Journal of Livestock Biodiversity

Genetic parameters of lifetime traits in Hariana cattle

S. Singh[1], Z.S. Rana[2], S.S Dhaka[3] and B.L. Pander[4]
CCS Haryana Agricultural University, Hisar, Haryana - 125004 India

ABSTRACT

The data pertaining to lifetime traits of 762 Hariana cows born to 23 sires and spread over a period of 35 years (1966 to 2000) maintained at Government Livestock Farm, Hisar were considered for the estimation of genetic parameters. The least square means for number of lactations completed (NLC), herd life (HL), lifetime milk yield (LTMY), productive life (PL), milk yield per day of productive life (MYPDPL) and milk yield per day of herd life (MYPDHL) were obtained as 5.15±0.43, 2260.14±152.24 days, 6420.29±524.21 kg, 1284.54±94.42 days, 4.49±0.17 kg/day and 2.58±0.13 kg/day, respectively. The effects of period and season of calving and age at first calving were statistically non-significant on all the lifetime traits under study. However, autumn season calvers excelled in performance while the least square means for NLC, PL and MYPDHL were the lowest for the rainy season calvers and for the rest of lifetime traits; it was the lowest for summer calvers. All the lifetime traits had low estimates of heritabilities, ranging from 0.070 to 0.192, except the heritability estimates for MYPDPL, which was moderate. All the lifetime traits had high, positive genetic and phenotypic correlations among themselves, which ranged from 0.906 to 0.990 and 0.373 to 0.938, respectively. It may be inferred that the selection on the basis of MYPDPL will help in the improvement of other traits through correlated response.

Keywords: Heritability, correlations, cifetime traits, Hariana breed

INTRODUCTION

The overall productivity of dairy animals depends on their lifetime performance rather than on a single lactation performance. Lifetime performance of the dairy livestock is critical for determination of the profitability of dairy enterprise. Opinions expressed at scientific discussions in the recent past indicate the need for present selection methods to be better oriented towards improving the lifetime performance. The ability to produce and reproduce for many years is a desireable trait in dairy cattle since it takes 3-4 years of production for a cow to repay her cost of rearing, a long productive life is financially beneficial and also allows the genetically superior animals to leave more offspring. In fact, the economy of dairy industry mainly relies upon the performance parameters of dairy animals. Therefore, it becomes more relevant to tackle out the means for ameliorating the performance deficiencies 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 lifetime traits in Hariana cattle.

MATERIAL AND METHODS

In order to achieve the objective, the data pertinent to lifetime traits on 762 Hariana cows born to 23 sires and spread over a period of 35 years from 1966 to 2000, maintained at government livestock farm, Hisar were utilised. The duration of 35 years was divided into 7 equal periods of five years each. The four seasons were delineated as summer (April-June), rainy (July-September), autumn (October-November) and winter (December-March) on the basis of geo-climatic conditions prevailing in the region. The lifetime traits recorded were: number of lactations completed (NLC), herd life (HL), lifetime milk yield (LTMY), productive life (PL), milk yield per day of productive life (MYPDPL) and milk yield per day of herd life (MYPDHL). Herd life (HL) was defined as the total number of days from the date of first calving to the date of disposal/death from/in the herd. LTMY is the total amount of milk produced by a cow from initiation of first lactation till last day in milk in the herd. PL is the total number of days in milk from date of first calving to date of disposal or the last dry date if the cow remained in the herd. MYPDPL was measured as lifetime milk yield divided by the productive life. MYPDHL was measured as lifetime milk yield divided by the herd life. 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:

