Estimation of Genetic, Phenotypic and Environmental Trends in Hariana Cattle

K. Singh, M. L. Sangwan* and D. S. Dalal

Department of Animal Breeding, CCS Haryana Agricultural University, Hisar-125004, India

ABSTRACT : The breeding data relating to Hariana herd spread over 18 years (1979-96) were analysed to estimate genetic, phenotypic and environmental changes in characters of economic importance which might have taken place during the several years of selective breeding practiced in the herd. The average genetic changes in a given character were estimated by four methods. The phenotypic trends observed for different economic traits were not significant. On changing the method of estimation, magnitude and direction of genetic trends changed. Comparison of estimates of genetic trends by different methods showed that adjustments for biases due to non-random allotment of dams with respect to their age and merit suggested by Powell and Freeman (1974) were useful for increasing the precision of the estimates. Hence, this method was found to be the best method for estimation of genetic trends. The estimate of genetic trends by this method were 4.03±6.21 days, 3.24±5.33 kg, 0.15±0.43 days, 0.09±0.59 days, 0.01±0.02 kg and 0.01±0.01 kg for age at first calving, first lactation milk yield, first lactation length, first calving interval, first lactation milk yield per day lactation length and first lactation milk yield per day of calving interval, respectively. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 1 : 7-10)***

Key Words : Genetic Trends, First Lactation Milk Yield, Age at First Calving

INTRODUCTION

The average genetic gain per unit time due to selection for milk production can be predicted with the help of an estimate of the heritability and selection differential of the characters. But the predicted gain may not be actually realized because selection scheme which may not be applicable in an actual practice, the managemental and feeding conditions are likely to change over period of time, and inaccurate information of the genetic status. Even when data are adjusted for yearly changes, the genetic changes still intermingled with environmental changes. Therefore, it is imperative to separate the genetic change from the environment ones, as accurately as possible.

Several methods are being developed to measure the genetic change in the animal population. More recently, Smith (1962) and Powell and Freeman (1974) gave different methods of estimation of genetic change in field records. Hence, there is need to know which is more precise.

MATERIALS AND METHODS

The breeding data used in the present study relates to 624 Hariana cows, progenies of 19 sires maintained at Govt Livestock Farm, Hisar over a period of 18 years from 1979-96. Cows having incomplete and abnormal lactation records due to sickness, abortion, and stillbirth were excluded. The traits included in the study were age at first calving (AFC), first lactation milk yield (FLMY), first lactation length (FLL), first calving interval (FCI), first lactation milk yield per day of lactation length (FLMYLL), first lactation milk yield per day of calving internal (FLMYCI). Depending upon the climatic conditions, entire duration of 18 years was partitioned into 6 periods, each having three consecutive years. Various values used in estimation of phenotypic and genetic trends were obtained by using least squares analysis techniques of fitting constant for disproportionate subclass numbers (Harvey, 1966) with the following model including sire as random effect, period and season as fixed effects and AFC was used as a covariate.

$Y_{ijkl}=\mu+S_i+P_j+T_k+b(X_{ijkl}-\overline{x})+e_{ijkl}$

Where, $Y_{ijkl}=l_{th}$ observation on i_{th} sire, j_{th} period and k_{th} season

μ=Overall mean of the population

S_i=random effect of ith sire normally and independently distributed with mean zero and variance σ^2s.

P_j=Fixed effect of jth period

T_k=fixed effet of kth season

B=linear regression of trait on age at first calving

X_{ijkl}=Age at first calving pertaining to Y_{ijkl} observation

$\overline{x}$=Mean age at firt calving

e_{ijkl}=random error associated with each observation assumed to be NID (0, σ^2e).

The phenotypic trend for each trait was calculated as regression of performance of population on period [b (P.T.). The methods of estimating genetic trends were obtained by procedure suggested by Smith (1962) i.e. method I and II and its modification by Powell and Freeman (1974) i.e. method III and IV:

Method I $g=2(b_{PT}-b_{PT/S})$

Method II $g=-2(b_{(P-\bar{P})T/S})$

Method III $g=2(b_{PT}-b_{PT/S}+\Delta D_1/2)/(1+b_{DA\,T/S}-b_{DA\,T})$

Method IV $g=-2(b_{(P-\bar{P})T/S}-\Delta D_2/2)/(1+b_{DA\,T/S}-b_{DA\,T})$

* Corresponding Author: M. L. Sangwan. Tel: +91-1662-31171-4262, Fax: +91-1662-39452, E-mail: dcoans@hau.nic.in

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Where, b_{PT} is regression of population performance on period

$b_{PT/S}$ is within sire regression of population performance on period

$b_{(P-\bar{P})T/S}$ within sire regression of population performance on period records being deviated from population mean.

