Genetic Studies on Production Efficiency Traits in Hariana Cattle

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ABSTRACT : The data on 512 Hariana cows, progeny of 20 sires calved during period from 1974 to 1993 maintained at Government Livestock Farm, Hisar were considered for the estimation of genetic parameters. The means for first lactation milk yield (FLY), wet average (WA), first lactation peak yield (FPY), first lactation milk yield per day of first calving interval (MCI) and first lactation milk yield per day of age at second calving (MSC) were 1,141.58 kg, 4.19 kg/day, 6.24 kg/day, 2.38 kg/day and 0.601 kg/day, respectively. The effect of period of calving was significant ($p < 0.05$) on WA, FPY and MCI while the effect of season of calving was significant only on WA. Monsoon calvers excelled in performance for all the production efficiency traits. The effect of age at first calving (linear) was significant on all the traits except on MCI. Estimates of heritabilty for all the traits were moderate and ranged from 0.255 to 0.333 except for WA (0.161). All the genetic and phenotypic correlations among different production efficiency traits were high and positive. It may be inferred that selection on the basis of peak yield will be more effective as the trait is expressed early in life and had reasonably moderate estimate of heritability. *(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 4 : 466-469)*

INTRODUCTION

High production efficiency in livestock production is an economically desirable attribute that targets ultimately for genetic up gradation. In fact, the economy of dairy industry mainly rely upon the performance parameters of dairy animals, therefore, it becomes more relevant to tackle out the means for ameliorating the performance efficiencies by developing certain guidelines for selection. Indeed, the knowledge of genetic variability with respect to each trait and co-variability existing among different traits are a beacon light for planning appropriate selection and breeding strategies for the genetic improvement of dairy animals. Therefore the present investigation was planned with a view to study the genetic variation in production efficiency traits in Hariana cattle.

MATERIALS AND METHODS

In order to achieve the objective, the data pertinent to first lactation production efficiency traits on 512 Hariana cows calving from 1974 to 1993, progeny of 20 sires maintained at Government Livestock Farm, Hisar were considered. The duration of 20 years was divided into 4 periods of five years each. The three seasons were delineated as winter (November-February), summer (March-June) and monsoon (July-October) on the basis of geo-climatic conditions prevailing in the region. The production efficiency traits recorded were: first lactation milk yield (FLY); wet average (WA)=first lactation milk yield (FLY)/first lactation length (FLL); first lactation peak

yield (FPY); first lactation milk yield per day of first calving interval (MCI)=first lactation milk yield (FLY)/first calving interval (FCI) and first lactation milk yield per day of age at second calving (MSC)=first lactation milk yield (FLY)/age at second calving (ASC=age at first calving+first calving interval). Sires with at least five progenies were considered for this study. Records of cows with some specific or non-specific diseases, reproductive disorder and physical injury were excluded from the present investigation. The least-squares solutions were obtained using the model given below:

$$Y_{ijkl}=\mu+S_i+H_j+C_k+b_1 (X_{ijkl}-\overline{X})+b_2 (X_{ijkl}-\overline{X})^2+e_{ijkl}$$

Where: Y_{ijkl}=is the lth record of individual of ith sire in jth period and kth season; μ=is the overall population mean; S_i = is the fixed effect of ith sire; H_j=is the fixed effect of jth period of calving (first period=1974-78, second period =1979-83, third period=1984-88 and fourth period=1989-93); C_k=is the fixed effect of kth season of calving; b_1 and b_2 are linear and quadratic regression coefficients, respectively of age at first calving on MY/SC; X_{ijkl}=is the age at first calving; X bar=is the mean for age at first calving; and e_{ijkl}=is the random error associated with each observation and assumed to be normally and independently distributed with mean zero and variance $\sigma_e 2$.