Present address: [1] Scientist, KVK Sangaria (Hanumangarh); [2] Ex Professor & Head Animal Breeding; [3]Scientist; [4]Senior Scientist, Department of Animal Breeding, College of Animal Science.
Phone: 0091-1662-289262(Off.); 0091-9466449957 (Resi.), Fax:0091-1662-239452, E-mail: zuludhaka@gmail.in

$$Y_{ijkl} = \mu + S_i + P_j + SE_k + b\,(A_{ijkl} - \bar{A}) + e_{ijkl}$$

Where: Y_{ijkl} = is the l^{th} record of individual of i^{th} sire in j^{th} period and k^{th} season;
μ = is the overall population mean;
S_i = is the random effect of i^{th} sire;
P_j = is the fixed effect of j^{th} period of calving (first period = 1966 – 70, second period = 1971 – 75, third period = 1976 – 80, fourth period = 1981 – 85, fifth period = 1986 – 90, sixth period = 1991 – 95 and seventh period = 1996 - 2000);
SE_k = is the fixed effect of k^{th} season of calving;
b =is linear regression coefficients of age at first calving (AFC) on the trait (s);
A_{ijkl} = is the age at first calving;
$\bar{A}$ = 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 σ_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 lifetime traits. Duncan's multiple range test as modified by Kramer (1957) was employed for making all possible pair wise comparison of means. Heritability estimates for different lifetime traits were obtained by the paternal half-sib correlation method. The standard errors of heritability estimates were obtained by using formula given by Swiger *et al.* (1964). Genetic correlations among different traits 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).

RESULTS AND DISCUSSION

The least-squares means and their standard errors for lifetime traits, presented in Table 2, indicated that the means for NLC, HL, LTMY, PL, MYPDPL and MYPDHL were 5.15±0.43, 2260.14±152.24 days, 6420.29±524.21 kg, 1284.54±94.42 days, 4.49±0.17 kg/day and 2.58±0.13 kg/day, respectively. The present estimates are in line with those obtained by Kumar *et al.* (1997) for NLC in crossbred cattle; Singh *et al.* (1988), Kumar and Reddy (1989), Raheja (1994) for HL; Kumar and Reddy (1989) for PL; Thakur (1997) and Singh and Nivsarkar (1998) for MYPDPL in Jersey and Hariana cattle, respectively. However, reports for higher and lower than these estimates of lifetime traits are also available in literature (Ganpule and Desai, 1983; Reddy and Nagarcenkar, 1988; Jadhav *et al.*, 1994; Kaushik *et al.*, 1994).

Table 1.Analysis of variance for lifetime traits

Source	df	Mean squares					
		NLC	HL	LTMY	PL	MYPDPL	MYPDHL
Sire	22	3.240 1	723690.765	12400389.562	309156.069	0.767	0.429
Period	5	8.333	1247535.548	26906010.779	665753.669	1.189	1.089
Season	3	2.148	475996.105	2438455.134	322507.519	1.292	0.137
Regression AFC	1	9.121	78788.042	12805313.525	123445.248	1.211	1.283
Error	730	4.239	777951.082	12164893.723	330948.742	0.469	0.338

df = degree of freedom

The least squares analysis of variance, depicted in Table 1, showed that the effect of period and season of calving and age at first calving was statistically non-significant on all the lifetime traits under study. Non-significant effect of period and season of calving on HL, LTMY and PL have also been reported by Singh *et al.* (2002). Period wise least squares means for lifetime traits, depicted in table 2, revealed that first period calvers (1966-1970) excelled in performance for the entire traits under study except for

Table 2. Least square means with standard error (SE) across various non-genetic factors for different lifetime traits

Effect	No. of obs.	NLC	HL (days)	LTMY (kg)	PL (Days)	MYPDPL	YPDHL
Overall	762	5.15±0.43	2260.14±152.24	6420.29±524.21	1284.54±94.42	4.49±0.17	2.58±0.13
Period							
1	7	7.05±1.60	3159.10±719.51	7985.04±2481.37	1732.58±447.32	4.38±0.56	2.48±0.46
2	67	5.96±0.82	2751.39±339.63	8804.61±1170.98	1526.13±211. 06	5.23±0.29	2.80±0.23
3	99	5.86±0.59	2605.28±230.52	7586.07±794.49	1418.36±143.17	4.94±0.21	2.66±0.17
4	177	5.80±0.55	2373.58±209.59	7448.83±722.28	1432.01±130.15	4.76±0.20	2.93±0.16
5	151	4.89±0.59	2106.65±233.29	5917.91±804.07	1245.74±144.90	4.29±0.22	2.53±0.17
6	184	3.95±0.63	1710.69±250.74	4340.21±864.28	985.76±155.76	4.08±0.22	2.39±0.18
7	77	2.51±0.76	1114.28±311.55	2859.37±1074.11	651.18±193.59	3.76±0.27	2.28±0.22
Season							
Summer	158	4.96±0.46	2205.36±167.55	6100.82±576.56	1265.62±103.86	4.33±0.17	2.52±0.14
Rainy	46	4.90±0.59	2246.07±230.46	6140.24±794.28	1203.13±143.13	4.53±0.21	2.44±0.17
Autumn	47	5.61±0.59	2402.03±230.35	7129.85±793.92	1383.73±143.07	4.66±0.21	2.70±0.17
Winter	511	5.12±0.42	2187.08±146.31	6310.25±503.72	1285.67±90.72	4.46±0.16	2.66±0.13
Regressn AFC		-0.0008±0.0003	0.27±0.27	1.57±0.94	0.1852±0.17	0.0004±0.007	0.0005±0.007

