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Research Article

ESTIMATES OF GENETIC AND PHENOTYPIC PARAMETERS OF PRODUCTION PERFORMANCE TRAITS IN HARDHENU CATTLE

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Abstract: The data on 862 Hardhenu cattle sired by 63 pertaining to production performance traits were collected from history cum pedigree sheets maintained at Cattle Breeding Farm (CBF), Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar over a period of 20 years from 1997 to 2016. Analysis of variance done by restricted maximum likelihood method of Harvey (1990) using mixed linear model. The heritability estimates along with standard errors for different production performance traits *viz*., LMY, LMY-305, LL, PY, AMY, MCI, MSC, Persistency, AFC, SP, CI and DP summarized as 0.41±0.11, 0.36±0.11, 0.26±0.09, 0.44±0.16, 0.30±0.10, 0.31±0.10, 0.50±0.12, 0.26±0.09, 0.45±0.20, 0.04±0.01, 0.10±0.07 and 0.11±0.07, respectively. The heritability estimates for various production performance traits were found to be low to high ranging from 0.04 (SP) to 0.50 (MSC). The genetic and phenotypic correlations between production performance traits were low to high ranged -0.70 (LL/DP) to 0.99 (LMY-305/SP) and -0.55 (MSC/DP) to 0.96 (LMY/LMY-305). The genetic and phenotypic correlations of MSC with all production performance traits were moderate to high ranged from 0.28 (SP) to 0.90 (LMY) and 0.28 (SP) to 0.90 (AMY), respectively. Therefore, selection based on MSC would result in improvement in desirable direction through positive correlated response in most of the traits under study.

Keywords: Crossbreed cattle, Genetic correlations, Heritability, Hardhenu cattle

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Introduction

India occupies pre-eminent position in milk production with an annual output of 165.40 million tonnes accounting for 18.5 per cent of world production. Out of which, share of milk production by exotic/crossbred cows was 25% and that of indigenous/non-descript was 20% [2]. Out of the 190.90 million cattle population, crossbred population was 19.42 million while that of indigenous was 48.12 million [6} Crossing Zebu cattle (*Bos indicus*) with temperate breed (*Bos taurus*), undertaken for improving the milk production to cater the needs of ever increasing human population has led to the synthesis of several new crossbred strains of cattle. During late nineties Frieswal bulls were also used on synthetic dams having a composition of Friesian and indigenous Hariana cattle at Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS) formerly CCS, HAU, Hisar, animal farm. The principle objective was identification of superior breeding bulls and faster multiplication of their progenies in rural and urban farmers of Haryana state in particular and whole of country in general. Hardhenu, is a cross between North American Holstein Friesian, Hariana and Sahiwal breeds with a inheritance ratio of exotic to indigenous as 62.5 %: 37.5%. 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 parameters by developing certain guidelines for selection. In most of the genetic improvement programmes in the country selection has been focussed on production traits and fertility performance of the animal has not been given the due emphasis. Though such selection would slow down the rate of improvement in productivity of dairy cattle, however such reduction can be more than compensated by simultaneous improvement in fertility traits. Estimates of genetic parameters are needed for the prediction of breeding values and planning of selection strategies for desired genetic advancement with this object in view, the present investigation was conducted for estimating the genetic and phenotypic parameters of production performance traits.

Materials and methods

The data on 862 crossbreed cattle pertaining to production performance traits up to five lactations were collected from history cum pedigree sheets maintained at Cattle Breeding Farm (CBF), Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar over a period of 20 years from 1997 to 2016 were analysed to study the genetic parameters. Animals having lactation shorter than 100 days, suspected outliers on the basis of histograms and abnormal records like abortion, mastitis and chronic illness were excluded from present study. Following production performance traits was recorded up to fifth lactations: LMY (Lactation milk yield in kg), LMY-305 (305 days milk yield in kg), LL (Lactation length in days), PY (Lactation peak milk yield in kg/day), AMY (Average daily milk yield = LMY/LL in kg/day), MCI (Milk yield per day of calving interval in kg/day), MSC (Milk yield per day of age at second calving in kg/day), persistency (Persistency in days), age at first calving (AFC), SP (Service period in days) and CI (Calving interval in days) and DP (dry period in days). Assuming that there is not much variation in adjacent years, entire period of twenty years was divided into five equal periods from 1997-2000, 2001-2004, 2005-2008, 2009-2012 and 2013-2016. Each year was further delineated into 4 seasons of calving according to the prevailing agro-climatic conditions in the region *viz*., Summer (April to June), Rainy (July to September), Autumn (October to November) and Winter (November to March). In order to overcome non-orthogonality of the data due to unequal subclass frequencies, least squares and maximum likelihood computer program of [15] using Henderson's Method III was utilized to estimate the effect of various tangible factors on production performance traits and to estimate genetic and phenotypic parameters. Paternal half-sib correlation method using Henderson's Method III [16] was utilized to estimate heritability of the traits under study after adjustment of data for various significant effects The following statistical model will be used to explain the underlying biology of the traits included in the study.