The least-squares and maximum likelihood computer program of Harvey (1987) was used to estimate the effect of various tangible factors on different production efficiency traits. Duncan's multiple range test as modified by Kramer (1957) was employed for making all possible pairwise comparison of means. Heritability estimates for different efficiency traits were obtained by the paternal half-sib correlation method. The standard errors of heritability estimates were obtained by using formula given by Sweger et al. (1964). Genetic correlations among different traits

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were calculated from sire components of variances and covariances. The standard error of genetic correlation was estimated by using the formula given by Robertson (1959). Phenotypic correlations among various traits were calculated from variance-covariance analysis. The standard error of phenotypic correlation was computed using the formula given by Snedecor and Cochran (1968).

RESULT AND DISCUSSION

The least-squares constant and their standard errors for production efficiency traits presented in table 2 indicated that the means for FLY, WA, FPY, MCI and MSC averaged as 1141.58 kg, 4.19 kg/day, 6.24 kg/day, 2.38 kg/day and 0.601 kg/day, respectively. Similar results for averages of production efficiency traits are also available in the literature (Rana, 1985; Pundir and Raheja, 1994). However, Ashraf et al. (2000) reported 1495.00 kg and 5.25 kg/day as averages for lactation yield and daily milk yield,

respectively in Local × Hariana crossbred cattle.

The least-squares analysis of variance depicted in table 1 showed that the effect of sire was non-significant on all the traits under study. The effect of period of calving was statistically significant ($p < 0.05$) on WA, FPY and MCI while the effect of season of calving was significant only on WA. Critical review of table 2 revealed that the performance of all the production efficiency traits was the lowest for the first period calvers (1974-78) while the performance of fourth period calvers was the highest for FLY and MSC. Moreover, the means for WA, FPY and MCI excelled in performance for third period calvers which did not differ significantly from those calved during fourth period. In general an increasing trend was observed for all the production efficiency traits with the increase in period of calving from first towards fourth barring few exceptions which were non-significant.

The effect of season of calving was significant only on wet average. Monsoon season calvers (July-Oct.) performed

Table 1. Character-wise least-squares analysis of variance in Hariana cattle

Source	D.F.	Mean souares				
		FLY	WA	FPY	MCI	MSC
Sire	19	348745.08	1.84	5.88	1.72	0.096
Period	3	284522.34	3.96*	12.32*	2.49*	0.024
Season	2	326108.19	4.25*	1.01	0.68	0.067
Regressions						
AFC (Linear)	1	942402.53*	8.70*	13.32*	2.09	0.508*
AFC (Quadratic)	1	14339.54	0.32	5.12	0.68	0.056
Remainder	485	142138.74	0.97	2.19	0.59	0.039

* ($p < 0.01$)

D.F.=Degree of freedom, FLY=First lactation milk yield, WA=Wet average, FPY=First lactation peak yield, MCI=First lactation milk yield per day of first calving interval, MSC=First lactation milk yield per day of age at second calving.

Table 2. Least-squares means and their standard errors for first lactation milk yield (kg)

Ind. Variable	Obs.	FLY Mean±SE	WA Mean±SE	FPY Mean±SE	MCI Mean±SE	MSC Mean±SE
Overall	512	1141.58±57.45	4.19±0.13	6.24±0.24	2.38±0.13	0.601±0.030
Periods						
1974-78	53	989.84±90.22	3.98[b]±0.22	5.98[b]±0.36	2.01[b]±0.19	0.571±0.047
1979-83	142	1176.15±69.71	4.14[ab]±0.16	6.07[ab]±0.29	2.29[ab]±0.15	0.579±0.037
1984-88	172	1187.69±67.62	4.52[a]±0.16	6.82[a]±0.28	2.64[a]±0.15	0.622±0.035
1989-93	145	1212.63±81.28	4.10[ab]±0.19	6.09[ab]±0.33	2.58[a]±0.18	0.630±0.043
Seasons						
Winter	305	1082.09±56.77	4.03[b]±0.14	6.26±0.24	2.31±0.13	0.574±0.030
Summer	168	1146.81±60.64	3.99[b]±0.13	6.13±0.25	2.31±0.14	0.594±0.032
Monsoon	39	1195.83±81.66	4.52[a]±0.19	6.32±0.33	2.52±0.18	0.635±0.043
Regressions						
AFC (Linear)		0.2654±0.1031	0.00081±0.00027	0.0010±0.0004	0.00040±0.00021	-0.00019±0.00005
AFC (Quadratic)		0.0001±0.0003	0.00000±0.0000	0.0000±0.000	0.00000±0.0000	0.00000±0.0000

[a,b] Means superscripted by different letters differ significantly among themselves.