LTMY, MYPDPL and MYPDHL and these performances were the lowest for the seventh period calvers (1996-2000). Although, period wise means for lifetime traits did not differ significantly among themselves yet a declining trend was observed for all the lifetime traits with the increase in period of calving from first period barring few exceptions. This declining trend was due to the fact that cows calved during later periods did not have opportunity to complete more number of lactation.

Autumn season calvers (October-November) performed better while the least squares means for NLC, PL and MYPDHL was the lowest for the rainy season calvers (July-September) and for the rest of lifetime traits, it was the lowest for summer calvers (April-June). The regression of AFC on lifetime traits was low and positive except for NLC where it was in negative direction (-0.0008), however, the effect of AFC was non - significant on all the lifetime traits.

Heritability estimates: All the lifetime traits had low estimates of heritabilities ranging from 0.070 to 0.192 except MYPDPL (0.220) (Table 3). Similar results were reported by Miller *et al.* (1967), Hargrove *et al.* (1969), Hoque and Hodges (1980) and Singh *et al.* (2002). These estimates indicated that these characters are controlled by factors other than additive gene action. These low to moderate estimates of heritability for these lifetime traits revealed that there is restricted scope for improvement in these traits through individual selection while the selection on the basis of progeny performance coupled with corrective measures of management and feeding will be more effective for bringing out genetic improvements in these traits.

Genetic and Phenotypic Correlations: All the lifetime traits had high, positive genetic and phenotypic correlations among themselves which ranged from 0.906 to 0.990 and 0.373 to 0.938, respectively (Table 3). High positive genetic and phenotypic correlations have also been reported by Gill and Allaire (1976), Hoque and Hodges (1980), Basu *et al.* (1983), Singh *et al.* (1995), Norman *et al.* (1996) and Thakur (1997). These high genetic and phenotypic correlations among lifetime traits suggest that they are governed by similar set of genes i.e. they are the result of pleiotropic action of genes. Hence selection based on any one of these traits would result into positive correlated response in all the traits.

Table 3. Estimates of heritability (diagonal), genetic (above diagonal) and phenotypic (below diagonal) correlations among lifetime traits

	NLC	HL	LTMY	PL	MYPDPL	MYPDHL
NLC	*0.137±0.080*	0.965±0.024	0.956±0.028	0.956±0.025	0.906±0.066	0.919±0.062
HL	0.910±0.016**	*0.070±0.066*	0.964±0.028	0.983±0.013	0.926±0.069	0.931±0.073
LTMY	0.860±0.015**	0.879±0.015**	*0.070±0.066*	0.965±0.21	0.988±0.017	0.990±0.016
PL	0.924±0.016**	0.938±0.016**	0.934±0.016**	*0.070±0.066*	0.919±0.065	0.960±0.047
MYPDPL	0.433±0.034**	0.451±0.034**	0.728±0.026**	0.473±0.034**	*0.220±0.096*	0.977±0.014
MYPDHL	0.460±0.034**	0.373±0.035**	0.743±0.026**	0.561±0.031**	0.856±0.015**	*0.192±0.091*

From these results it may be concluded that the milk yield per day of productive life had moderate estimates of heritability and high genetic correlations with all the lifetime traits. Thus selection on the basis of MYPDPL will help in the improvement of other traits through correlated response.