$$Y_{ijklm}= \mu+S_i+P_j+C_k+R_l+e_{ijklm}$$

Where, Yijklm = mthrecord of individual calved in j^{th} period, k^{th} season and l^{th} parity pertaining to i^{th} sire, 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, C_k = is the fixed effect of k^{th} season of calving, R_l = is the fixed effect of lth parity, e_{ijkl} = is the random error associated with each and every observation and assumed to be normally and independently distributed with mean zero and variance σ^2 e.

Results and Discussion

Accurate estimates of heritability of various economic traits are essential in assessing the progress in different traits and for planning future selection and breeding programmes. The heritability estimates along with standard errors for different production performance traits *viz*., LMY, LMY-305, LL, PY, AMY, MCI, MSC, Persistency, AFC, SP, CI and DP summarized as 0.41±0.11, 0.36±0.11, 0.26±0.09, 0.44±0.16, 0.30±0.10, 0.31±0.10, 0.50±0.12, 0.26±0.09, 0.45±0.20, 0.04±0.01, 0.10±0.07 and 0.11±0.07, respectively (Table 1). The heritability estimates for various production performance traits were found to be low to high ranging from 0.04 (SP) to 0.50 (MSC). Heritability estimates of LMY, PY, MSC and AFC were high. Estimates of similar magnitude for above traits were also reported by workers [38, 18, 27, 12, 5, 14, 40 and 41] in crossbred cattle. The estimates of heritabilities for LMY-305, LL, AMY, MCI and persistency were moderate. Similar findings were supported by many workers [9, 12, 19, 23, 26, 29, 30, 34 and 38]. However, lower to moderate estimates were reported in literature by many workers [1, 7, 9, 10, 11, 17, 21, 23, 24, 25, 32, 35 and 37]. The heritability estimates for production performance traits *viz*. SP, CI and DP were low. Likewise, [5, 9, 12, 13 and 24] also reported similar estimates of heritability. However, moderate to higher estimates for heritability were reported in literature by [3, 5, 11, 24 and 30]. Moderate to high heritability estimates for all production performance traits except SP, CI and DP indicated that additive genetic variance exist in the population for these traits, which can be exploited through progeny testing coupled with improved managemental practices. Genetic and phenotypic correlations among production performance traits indicated that LMY and LMY-305 had high genetic correlations with all production performance traits except negative associationship with AFC and DP (Table 1). On the other hand, phenotypic correlations of LMY and LMY-305 with all the production performance traits were found to be low to high ranging from 0.08 (AFC) to 0.96 (LMY-305) and 0.06 (AFC) to 0.90 (MCI), respectively except moderately negative association ship with DP. Similar reports for genetic and phenotypic correlations between LMY and AFC in literature [4 and 12]. Similarly, the genetic and phenotypic correlation between lactation milk yield and lactation milk yield-305 was highest and significant in crossbred cattle as reported in literature by [25 and 35]. Likewise significantly high genetic and phenotypic correlations between LMY and LL in crossbreed cattle [20 and 25]. The moderate to high genetic correlations between LMY and persistency to the tune of 0.56 to 0.61 and corresponding phenotypic correlations to the tune of 0.38 in Sahiwal cross and Red-Sindhi cattle [31 and 33]. Likewise, high estimates of genetic and corresponding phenotypic correlations of LMY-305 with LL [35 and 9]. Similarly, moderate to high estimates of genetic and phenotypic correlations of LMY-305 with PY [25 and 28] Similar, estimates of genetic and phenotypic correlations of LMY-305 with AMY and MCI were reported in Karan-Fries cattle [9]. Similarly, high genetic correlations of LMY-305 with persistency and moderate estimates of phenotypic correlations was reported in H.F cattle [3]. The positive association of LMY with SP explains that with increase in service period the phase of pregnancy will shift and thus production will increase. Since this association is not favourable, an optimum service period needs to be decided so that favourable trend in it does not adversely affect the production performance of individual. LL and PY had moderate to high genetic correlations with all production performance traits ranging from 0.29 (persistency) to 0.84 (CI) and 0.56 (CI) to 0.96 (AMY), respectively except low and negative associations of both traits with AFC (-0.03), (-0.23) and DP (-0.70), (-0.32). While, negative genetic correlations of PY with persistency (-0.41). Likewise, LL and PY had varied magnitude *i.e*. low, moderate to high significantly positive