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RESEARCH ARTICLE

Genetic and Phenotypic Trends for Milk Yield per Lactation in Sahiwal Cattle under Arid and Semi Arid Conditions of Pakistan

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ABSTRACT

The aim of the study was to evaluate the Sahiwal cattle genetically. Annual genetic and phenotypic trends were drawn for lactation milk yield to evaluate previous selection strategies. Data on (n=24182) multiple lactations of 7351 Sahiwal cows maintained at five institutional herds of Punjab, Pakistan from 1969 to 2006 were used. The heritability for total milk production was estimated by using paternal half-sib analysis. Overall least squares means and standard errors for total milk production for five institutional herds ranged from 1028±16 to 1401±16 kg with the mean value of 1323±701 kg. Total milk production was significantly influenced by herd, year, season of calving, lactation number and days in milk (P<0.01). An heritability of 0.27±0.01 for total milk yield was estimated, and breeding values of sires and cows ranged from -266 to 702 and -893 to 1469 kg, respectively. The least squares means during the examined periods showed greatly fluctuations. Genetic and phenotypic trends for total milk production showed slightly upward increasing tendency. The phenotypic trends was maximum in 1972 (1648 kg) and minimum in 1978 (954 kg).

INTRODUCTION

Sahiwal cow (*Bos indicus*) is one of the time-honored dairy cattle breed of tropical and sub-tropical regions on the globe. Its peculiar features include resistance to ticks and other diseases, tolerance towards heat and high productivity under harsh climatic conditions. The original home tract of Sahiwal Cattle breed, as indicated by its name, is Sahiwal (Montgomery) District, of the Punjab, located between Setluj and Ravi rivers. During the Colonial rule, due to the introduction of canal system, grazing areas for Sahiwal cattle were disturbed and the breed scattered throughout the Punjab. There are 2.75 million Sahiwal cattle in the country out of which 2.06 million heads in the Punjab province (Anonymous, 2006).

Genetic evaluations express the relative merit of animals, providing the base for ranking of animals and an estimate of the magnitude of differences between animals. These provide us the criterion of selection also. Genetic evaluation procedures are based upon separating different factors into components that affect a trait. All evaluation procedures modeled as fixed, random or mixed effects to account for various aspects of environment either permanent or temporary. The more similar situation within a management group, the minimum environmental effect is exerted. Non-genetic effects are excluded through the pre-correction of data, best fitted model and properly weighting the remainder. The Best Linear Unbiased Prediction (BLUP) procedure is widely applied not only to sire evaluation but also to estimate the genetic trend and combining ability in the United States, Canada, and some European countries Mingfeng et al. (1988). The advantage of the BLUP animal model is that it considered all relatives, no matter how distant, all animals of a breed are evaluated simultaneously, male and female (Wiggans et al., 1988).

The aim of the study was to evaluate the Sahiwal cattle genetically. Annual genetic and phenotypic trends were drawn for total milk yield to evaluate previous selection strategies.

MATERIALS AND METHODS

Data collection

Data on (n=24182) multiple lactation records of (7351) Sahiwal cows kept at five government institutional herds of Punjab, Pakistan (Livestock Experiment Stations) Bahadurnagar, Distt. Okara; Jahangirabad, Distt. Khanewal; Khizarabad, Distt. Sargodha; Kalour Kot, Distt. Bhakkar and Fazil Pur, Distt. Rajan Pur from 1969 to 2006 were used in the present study.

Environmental effects model

The collected data were analyzed estimating the effect of non-genetic factors, viz. herd, year and season of calving, lactation number on the total milk production while days in milk was used as co-variable (linear regression) by using GLM (SPSS version 12). The year of calving was divided into four seasons: winter (December to February), spring (March to April), summer (May to September) and autumn (October to November). The mathematical model as described by Steel et al. (1997) for fixed effects was:

$Y_{ijl}=\mu+F_i+b_{ij}+e_{ijl}$

Where Y_{ijl} is the measurement of particular trait, μ is the population mean, F_i all fixed effects with the restriction that $\Sigma F_i=0$, b_{ij} is linear regression effect (co-variable) and e_{ijkl} the random error associated with each observation.