Table 3. Heritabilty, genetic and phenotypic correlations among various efficiency traits

Traits	FLY	WA	FPY	MCI	MSC
FLY	0.255±0.123	0.735±0.030*	0.748±0.029*	0.755±0.029*	0.823±0.025*
WA	0.762±0.190	0.161±0.099	0.799±0.027*	0.793±0.027*	0.727±0.030*
FPY	0.855±0.104	0.940±0.090	0.294±0.132	0.774±0.028*	0.715±0.031*
MCI	0.854±0.114	0.982±0.078	0.874±0.151	0.333±0.141	0.808±0.026*
MSC	0.897±0.088	0.913±0.121	0.861±0.178	0.963±0.055	0.258±0.123

* $p < 0.05$.
FLY=First lactation milk yield, WA=Wet average, FPY=First lactation peak yield, MCI =First lactation milk yield per day of first calving interval, MSC=First lactation milk yield per day of age at second calving, Diagonal=Heritabilty, Above the diagonal=Phenotypic correlations, Below the diagonal=Genetic correlations

better in terms of the production efficiency traits while the performance of winter calvers was the worst except for summer calvers in case of WA that too did not differ significantly from those calved during winter season. The better performance of monsoon calvers might be attributed to availability of green fodder in monsoon season as well as in the subsequent winter season.

The effect of age at first calving (linear) was statistically significant ($p < 0.05$) for all the traits except MCI while the effect of AFC (quadratic) was non-significant on all the traits. The regression of AFC on FLY, WA, FPY and MCI was positive indicating that with unit increase in AFC there would be corresponding increase in the trait(s). Negative and significant regression of AFC on MSC indicated that increase in AFC by one day would decrease the milk yield per day of age at second calving by 0.20 grams per day.

Heritabilty estimates: The moderate estimates of heritability obtained for FLY, FPY, MCI and MSC were 0.255, 0.294, 0.33 and 0.258, respectively (table 3). The heritabilty estimate for wet average was low (0.161). These estimates indicated that these characters are controlled by factors other than additive gene action. These low to moderate estimates of heritabilty for these production efficiency traits revealed that there are limiting scope for improvement in these traits through individual selection and it requires information from other relatives and improvement in managemental practices to improve these traits. Singh (1994) and Katkade et al. (1995) also reported similar results for heritabilty estimates of MCI and MSC, respectively.

Genetic correlations: All the production efficiency traits had high positive genetic correlations among themselves ranged from 0.762 (FLY×WA) to 0.982 (WA×MCI). High genetic correlations have also been reported by Yadav (1988) and Dutt and Taneja (1994) among production efficiency traits in Hariana breed of cattle and Murrah buffaloes, respectively. High genetic correlations among FLY and the other efficiency traits are obvious because the latter are derived from FLY i.e. all the efficiency traits have FLY as numerator. High genetic correlations among these traits indicate simultaneous improvement in other traits

while selecting anyone of them.

Phenotypic correlations: The phenotypic correlations among all the production efficiency traits were on the lower side as compared to genetic correlations except for phenotypic correlation between FLY and WA. Phenotypic correlations among all the production efficiency traits were high, positive and significant ranging from 0.715 to 0.823 suggesting that they are governed by similar set of genes i.e. they are the result of pleiotropic action of genes. Hence selection for any one of the trait(s) will result into the improvement of the other traits with correlated response.

From these results it may be concluded that the peak yield can be measured earlier than the first lactation yield and had moderate estimate of heritability and high genetic correlations with all efficiency traits. Thus selection on the basis of peak yield will reduce the generation interval considerably and hence the genetic gain per unit of time will be reduced. This genetic gain will also be reflected in the other traits through correlated response.

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