Environmental trends were calculated by subtracting genetic trends for every economic trait. The estimates of genetic trends obtained by four methods were compared by their standard errors. The standard errors were calculated using the method of Van Vleck et al. (1960) and Kempthorne (1969).

RESULTS AND DISCUSSION

The estimates of phenotypic trends are given in table 1 and estimates of genetic and environmental trends are outlined in table 2.

Age at first calving

Estimate of phenotypic trends was 46.44±25.15 days, which was found to be non-significant. The present findings are in line with those of Narain and Garg (1972) for Red Sindhi, Kangayam and Tharparkar herds. The increasing trend in AFC as observed in the present study was not in a desirable direction and needs to be reduced to the optimum level through both genetic and environmental paths. The estimates of genetic trends by four methods were -64.56±27.83, -1.77±10.87, 4.03±6.21 and -5.74±8.55 days, respectively (table 2). These estimates indicate desirable reduction in AFC on genetic scale, but because of environment trends being in the opposite direction, no significant change in AFC could be observed phenotypically. The present estimates by Smiths method (I, II) are in close conformity with those reported by Acharya and Lush (1968) and Narain and Garg (1972) and these estimates were on the higher sides than those reported by Hingane (1980) by all four methods in Hariana cattle.

First lactation milk yield

The rate of phenotypic changes in FLMY was -53.51±26.08 kg per period indicating declining trends in milk production. Similar trend were also observed by Kumar and Narain 1979) and Singal (1993) in Tharparkar and Sahiwal herds. Hingane (1980) also reported negative trends in FLMY in Hariana cattle. The estimates of genetic trends for FLMY by four methods were -54.88±37.91, -76.27±0.25, 3.24±5.33 and 4.56±6.99 kg, respectively. The corresponding environmental trends were 1.37±46.02, 23.07±37.72, -56.75±26.62 and -58.6±27 kg, respectively. Hingane (1980) reported positive genetic trends by all four methods. The estimate by method III and IV are lesser than those reported by Hingane (1980). Tomer and Singh (1981) and Singal (1993) in different indigenous breeds of cattle. Genetic trends estimated by method I and II are comparable with those calculated by Kumar and Narain (1979) in Sahiwal cattle and less than those calculated by Hingane (1980) and Singal (1993) in Hariana and Sahiwal breeds, respectively.

First lactation length

Phenotypic trends for FLL were found to be negative. Hingane (1980) and Singal (1993) reported similar phenotypic trends for FLL in Hariana and Sahiwal herds, respectively. The estimates of genetic trend by method I and II showed negative changes indicating no genetic improvement in this trait while method III and IV showed slight improvement.

First calving interval

The phenotypic trends estimated for FCI was in positive direction, which is not desirable. Tomer and Singh (1981) obtained similar results in Hariana cattle. Hingane (1980) and Singal (1993) reported negative phenotypic trend for FCI in Hariana and Sahiwal cattle, respectively. Genetic trends estimated by four methods were -1.45±9.50, -15.03±6.92, 0.09±0.59 and 0.88±1.37 days. Estimates of genetic trends by Smiths methods (I, II) are comparable with those calculated by Tomer and Singh (1981) in Hariana cattle. Estimates of FCI by Powell and Freemans methods were higher than those reported by Hingane (1980) in Hariana cattle. Estimates in present study had large standard errors indicating less reliability of the estimates. As the trait is mainly governed by non-genetic factors, managemental practices should be improved for lowering the FCI.

