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PHENOTYPIC AND GENETIC CORRELATIONS BETWEEN FIRST LACTATION MILK YIELD AND SOME PERFORMANCE TRAITS IN SAHIWAL CATTLE

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ABSTRACT

Data on 8948 pedigree, breeding and performance records of a purebred herd of Sahiwal cattle maintained at the Livestock Experiment Station Jahangirabad district Khanewal (Pakistan) during the period 1939-98 were analysed. The phenotypic, genetic and residual correlations between first lactation milk yield and some first lactation and lifetime traits were estimated, using Bivariate REML analysis. Phenotypic, genetic and residual correlations between first lactation milk yield and age at first calving were 0.67, 0.61 ± 0.30 and 0.73; between first lactation milk yield and first lactation length were 0.35, 0.48 ± 0.38 and 0.31; between first lactation milk yield and first calving interval were 0.39, 0.46 ± 0.46 and 0.39; between first lactation milk yield and first dry period were 0.35, 0.49 ± 0.46 and 0.30; between first lactation milk yield and lifetime milk yield were 0.02, 0.01 ± 0.77 and 0.05. Positive and high genetic correlation between first lactation milk yield and age at first calving indicated that the selection for higher first lactation milk yield would increase the age at first calving, which is not advantageous.

Key words: First lactation; milk yield; genetic and phenotypic correlations; Sahiwal cattle.

INTRODUCTION

The genetic composition of a population can be studied by considering the relative importance of heredity and environmental factors affecting the performance of individuals in that population (Falconer and Mackay, 1997). The estimates of genetic parameter are helpful in determining the method of selection to predict direct and correlated response to selection, choosing a breeding system to be adopted for future improvement as well as in the estimation of genetic gains. If genetic correlation between the two traits is high, the selection for one trait would result in an improvement/deterioration for the other trait as a correlated response. The phenotypic correlation is an expression of observed relationship between the phenotypic performance of different traits while the degree of association between genes responsible for the additive variance of different traits is measured through genetic correlation. The genetic correlations give the information that genes affecting one trait also affect the other traits. The effectiveness of selection and net genetic progress can be measured when selection is made for more than one trait.

The present investigation was made to explore the phenotypic and genetic correlations between first lactation milk yield and some other first lactation and lifetime traits in Sahiwal cattle. It is envisaged that this information will be useful for the formulation of future breeding strategy for the genetic improvement of Sahiwal cattle in Pakistan and elsewhere.

MATERIALS AND METHODS

Data on 8948 pedigree, breeding and performance records of a purebred Sahiwal herd maintained at the Livestock Experiment Station Jahangirabad, Khanewal (Pakistan) during the period 1939-98 were utilised for the present study. The data on first lactation traits (age at first calving, milk yield, lactation length, calving interval and dry period) and lifetime milk yield were analysed to estimate the phenotypic, genetic and residual correlations between first lactation milk yield and age at first calving; first lactation milk yield and first lactation length; first lactation milk yield and first calving interval; first lactation milk yield and first dry period; and first lactation milk yield and lifetime milk yield. The data were edited as far as the accuracy and reliability of records were concerned for pedigree information. Various edit criteria applied were the same as reported elsewhere (Javed *et al.,* 2002)

The performance traits were analysed statistically for the estimation of genetic and phenotypic correlations between various performance traits. For

this purpose, bivariate analysis was carried out using Restricted Maximum Likelihood (REML) procedure with an Individual Animal Model. The fixed effects for various performance traits in this analysis were the same as considered in the univariate analysis (Javed *et al.*, 2001: Javed *et al.*, 2002a).

