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Evaluation of reproductive performance of crossbred cattle maintained at an organized farm in Punjab

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Abstract
Records of 642 animals belonging to 79 sires maintained at GADVASU livestock farm, Ludhiana, Punjab were analyzed to study the effect of genetic and non genetic factors on birth weight (BW), age at first service (AFS) and age at calving (AFC). The least square means for BW, AFS and AFC were 28.32±0.35 kg, 604.79±13.24 days and 942.39±12.00 days, respectively. The heritability estimates of BW, AFS and AFC were 0.149±0.046, 0.525±0.142 and 0.408±0.132 respectively. The effect of sire was significant on AFS and AFC and non significant on BW. Animal's genetic group did not significantly affect any trait. BW was significantly affected by season of birth. The period of birth significantly affected the AFS and AFC. The moderate – high heritability estimates suggest ample scope of improvement in the reproductive performance of crossbred cattle through direct selection.

Keywords: Birth weight, age at first service, age at first calving, heritability

Introduction
India is predominantly an agricultural country with about 70% of the population is engaged in agriculture and rearing of livestock. The cattle population of India is 190.90 million out of which 39.73 million are crossbred cattle showing an increase of 20.18% compared to 2007. There has been an overall increase of 37% in crossbred cattle population in Punjab as compared to the previous census of 2007 (19th livestock census) [1]. In India, there are 43 registered breeds of cattle (NBAGR, 2019) [2]. In spite of large genetic resources, productivity remains low. The productivity can be increased by crossing low producing indigenous cattle with high yielding exotic cattle. The crossbreeding programme is aimed at improving the genetic potential of animals for milk production by increasing the proportion of high yielding crossbred cattle and enhancing the reproductive efficiency of female stock. The knowledge of genetic and non-genetic factors influencing the performance traits is essential to obtain correct estimates of genetic parameters and for developing a suitable selection criterion (Kumar *et al.*) [3]. Genetic parameter estimates are needed for implementation of breeding programs and assessment of progress of ongoing programs where accuracy in their estimation is of paramount importance (Wasike *et al.*) [4]. The estimates of heritability, and the magnitude and type (direction) of genetic association among economic traits are the most important genetic parameters needed for designing a breeding plan to bring about genetic improvement in overall productivity of herd. Phenotypic and environmental associations among these traits are required for efficient flock/herd management system so as that genetic potential can be fully realized.

Material and Methods
The data for the present study was collected from the history-cum-pedigree sheets and performance records of crossbred cattle, having inheritance of Holstein Friesian, Red Dane and Sahiwal, born over a period of 24 years from 1991-2014 at Directorate of livestock farm, GADVASU, Ludhiana. The records of 642 animals sired by 79 sires were utilized to study the effect of sire, genetic group, period of birth and season of birth. Only the sires having three or more progenies were included. Only the data on normal births and normal calves were considered for study. According to the presence of exotic inheritance the animals were grouped in four groups viz. less than 75%, equal to 75%, more than 75% and less than 87.5%, and more than 87.5% exotic inheritance. The entire duration of 24 years from 1991 to 2014 was divided into 6 periods each having four years duration viz. 1991-1994, 1995-1998, 1996-

2002, 2003-2006, 2007-2010, 2011-2014. Year to year variation within the period were assumed to be non-significant. Each year was divided into four seasons viz. winter (October to December), spring (January to March), summer (April to June), rainy (July to September) on the basis of fluctuations in atmospheric temperature and relative humidity.

Statistical analysis: The data was analyzed using the Mixed Model Least-Squares and Maximum Likelihood Computer Program of Harvey [5]. The statistical model used in present study is as follows

$$Y_{ijklm}=\mu + S_i + G_j + P_k+ S_{El} + e_{ijklm}$$

Where,

Y_{ijklm} = Observation on the mth individual in ith sire jth genetic group kth period lth season.