phenotypic correlations ranging from 0.07 (AFC) to 0.69 (CI) and 0.01 (AFC) to 0.55 (LL), respectively except negative associations with DP (-0.31), (-0.16). Likewise, associationship of PY with persistency was low and negative (-0.09). Low and negative estimates of genetic and phenotypic correlations between PY and DP [40 and 41]. While, low genetic correlations to the tune of 0.07 and negative phenotypic correlations to tune of -0.07 between PY and AFC was reported in Gir cattle [8]. Similarly, high genetic correlations between LL and persistency in Red-Sindhi cattle [30]. In addition to this higher estimate of genetic and phenotypic correlations of PY with AMY, MCI and MSC in Frieswal cattle [40 and 41]. Also, moderate to high genetic and phenotypic correlations of PY with persistency [33]. The negative genetic and phenotypic correlations of production performance traits with DP is in desirable direction because unproductive life of the animal decreases by decrease in dry period and increase in economic traits viz. lactation length, lactation length, peak yield etc. Similar findings were also supported by many workers [39-41]. The genetic correlations of AMY and MCI with production performance traits varied from low to high ranging from 0.46 (persistency) to 0.96 (LMY-305) and 0.06 (AFC) to 0.78 (LMY-305) except negative correlations of AMY with AFC (-0.08) and correlations of MCI with DP (-0.19). While, phenotypic correlations of AMY and MCI varied from low to high ranging from 0.02 (CI) to 0.90 (MSC) and 0.09 (AFC) to 0.91 (LMY), respectively except negative associations of AMY with DP (-0.44) and of MCI with SP (-0.07), CI (-0.08) and DP (-0.09). The genetic correlations of MSC and persistency with production performance traits were moderate to high ranging from 0.28 (SP) and 0.94 (AMY) and 0.11 (AFC) to 0.51 (LMY), (LMY-305), respectively except associationship of MSC with AFC (-0.45) and DP (-0.53), which were of highly negative in magnitude. On the contrary, genetic correlations of persistency were moderate to high and negative with PY (-0.41) and DP (-0.22) (Table 1). The phenotypic correlations of MSC and persistency varied from low to high ranging from 0.28 (CI) to 0.90 (AMY) and 0.11 (AFC) to 0.76 (LMY) except negative associationship of MSC with AFC (-0.23) and DP (-0.55). While negative associationship of persistency with PY (-0.09) and DP (-0.35). Low but positive estimates of genetic correlations of AMY and MCI with AFC reported in literature [40 and 41]. Similarly, higher estimates of genetic and phenotypic correlations of AMY and MCI with MSC was reported in literature [10 and 11]. (Table 1). AFC had low to moderate and negative genetic correlations with all production performance traits ranged from -0.48 (SP) to -0.03 (LL) except low and positive relationship with MCI (0.06) and Persistency (0.11). Whereas, low and positive phenotypic correlations of AFC ranging from 0.01 (PY) to 0.11 (Persistency) except low and negative associationship with MSC (-0.23), SP (-0.02) and DP (-0.07). Similar estimates were reported in Frieswal cattle [40 and 41]. However, low but positive estimates of genetic and phenotypic correlations between AFC and DP in Gir cattle [8]. Also, SP had moderate to high genetic correlations with production performance traits ranged from 0.18 to 0.99, with the highest value to the tune of 0.99 (LMY-305) except associationship of SP with AFC which was highly negative (-0.48). Whereas, SP had moderate to high and significant phenotypic correlations with various production performance traits ranging from 0.25 (PY) to 0.94 (CI) except low correlation with AMY (0.02) and negative correlations with MCI (-0.07). Similar estimates of genetic and phenotypic correlations in Frieswal cattle in literature [40 and 41]. Likewise, CI had moderate to high genetic correlations with all production performance traits ranged from 0.23 (Persistency) to 0.84 (LL) except high negative associationhip with DP (-0.53). Similarly, low to highly positive phenotypic associations of CI with all production performance traits ranged from 0.02 (AFC) to 0.94 (SP) except negative association with MCI (-0.08). DP had varied range of genetic correlations ranged from -0.70 (LL) to -0.19 (AMY) i.e. low to highly negative associations with production performance traits. Likewise, DP had low to highly negative phenotypic correlations ranged from -0.55 (MSC) to -0.07 (AFC) except highly positive significant associations with SP (0.44) and CI (0.43). Likewise, similar estimates of genetic and phenotypic correlations were reported in Frieswal cattle [4, 40 and 41].