The various parameters estimated from the bivariate analysis were:

Phenotypic correlation (r_P) = $Cov_{Pi, Pj} / \sigma_{Pi,} \sigma_{Pj}$

Genetic correlation (r_G) = $Cov_{Ai, Aj} / \sigma_{Ai,} \sigma_{Aj}$

Residual correlation (r_R) = $Cov_{Ri, Rj} / \sigma_{Ri,} \sigma_{Rj}$

where,

σ^2_{Ai} = additive genetic variance for the ith trait

σ^2_{Pi} = phenotypic variance for ith trait

σ^2_{Ri} = residual variance for the ith trait

$Cov_{Pi, Pj}$ = phenotypic covariance for the traits i and j

$Cov_{Ai, Aj}$ = additive genetic covariance for the traits i and j

$Cov_{Ri, Rj}$ = residual covariance for the traits i and j

All these analyses were performed using Derivative Free Restricted Maximum Likelihood (DFREML) set of computer programmes (Meyer, 1997). The approximate standard errors of the genetic correlations were calculated after Falconer and Mackay (1997).

RESULTS AND DISCUSSION

First lactation milk yield and age at first calving

The phenotypic, genetic and residual correlations between first lactation milk yield and age at first calving were 0.67, 0.61 ± 0.30 and 0.73, respectively. The phenotypic correlation (0.67) as obtained in the present study was positive and high. These findings are in agreement with those of Singh and Raut, (1982) who found high and positive phenotypic correlation between age at first calving and first lactation milk yield in Gir cattle. However, Ali *et al.* (1992) and Khan *et al.* (1999) reported positive, but non-significant estimates of phenotypic correlation between the two traits (0.018 and 0.03) in Sahiwal cattle. The genetic correlation (0.61 ± 0.30) between first lactation milk yield and age at first calving as obtained in the present study was positive and high. These findings are similar to the finding (0.77) as reported by Bhatnagar *et al.* (1983) in Indian Sahiwals. However, Khan *et al.* (1999) analysed data on Sahiwal cattle and reported a negative genetic correlation (-0.12 ± 0.14) between the two traits. In a recent study, Ahmad *et al.* (2001) also reported a negative (-0.26) phenotypic and high (0.63) genetic correlation between age at first calving and lactation milk yield after analysing a combined data set on Pakistani Sahiwals and their crosses with Friesian and Jersey cattle.

High phenotypic and genetic correlations between first lactation milk yield and age at first calving found in our study indicated that the two traits are controlled fairly by the same genes and selection for high first lactation milk yield will increase the age of the cow at first calving that is not advantageous for economical dairy production. A reduction in age at first calving can be achieved through better feeding, management, disease control and efficient heat detection and timely service programme.

First lactation milk yield and first lactation length

The phenotypic, genetic and residual correlations between first lactation milk yield and first lactation length were 0.35, 0.48±0.38 and 0.31, respectively. The present estimate of phenotypic correlation between the two traits is comparable to the estimates reported by Singh and Raut (1982), who reported phenotypic correlation between the two traits as 0.40 in Indian village cows. However, Samoilo (1978) reported higher estimate of phenotypic correlation (0.66) in dairy cattle.

The present estimate for genetic correlation between first lactation milk yield and first lactation length (0.48 ± 0.38) is higher than that reported by Tomar and Singh (1981), who reported the genetic correlation between the two traits as 0.16 in Sahiwal cattle. However, Khan (1987) reported higher estimate of genetic correlation (0.78) between the two traits in Holstein Friesian cows in Pakistan. In a recent study, Ahmad *et al.* (2001) reported bivariate estimates of phenotypic and genetic correlation between the traits under study as 0.74 and 0.91 in Sahiwal and their crossbreds with Friesian and Jersey cattle. The same authors performed multivariate analysis of the same data set (including lactation milk yield, 305 day milk yield, lactation length and milk yield per day of calving interval) and reported that the genetic correlation between the two traits improved to 0.98. These differences in estimates may be due to lactation, data set or method of estimation. The genetic correlation of 0.48 indicated the plieotropic effect of the genes on the two traits. It also suggested that lactation length would be increased as a correlated response to selection for milk production. However, lactation length more than 10 month duration would not be advantageous for economical livestock production (Javed *et al.*, 2000).