μ = Population mean

S_i = Effect of ith sire (i = 1 to 79)

G_j = Effect of jth genetic group (j = 1 to 4)

P_k = Effect of kth period (k = 1 to 6)

S_{El} = Effect of lth season (l = 1 to 4)

e_{ijklm}=Error associated withthe Y_{ijklm} and is assumed to be distributed normally with mean zero and constant variance

The statistical significance of various fixed effects in the least squares model was determined by 'F' test. For significant effects, the differences between pairs of levels of effects were tested by Duncan's multiple range tests as modified by Kramer [6]. Genetic and phenotypic parameters for different production traits were obtained by paternal half-sib correlation method as per standard procedure.

Results and Discussion

Effect of genetic and non-genetic factors

The result of the Combined Least-Squares Analysis of Variance to study the effects of various factors on different traits is shown in Table 1. The effect of sire on BW was non-significant and highly significant on AFS and AFC. Raja *et al*[7] found the sire effect to be significant on BW of crossbred calves in Kerala. The genetic group did not significantly influence the BW, AFS and AFC. This finding was in agreement with the finding of Islam *et al.* [8] on crossbred cattle maintained at selected farms of Bangladesh. The birth weight was higher in genetic group 4 indicating that there has been improvement in birth weight with the increased exotic inheritance. The age at first service was highest in animal genetic group 2 and lowest in animal genetic group 4 as compared to other groups. The trend indicates that AFS has decreased with the increased exotic inheritance. No systematic trend was observed for AFC.

There was no significant influence of period of birth on BW. The average birth weight ranged between 27.69 to 30.97 kg over the periods with no systematic time trend. Akbulut *et al.* [9], Bakir *et al.* [10] and Raja *et al.* [7] found significant effect. AFS and AFC were significantly influenced by period of birth. The AFS ranged from 550.78 to 660.10 days over the period. There was decreasing trend of AFS over the years suggesting improvement in the herd. Significant influence of the period of birth on AFS were also reported by Rahumathulla *et al.* [11], Demeke *et al.* [12], Akhtar *et al.* [13] and Vinothraj *et al.* [14]. The AFC ranged from 849.69 to 1059.12 days. Decreasing trend was observed up to sixth period suggesting improvement in the herd over the years. Dubey and Singh [15], Singh *et al.* [16], Choudhari *et al.* [17], Kumar *et al.* [18], and Japeth *et al.* [19] also observed significant effect of period of birth on average AFC.

The season of birth highly significantly influenced the birth weight. The birth weight was generally higher in spring and summer as compared to other seasons. The season trend indicates that maximum number of calves was born during winter season followed by rainy and least number of calves were recorded during summer season. Singh & Ray [20], Mathai *et al.* [21], Shibata & Kumazaki [22], Sang & Kim [23], Ulsan [24] and Bakir *et al.* [10] also reported significant influene of season of birth on birth weight. However, Anderson & Plum [25], Mathai *et al.* [26], Matai & Raja [27], Ornelas & Ponce [28], Akbulut *et al* [9] and Raja *et al.* [7] found no significant variation in birth weight of calves born in different seasons. The season of birth did not significantly influence the AFS. Similar finding was observed by Vinothraj *et al.* [14] whereas non significant effect was observed by Rahumathulla *et al*[11]and Varaprasad *et al.* [29].The season of birth did not significantly influence the AFC and is in accordance with the study of Rafique *et al.* [30], Yadav *et al.* [31], Dubey and Singh [15], Choudhari *et al.* [17] and Kumar *et al.* [18]. AFC was observed to be lowest in spring season born animals.

