.4	428.2 ± 12.8
5	70	39.2 ± 0.8	1984.0 ± 90.0	309.4 ± 8.6	445.3 ± 13.1
6	47	39.4 ± 0.9	1992.5 ± 104.7	319.7 ± 10.5	440.7 ± 16.1
7	42	40.6 ± 1.0	1918.7 ± 108.2	319.6 ± 10.9	453.6 ± 16.8
8	23	38.9 ± 1.3	2014.1 ± 139.5	305.6 ± 14.7	420.3 ± 22.8
9	20	37.9 ± 1.3	1849.2 ± 145.1	299.2 ± 15.4	432.0 ± 23.9
10	8	35.5 ± 2.1	1990.3 ± 220.1	288.8 ± 24.1	428.1 ± 37.6
11	7	39.9 ± 2.3	2129.8 ± 243.6	372.3 ± 26.8	494.7 ± 41·8

Table 2. Analysis of variance for economic traits in Tharparkar cows

Sources of variation	d.f.	Mean sum of squares			
		Age at first calving	305-day lactation yield	Days in lactation	Calving interval
Period of calving	3	4241.74**	26009868.18**	141117.21**	22877.45
Sires within periods	69	48.74**	680487.49**	4676.54	10097.33
Months of calving	11	64.86**	441989.30	5867.01	11808.17
Dams' parity	10	23.86	331817.69	7543.78	9602.55
Error	659	30.25	342414.87	4324.87	10526.32

*$P < 0.05$; **$P < 0.01$.

Table 3. Estimates of correlations and heritability in Tharparkar cows

Parameters	Correlations			Heritability
	Phenotypic	Genetic	Environmental	
305-day milk yield with				0.372 ± 0.117
(i) Lactation length	0.506	0.561 ± 0.579	0.598	
(ii) Age at first calving	0.025	−0.430 ± 0.271	0.302	
(iii) Calving interval	0.254	0.0	0.0	
Lactation length with				0.034 ± 0.076
(i) Age at first calving	0.079	−0.381 ± 0.792	0.149	
(ii) Calving interval	0.472	0.0	0.0	
Calving interval with				0·0
(i) Age at first calving	0.117	0.0	0.0	0·239 ± 0.102

these two traits could be improved through mass selection. The lactation length and calving interval had heritability estimate of 0.034 and 0, respectively, indicating that these would respond to the choice of better management practices.

Phenotypic and environmental correlations indicated strong association between milk yield and lactation length. However, the genetic correlation was very low, indicating that this relationship was entirely due to environmental causes. The genetic relationship between age at first calving and milk yield was moderate and negative while environmental correlation was positive. This probably resulted in very low phenotypic correlation. The negative genetic correlation between milk yield and age at first calving will aid the improvement of milk yield by placing negative emphasis on high age at first calving. Lactation length and age at first calving had negative genetic correlation of -0.38 ± 0.79, while the environmental and phenotypic correlations were low. The phenotypic correlation between lactation length and calving interval was 0.472, while the genetic and environmental correlations were zero.

The results from various selection models involving single trait and index, using the parameter estimates from this study, are detailed in Tables 4 and 5. The expected changes have been calculated assuming a selection differential of one standard deviation. Of interest is the fact that selection for milk yield would result in correlated change in lactation length which is more than direct selection for the trait. Similarly the correlated change in lactation length on account of selection for age at first calving was slightly higher than the direct selection for lactation length. However, it may be mentioned that the lactation length in this herd was 315 days. Hence, further increase in lactation length would not be desirable, though the increase may be unavoidable because of positive genetic correlation between milk yield and lactation length unless a restriction is put. The direct selection for milk yield would result in moderate decline in age at first calving. Similarly, direct selection for age at first calving would bring in increase in milk yield which was much lower than that obtained by direct selection. The estimates of heritability for calving interval being zero, no changes on account of direct or indirect selection would be expected. The results on the whole suggested that single-trait selection for milk yield alone will be effective to improve simultaneously milk yield and age at first calving. Increase in lactation length in this population will not be desirable because of positive phenotypic correlation between lactation length and calving interval.

Response on account of index selection was also computed. Two indexes were constructed, one considering milk yield and age at first calving, and the second milk yield, age at first calving and lacta-

Table 4. Direct and collateral responses from single trait selection based on a selection differential of one standard deviation

Trait selected	Response in			
	Milk yield (kg)	Age at 1st calving (month)	Lactation (days)	Calving interval (days)
Milk yield	**255.19**	—0.71	4.17	0
Age at 1st calving	87.93	**—1.32**	2.27	0
Lactation length	43.26	—0.19	**2.25**	0
Calving interval	0	0	0	0

Diagonal elements are direct responses.

Table 5. Expected genetic gain ($\triangle$G) from index selection based on a selection differential of one standard deviation in index values

Traits selected	Values of $\triangle$G	
	I_1	I_2
Milk yield (kg)	243.93	257.74
Age at 1st calving (months)	—1.1674	—1.1429
Lactation length (days)	—	4.3746

Index		RIH
I_1 = 0.3783 (milk)	—15.3901 (AFC)	0.65
I_2 = 0.4667 (milk)	—14.8044 (AFC)— 1.4627 (LL)	0.69

tion length (Table 5). The second index (I_2) had slightly higher R_{IH} value (0.69) and resulted in slightly more milk yield and lower age at first calving than the first index (I_1). The second index (I_2) would give an expected genetic change of 257.74 kg as against 255.19 kg from direct selection for milk yield. Thus compared to single trait selection (Table 4), index I_2 was more effective in improving the net genotypic worth of the animals by increasing slightly more milk yield and decreasing the age at first calving.

REFERENCES

AMBLE, V. N., KRISHNAN, K. S. and SONI, P. N. 1958. Age at first calving and calving interval for some Indian herds of cattle. *Indian J. vet. Sci.* **28** : 83–92.

DASS, S. K., BHATNAGAR, D. S. and GURNANI, M. 1971. Relative importance of the factors affecting milk production in Tharparkar cattle. *Indian vet. J.* **48** : 1241–48.

FALCONER, D. S. 1960. *Introduction to Quantitative Genetics*. Longman, London.

GURNANI, M., BHATNAGAR, D. S. and SUNDARESAN, D. 1976. Estimates of heritability, genetic and phenotypic correlation coefficients among traits in Tharparkar and Sahiwal cows. *Indian J. Dairy Sci.* **29** : 233–35.

HARVEY, W. R. 1966. *Least-squares Analysis of Data With Unequal Subclass Numbers*. pp. 156.ARS, U.S.D.A.

NAGPAL, P. K. and BHATNAGAR, D. S. 1971. Age at first calving affecting milk production in Tharparkar cattle. *Indian vet. J.* **48** : 44–49.

SHARMA, R. C., DUTT, M. and TOMER, S. P. S. 1972. Role of seasonal variations on some economic traits of Tharparkar herd of Uttar Pradesh. *Indian vet. J.* **49** : 256–62.

SINGH, O. N. 1957. Age at first calving and its relation to calving interval in dairy cattle. *Indian J. Dairy Sci.* **10** : 63–66.

SINGH, O. N., PRASAD, R. B. and SINGH, R. N. 1962. Seasonal distribution of calving and its influence on milk yield in dairy cattle. *Indian J. Dairy Sci.* **15** : 56–60.

TANEJA, V. K. 1974. Comparative study of various economic traits in indigenous dairy breeds. *JNKVV Res. J.* **8** : 68–69.