First lactation milk yield and first calving interval

The phenotypic correlation between first lactation milk yield and first calving interval was estimated to be 0.39 in the present investigation. These findings are substantiated by those of Mantysaari and Van Vleck

(1989), who reported a phenotypic correlation of 0.30 between the two traits in Holstein cattle. However, Dong and Van Vleck (1989) reported slightly lower estimate of phenotypic correlation (0.27) between the two traits after analysing 585,830 records on Holstein cows.

The genetic correlation between first lactation milk yield and first calving interval was 0.46 ± 0.46 as obtained in the present study. It indicated that the two traits were under the influence of almost the same genes. In other words, selection for improvement in first lactation milk yield will cause prolonged calving intervals which is undesirable for economical livestock production. These findings are substantiated by Mantysaari and Van Vleck (1989) and Khan *et al.* (1999). However, Sharma *et al.* (1982) reported negative genetic correlation between the two traits in Sahiwal cattle. Ahmad *et al.* (2001) also reported a negative genetic correlation (-0.56) with standard error above unity and phenotypic correlation as 0.28 after analysing a combined data set on Sahiwal cows and their crossbreds in Pakistan. The genetic correlations are strongly influenced by gene frequencies (Bohren *et al.*, 1966), hence these differences may be attributed to the genetic make up of different populations.

First lactation milk yield and first dry period

The phenotypic, genetic and residual correlations between first lactation milk yield and first dry period obtained in the present study were 0.35, 0.49 ± 0.46 and 0.30, respectively. The estimate of genetic correlation obtained in the present investigation is not in line with the findings of Katoch and Yadav (1990), who reported genetic correlation of 0.75 ± 0.67 between the two traits in Jersey cattle. This difference may be due to breed, lactation and data set differences. The present findings indicated that selection for higher milk yield would cause longer dry period as a correlated response, which is not advantageous.

First lactation milk yield and lifetime milk yield

The phenotypic, genetic and residual correlations between first lactation milk yield and lifetime milk yield were 0.02, 0.01 ± 0.77 and 0.05, respectively. High standard error of the present estimate of genetic correlation indicated the low precision of the estimate. These findings are not in line with other studies. Bhatia (1980) studied records of 816 Sahiwal cows, the progeny of 77 sires in seven herds and found genetic correlation of lifetime milk yield and first lactation milk yield as 0.96. Gandhi and Gurnani (1988) and Hussain (1988) reported genetic correlation between the two traits as 0.81 and 0.73 in Indian and Pakistani Sahiwals, respectively.

To investigate the argument that animals having a lifetime milk yield records have been subjected to some culling on the basis of their first lactation milk yield records, thus creating a bias in the genetic parameter estimates, the phenotypic selection differential (Falconer and Mackay, 1997) was calculated for first lactation milk yield. From the selection differential, the culling rate appeared to be very low (around 1%). It was also observed that in this herd of Sahiwal cows, selection of the animals was mainly done on the basis of colour pattern, type and conformation of the individuals. Selection on the basis of merit for first lactation milk yield i.e. truncation selection in its true sense has not been practised. Thus, it is very difficult to exactly quantify the effects of selection, if any, exerted on the basis of first lactation milk yield (Javed *et al.*, 2002).

CONCLUSION

The genetic correlations between first lactation milk yield and other traits were generally on higher side, suggesting that all the traits were fairly controlled by similar genes. A positive and high genetic correlation between first lactation milk yield and age at first calving indicated that selection for higher first lactation milk yield will increase the age at first calving which is not advantageous. Similarly, selection for first lactation milk yield will also prolong the calving intervals as a correlated response which is not desirable for economical dairy production. A reduction in age at first calving and calving interval can be achieved through better feeding, management, disease control and efficient heat detection and timely service programme.

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