Genetic parameters model

The heritability for total milk production was estimated by using paternal half-sib analysis. The variance components for the estimates of heritability were obtained from the following model: $Y_{ijk}=\mu+F_i+A_{ij}+\varepsilon_{ijk}$

Where Y_{ijk} is the measurement of particular trait, μ is the population mean, F_i all fixed effects, A_{ij} is the random additive genetic effect of animal and ε_{ijk} random error with mean zero and variance σ_e^2. Restricted Maximum Likelihood Procedure outlined by Patterson and Thompson (1971) fitting an individual Animal Model. For this aim, DFREML 3.1 software (Meyer, 2000) set of computer program were used. The convergence criterion (variance of function values -2 log likelihood) for heritability estimation was $1x10^{-8}$. There were 341 sires and 3195 dams represented in the pedigree. Breeding values thus estimated were fitted in a fixed effects model that has year of birth as the only fixed effects. The assumed model can be written as follows:

$y= X\beta+Z\mu+e$

Where y is the vector of observations of the animals, X is the know designed matrix relating fixed effects to y, β is the vector of all fixed effects (herd, year and season of calving, lactation number and days in milk), Z is the known design matrix on animals direct additive genetic effects to y, μ is the vector of random animal solution and e is the vector of unknown random residual effects. The breeding values were drawn against year of birth to depict the genetic trend and least squares means of total milk production was plotted against the year of calving to determine phenotypic trends.

RESULTS AND DISCUSSION

Environmental factors affecting lactation milk yield

Results of least square means and analysis of variance for total milk production are given in Table 1. The effects of herds, year, season of calving, lactation number and days in milk (co-variable) were significant (P<0.01). Overall least squares means and standard errors for total milk production for five Livestock Experiment Stations (LES) ranged from 1028±16 to 1401±16 kg with an average of 1323±701 kg. These averages were higher compared to the averages of Khan et al. (2008). Mellado et al. (2011) analyzed records representing data from 1500 barren Holstein cows over an 8-ys period from a large commercial dairy farm in northern Mexico and reported 7607±145 and 9548±181 kg for first and ≥6-lactation cows, respectively. Maximum milk production was recorded at LES Khizarabad with 1385±14 kg and minimum yield was recorded at Kalour Kot. One of the main probable reasons for low milk yield for Kalour Kot was that culled animals from different LES belonging to Directorate of Livestock Farms (Lahore), Punjab, Pakistan were shifted there. Secondly, the farm is situated in the Thal desert where the feed resources were very limited. It is evident from the Table-1 that milk yield was maximum (1648±44 kg) during the year 1972 and minimum during the year 1978 (954±24 kg). Topal et al. (2010) reported that lactation period and peak yield were important variables affecting the actual milk yield in the dairy herd.

This variation in milk yield across different years of calving reflected the availability of financial resources and management practices adopted during different years. Similarly, the animals calved during the winter season produced more milk (1364±15 kg) compared to the animals calved in hot dry season (1246±15 kg). The maximum milk was produced during fifth lactation (1385±12 kg), but minimum milk production was recorded in first lactation (1194±9 kg). Variation among the present results with previous results in milk production might be resulted from many environmental factors with genetic factors. Environmental factors are well-known to have significant effects on milk production as a quantitative trait much more than genetic factors (Falconer and Mackay, 1996). Gebreyohannes et al. (2013) estimated variance components and genetic parameters for milk production and lactation pattern in an Ethopian multibreed dairy cattle population and reported that herd-year-season were important factors (p<0.001) on lactation milk yield.