REFERENCES

Basu SB, Bhatnagar DS and Taneja VK. 1983. Genetic and phenotypic parameters of lifetime production traits in Tharparkar cows. *Indian J. Dairy Sci.* 36: 207-211.

Ganpule SP and Desai RN. 1983. Comparative efficiency of milk production of indigenous and crossbred cows. *Indian J. Anim. Sci.* 53: 763-766.

Gill GS and Allaire FR. 1976. Genetic and phenotypic parameters for a profit function and selection methods for optimizing profit in dairy cattle. *J. Dairy Sci.* 59: 1325-1333.

Hargrove GL, Salazar JJ and Legates JE. 1969. Relationship among first lactation and lifetime measurements in a dairy population. *J. Dairy Sci.* 52: 651-656.

Harvey WR. 1987. Mixed model least - squares and maximum likelihood computer program. January 1987.

Hoque M and Hodges J. 1980. Genetic and phenotypic parameters of lifetime production traits in Holstein cows. *J. Dairy Sci.* 63: 1900-1910.

Jadhav KL, Tripathi VN and Kale MN. 1994. Optimization of age at first calving for lifetime traits in Holstein × Sahiwal crosses. *Indian J. Anim. Prod. Mgmt.* 10: 165-168.

Kaushik SN, Agarwal SC and Garg RC. 1994. Lifetime traits in Hariana cattle. *Indian J. Anim. Sci.* 64: 1104-1107.

Kramer CY. 1957. Extension of multiple range tests to group correlated adjusted means. *Biometrics.* 13: 13-18.

Kumar AB, Jana DN, Suman CL, Saxena MM, Srivastava BB and Pandey HS. 1997. Comparative performance of crossbred cows at different levels of exotic inheritance. *Indian J. Anim. Prod. Mgmt.* 13: 104-108.

Kumar S and Reddy KM. 1989. Herd life and productive life among Karan Swiss and Karan Fries cattle. *Indian J. Dairy Sci.* 42: 277-279.

Miller PD, Van Vleck LD and Henderson CR. 1967. Relationships among herd life, milk production and calving interval. *J. Dairy Sci.* 50: 1283-1287.

Norman HD, Powell RL, Wright JR and Pearson RE. 1996. Phenotypic relationships of yield and type scores from first lactation with herd life and profitability. *J. Dairy Sci.* 79: 689-701.

Raheja KL. 1994. Genetic parameters for first lactation and life time production traits in Friesian-Hariana and Friesian-Sahiwal half-breeds estimated by multiple trait maximum likelihood procedure. *Indian J. Anim. Sci.* 64: 616-621.

Reddy KM and Nagarcenkar R. 1988. Studies on life time traits in Sahiwal cattle. *Indian J. Dairy Sci.* 41: 66-77.

Robertson A. 1959. The sampling variance of the genetic correlation coefficient. *Biometrics*. 15: 469-485.

Singh CB, Prasad RB, Gupta UD and Verma SK. 1988. Factors affecting the lifetime production in Sahiwal and its crosses with Jersey. *Indian J. Dairy Sci.* 41: 36-39.

Singh RV and Nivsarkar AE. 1998. Status of Gangatiri cattle in Uttar Pradesh. *Indian J. Anim. Prod. Mgmt.* 14: 148-149.

Singh MK, Sharma RC and Gupta AK. 1995. Association among lifetime traits in Karan Swiss cattle. *Indian J. Dairy Sci.* 48: 538-539.

Singh S, Khanna AS and Singh RP. 2002. Replacement and lifetime production traits: Effect of non - genetic factors and sire evaluation. *Asian - Aus. J. Anim. Sci.* 15: 11-15.

Snedecor GW and Cochran WG. 1968. Statistical Methods. 7th Ed. Oxford and IBH Publishing Co., Bombay.

Swiger LA, Harvey WR, Everson DO and Gregory KE. 1964. The variance of intraclass correlation involving groups without observation. *Biometrics*. 20: 818-826.

Thakur YP. 1997. Evaluation of Jersey sires used in hilly regions of North India. Ph.D. Thesis, C.S. Azad Univ. Agric. and Technology, Mathura Campus, Mathura, India.