Conclusion

In the present study heritability estimates for various production performance traits were found to be low to high ranging from 0.04 (SP) to 0.50 (MSC). The genetic and phenotypic correlations between production performance traits were low to

Table-1 *Estimates of heritability (diagonal), genetic correlation (below diagonal) and phenotypic correlation (above diagonal) among various production performance and reproduction traits*

Trait	LMY	LMY-305	LL	PY	AMY	MCI	MSC	Persistency	AFC	SP	CI	DP
LMY	0.41±0.11	0.96**±0.01	0.68**±0.10	0.52**±0.12	0.80**±0.05	0.91**±0.08	0.85**±0.03	0.76**±0.17	0.08±0.21	0.42**±0.62	0.44**±0.24	-0.27**±0.36
LMY-305	0.90±0.01	0.36±0.11	0.54**±0.14	0.48**±0.13	0.88**±0.03	0.90**±0.08	0.89**±0.02	0.75**±0.17	0.06±0.21	0.28**±0.71	0.29**±0.28	-0.29**±0.37
LL	0.79±0.10	0.72±0.14	0.26±0.09	0.55±0.15	0.15±0.22	0.56**±0.17	0.36**±0.16	0.50**±0.24	0.07±0.24	0.66**±0.40	0.69**±0.17	-0.31**±0.44
PY	0.59±0.12	0.58±0.13	0.42±0.15	0.44±0.16	0.39**±0.15	0.51**±0.12	0.43**±0.14	-0.09±0.20	0.01±0.20	0.25*±0.51	0.27**±0.26	-0.16±0.28
AMY	0.93±0.05	0.96±0.03	0.50±0.22	0.96±0.03	0.30±0.10	0.79**±0.09	0.90**±0.03	0.64**±0.20	0.06±0.20	0.02±0.78	0.02±0.36	-0.44±0.37
MCI	0.75±0.08	0.78±0.08	0.48±0.17	0.60±0.12	0.76±0.09	0.31±0.10	0.83**±0.10	0.66**±0.22	0.09±0.21	-0.07±0.12	-0.08±0.38	-0.09±0.31
MSC	0.90±0.03	0.50±0.22	0.75±0.16	0.59±0.14	0.94±0.03	0.73±0.10	0.50±0.12	0.66**±0.18	-0.23*±0.19	0.30**±0.88	0.28**±0.28	-0.55±0.44
Persistency	0.51±0.17	0.51±0.17	0.29±0.24	-0.41±0.20	0.46±0.20	0.16±0.22	0.50±0.18	0.26±0.09	0.11±0.22	0.30**±0.53	0.31**±0.35	-0.35±0.39
AFC	-0.11±0.21	-0.19±0.21	-0.03±0.24	-0.23±0.20	-0.08±0.20	0.06±0.21	-0.45±0.19	0.11±0.22	0.45±0.20	-0.02±0.01	0.02±0.01	-0.07±0.01
SP	0.94±0.62	0.99±0.71	0.66±0.40	0.57±0.51	0.85±0.78	0.18±0.12	0.28±0.88	0.37±0.53	-0.48±0.10	0.04±0.01	0.94**±0.25	0.44**±0.10
CI	0.72±0.24	0.64±0.28	0.84±0.17	0.56±0.26	0.49±0.36	0.62±0.38	0.51±0.28	0.23±0.35	-0.36±0.10	0.07±0.01	0.10±0.07	0.43**±0.10
DP	-0.57±0.36	-0.51±0.37	-0.70±0.44	-0.32±0.28	-0.19*±0.37	-0.31**±0.31	-0.53**±0.44	-0.22**±0.39	-0.37±0.22	-0.69±0.20	-0.53±0.15	0.11±0.07

*Where (** P<0.01)*

high ranged from -0.69 (SP/DP) to 0.99 (LMY/LMY-305) and -0.55 (MSC/DP) to 0.96 (LMY/LMY-305). The genetic and phenotypic correlations of MSC with all production performance traits were moderate to high ranged from 0.28 (SP) to 0.90 (LMY) and 0.28 (SP) to 0.90 (AMY), respectively. It may be interfered from the study that selection based on MSC that had high estimates of heritability (0.50) and appreciably high genetic and phenotypic correlations with production performance traits, would not only improve production performance but also take care of reproductive performance. Therefore, selection based on MSC would result in improvement in desirable direction through positive correlated response in all the traits under study. Milk yield per day of age at second calving can be used as index traits in selection programme as it is associated with AFC and milk yield, which is an important trait that determines the economic merit.

Application of research: The research findings will be beneficial for scientific community involved in animal breeding and sire selection.

Abbreviations: MSC (milk yield per day of age at second calving), AFC (age at first calving), CI (calving interval)

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