Table 1: Least square means and analysis of variance for total milk production

Fixed effects	LS Mean±SE (kg)	Particulars	LS Mean±SE (kg)
Overall mean±SE	1323±701	Year of calving	**
Herd	**	1969	1472±101 (20)
Jahangirabad	1385±14 (8274)	1970	1483±64 (43)
Khizarabad	1401±16 (4178)	1971	1456±55 (59)
Bahadurnagar	1328±15 (6751)	1972	1648±44 (97)
Kalour Kot	1028±16 (3880)	1973	1381±33 (191)
Fazil Pur	1351±191 (1099)	1974	1413±29 (264)
Season of calving	**	1975	1407±26 (346)
Winter	1364±15 (8080)	1976	1375±24 (398)
Spring	1266±15 (5030)	1977	1123±23 (449)
Summer	1246±15 (8123)	1978	954±24 (407)
Autumn	1319±16 (2949)	1979	1031±24 (433)
Lactation number	**	1980	1088±24 (392)
1	1194±9 (5811)	1981	1106±24 (409)
2	1311±10 (4648)	1982	1133±24 (413)
3	1354±10 (3680)	1983	1269±22 (488)
4	1357±11 (2939)	1984	1261±23 (476)
5	1385±12 (2256)	1985	1335±22 (524)
6	1377±13 (1733)	1986	1441±20 (718)
7	1359±14 (1293)	1987	1369±19 (774)
8	1342±16 (851)	1988	1362±19 (845)
9	1341±20 (512)	1989	1404±18 (910)
10	1215±65 (459)	1990	1382±18 (880)
		1991	1336±18 (878)
		1992	1309±18 (870)
		1993	1250±18 (947)
		1994	1257±18 (1027)
		1995	1286±17 (1060)
		1996	1223±18 (1040)
		1997	1164±18 (961)
		1998	1268±18 (905)
		1999	1407±18 (979)
		2000	1394±18 (934)
		2001	1288±18 (940)
		2002	1286±18 (917)
		2003	1284±18 (848)
		2004	1462±18 (883)
		2005	1330±19 (811)
		2006	1235±20 (646)
Regression coefficient on days in milk (Covariable)**			

** ($P<0.01$) Figure in parenthesis represents the number of observations

Heritability estimates

A heritability estimate of 0.27±0.01 for total milk production in the present paper were similar to heritability estimates found by some authors Ahmad (1972), Ruvuna et al. (1984) and Pundir and Raheja (1994) where as lower estimates was reported by Dahlin et al. (1998), Ilatsia et al. (2007), Khan et al. (2008) and Gebreqzibher et al. (2013). The difference in the present study with the previous studies might be due to the method of data analysis with variation in managerial conditions.

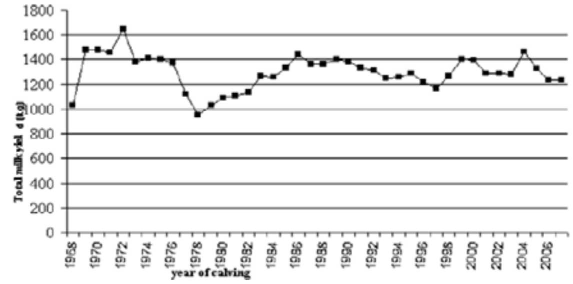

Fig. 1: Phenotypic trend for total day milk yield.

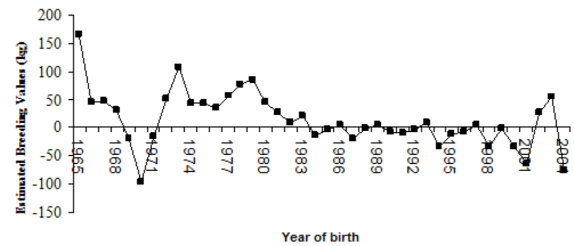

Fig. 2: Genetic trend for total milk yield

Breeding values, genetic and phenotypic trends

For total milk production, breeding values of sires and cows ranged from –266 to 702 and -893 to 1469 kg, respectively. Similar breeding values were reported (Javed, 1999) for Sahiwal cows. Phenotypic (Fig. 1) and genetic trends for total milk production is depicted in Fig. 2. Genetic and phenotypic trends were slightly upward and with increasing trend and wide fluctuation observed in the recent years. Similar results were also obtained by Rege and Wakhungu (1992); Raheja (1993); Javed (1999); Singh and Nagarcenkar (2000); Ilatsia et al. (2007); Khan et al. (2008) and Missanjo et al. (2012). The genetic trend for total milk production indicated that the breeding program in the herds during the period under study has not proved to be efficient. Results reflected that the selection of the animals could not be practiced in the proper direction and some sort of random mating had been practiced.

Conclusion

Environmental factors had significant influences on the milk production. Hence before estimation heritability these effects must be included for the estimation of genetic parameters. Heritability estimates in the present study low to moderate and genetic trends showed little upward increase. There is need to revise the selection strategies and improvement in these herds can be carried out through the implementation of effective breeding programs.

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