Least Squares Means and Heritability

Mean performance and factors affecting traits like body weight during different periods are of importance due to their effect on onset of sexual maturity, survival rate and to some extent on reproduction and production (Raja *et al.*) [7]. The least squares mean for birth weight (BW) was 28.32±0.35 kg (Table 1). The overall mean was, in general, higher than those reported by Khan & Khan [32], Islam *et al.* [8], Olawumi *et al.* [33] and Raja *et al.* [7]. Higher birth weight was reported by Bakir *et al.* [10], Bayram & Aksakal [34] and Akbulut *et al.* [9]. The overall least squares mean for age at first service (AFS) was 604.79 ±13.24 days (Table 1). Azizunnesa *et al.* [35], Bag *et al.* [36], Hasanuzzaman *et al.* [37] reported AFS as 32.2 months, 32.42 months and 2.7±1.7 years in Red Chittagong cattle of Bangladesh. Higher estimates were observed by Islam *et al.* [8], Maurya and Saswat [38], Varaprasad *et al* [29] and Vinothraj *et al.* [14]. The least squares mean for age at first calving (AFC) was 942.39 ±12.00 days (Table 1) and was within the range of those reported by Singh & Gurnani [39]. Higher estimates have been reported by Rafique *et al.* [30], Yadav *et al.* [31], Islam *et al.* [8], Dubey and Singh [15], Sinha *et al.* [40], Thomas and Kumar [41], Belay *et al.* [42], Hunduma *et al.* [43], Choudhari *et al.* [17], Hassan and Khan [44] and Kumar *et al.* [18] in crossbred cattle.

The heritability estimate of BW in the present study was moderate (0.149±0.046). Similar moderate heritability estimate was reported by Raja *et al.* [7] of value 0.19±0.09 in crossbred cattle. However low heritability estimate was reported by Keygisiz[45] in Simmental & Brown Swiss cattle. Higher estimates were reported by Akbulut *et al* [9], Khan & Khan [32], Islam *et al.* [8], Abera *et al.* [46] and Aksakal *et al.* [47]. The different estimates may be attributed to differences in breed, management of the herd and the methods used to derive the estimates. The heritability estimate of AFS in the present study was 0.525±0.142 which was in agreement to the estimates of 0.11 to 0.42 reported by different researchers (Souza *et al.* [48], Lee *et al.* [49] and Deb *et al.* [50]). The heritability of AFC was 0.408±0.132. Similar estimates ranging from 0.44 to 0.48 were reported by Demeke *et al.* [12], Choudhari *et al.* [17] and Versces Fielho *et al.* [51]. However lower estimates ranging from 0.05 to 0.26 was reported by Chaudhary *et al.* [52] and Dubey & Singh [15]. Bhadoria *et al.* [53] reported higher value of 0.68±0.07 in Gir cattle.

Table 1: Least Square Means along with standard error of BW, AFS and AFC for various factors

Factors	No of observation	BW (kg)	AFS(days)	AFC(days)
µ	642	28.32± 0.35	604.79 ±13.24	942.39 ±12.00
Genetic Group		NS	NS	NS
1 (<75%)	46	26.89±0.84	580.49±24.29	947.13 ±23.47
2 (= 75%)	395	28.70±0.44	583.94±15.08	924.97 ±13.97
3 (>75≤87.5%)	168	29.09±0.48	627.89±15.95	933.89 ±14.88
4 (>87.5%)	33	28.59±1.03	626.86±28.88	963.56 ±28.12
Period		NS	*	**
1991-1994	115	29.37±1.26	708.84 ±34.90^{a}	980.33±34.17^{a}
1995-1998	160	30.05±1.10	665.72 ±30.83^{b}	929.52±30.08^{ab}
1996 2002	121	28.98±0.91	632.39±26.082^{ab}	1000.84±25.29^{ab}
2003-2006	92	28.30±1.06	610.91 ±29.72^{ab}	973.79 ±28.96^{c}
2007-2010	100	28.23 ±1.50	552.92 ±41.05^{c}	917.93 ±40.33^{c}
2011-2014	54	24.97±1.85	457.98 ±50.16^{c}	851.91 ±49.41^{c}
Season		**	NS	NS
Winter	198	27.98 ±0.48^{a}	596.67 ±15.88	954.26 ±14.82
Spring	152	29.17±0.50^{a}	609.20 ±16.22	929.12 ±15.17
Summer	123	28.81±0.53^{b}	608.40 ±17.00	947.79 ±15.99
Rainy	169	27.31 ±0.49^{b}	604.91 ±16.01	938.38 ±14.95
Sire		NS	**	**

Conclusion

The moderate-high heritability estimates for reproductive traits suggest plenty of room for improvement in performance through direct selection. AFS and AFC improved significantly over the periods which indicated the possibility of improvement of reproductive performance through better management and selective breeding policy at the farm. Selection of superior sires is recommended for improvement of the genetic potential of the herd.

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