First lactation milk yield per day of lactation length

The phenotypic trends estimated for this trait was -0/13±0.05 kg. This revealed a decrease in average yield per day of lactation length over a period of 18 years, which is not a desirable direction. Genetic trends were -0.16±0.07, 0.01±0.2 and 0.01±0.02 kg respectively. These estimates

Table 1. Phenotypic trends per period in different economic traits

Traits	Phenotypic trends
Age at first calving (days)	46.44 ±25.15
First lactation milk yield (kg)	-53.51±26.08
First lactation length (days)	-7.44± 4.54
First calving interval (days)	3.93± 6.40
First lactation milk yield per day lactation length (kg)	-0.13± 0.05
First lactation milk yield per day calving interval (kg)	-0.12± 0.06

Table 2. Genetic and environmental trends per period in different economic traits

Traits	Trends	Smith, 1962		Powell and Freeman, 1974	
		Method I	Method II	Method III	Method IV
AFC	g	-64.56±27.83	-1.77±10.87	4.03±6.21	-5.74±8.55
	t	111.01±37.51	48.22±27.39	42.42±25.91	52.17±26.56
FLMY	g	-54.88±37.91	-76.51±27.25	3.24±5.33	4.56±6.99
	t	1.37±46.02	23.07±37.72	-56.75±26.65	-58.06±27.00
FLL	g	-2.48±6.41	-9.54±4.11	0.15±0.43	0.55±0.85
	t	-4.97±7.63	2.09±6.13	-7.59±4.56	-8.01±4.62
FCI	g	-1.45±9.50	-15.03±6.92	0.09±0.59	0.88±1.37
	t	5.37±11.46	18.95±9.43	3.83±6.44	3.03±6.55
FLMYLL	g	-0.16±0.09	-0.16±0.07	0.01±0.02	0.01±0.02
	t	0.03±0.11	0.02±0.08	-0.13±0.05	-0.13±0.05
FLMYLL	g	-0.11±0.08	-0.11±0.06	0.01±0.01	0.01±0.02
	t	-0.02±0.10	-0.02±0.08	-0.13±0.06	-0.13±0.06

g=genetic trend; t=environmental trend (Unit of traits as given in table 1).

showed considerable decline in the performance of this trait. Similar estimates were also reported by Singal (1993) in Sahiwal and Hingane (1980) in Hariana cattle. The trait should be improved through genetic and managemental manipulations.

First lactation milk yield per day of calving interval

Estimate of phenotypic trends (table 1) indicated no significant improvement in this trait. Similar report was given by Singal (1993) in Sahiwal breed, but reverse was the case with the findings of Hingane (1980). The estimates of genetic trends by methods I and II were in negative direction. However, estimates by method III and IV were in positive direction. These estimates are lower than those reported by Hingane (1980) in Hariana cattle. This trait can be improved through devising suitable selection programme to exploit and genetic variance and side by side improved managemental practices.

Comparison of different methods

The standard errors of all the traits under study by method II was of lower magnitude than those obtained by method I (table 2). Therefore, the method II seems to be better than method I, though the estimates obtained by method II are higher than method I. Method II is superior to method I because it removes period wise fluctuations in the environment as values of the traits have been deviated from the population mean. Hingane (1980) and Singal (1993) draw similar conclusion.

The estimates and standard error by method III are smaller than those obtained by method IV, hence period III seems to be better than method IV. However, Hingane (1980) and Singal (1993) reported contrary results.

In general, the estimates of the genetic trends by the methods of Powell and Freeman (III, IV) have small standard errors than by the methods of Smith (I, II). The same was expected because methods of Powell and Freeman remove biasness due to non-random allotment of the dams to the sires with respect to their age and merits. Hence, estimation of genetic trends from Powell and Freeman method are better than those obtained from Smiths methods.

Sign of estimates has changed its directions on changing the methods of estimation from Smith (1962) to Powell and Freeman (1974). It is because A, the factor due to non-random allotment of dams to sires with respect to their age, is negative in the present study. Hence, the values of Smith methods were erroneous, because of the assumption of methods with respect to allotment of dams and to their age and merit.

The method III showed lower standard error than method IV. Hence, adjustment for biasness due to non-random allotment of dams with respect to their age and merit was useful in increasing precision of the estimates of the genetic trends. It can, therefore, be concluded that method III (Powell and Freeman, 1974) is the most precise and the best method for estimation of genetic trends for economic traits.

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