STUDY OF GENETIC AND NON GENETIC FACTORS AFFECTING AGE AT FIRST CALVING AND WET AVERAGE IN MEHSANA BUFFALOES

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ABSTRACT

Mehsana buffalo is one of the best dairy breed of buffalo in Gujarat state. The aim of this study was to analyse the effects of non-genetic factors on Age at first calving (AFC) and Wet average (WA). The data set comprised 12560 records up to three lactations of 7870 Mehsana buffaloes, sired by 200 bulls from 1989 to 2013 under field progeny testing programme of Dudhsagar Research and Development Association (DURDA), Dudhsagar Dairy, Mehsana. The least squares maximum likelihood (LSML) program was used for estimation of various non-genetic factors on AFC and WA. The least squares mean with standard error of AFC and WA were 1383.30±3.50 days and 7.00±0.22 lit. Highly significant ($P<0.01$) effect of season and period of birth was recorded on AFC however, effect of clusters on AFC was observed to be non-significant ($P<0.05$). Further, highly significant ($P\leq0.01$) effect of all the non-genetic factors (parities, season of calving, clusters, period of calving and age at first calving group) under study was observed on wet average in Mehsana buffaloes. The heritability of AFC and WA were estimated as0.11±0.02 and 0.34±0.03 respectively. Heritability of traits are useful for prediction of genetic response to selection and measure for accuracy in selection. Very high and significant estimate of heritability of WA. It was concluded that selection of Mehsana buffaloes may be based on this production trait in the herd.

Keywords: *Bubalus bubalis*, buffalo, Mehsana buffalo, age at first calving, wet average, genetic, non-genetic

INTRODUCTION

India is leading milk producing country in the world. Gujarat possesses rich biodiversity of buffalo population, inhabits four well-established buffalo breeds *viz.*, Mehsana, Surti, Jaffarabadi and Banni. As per 19th Livestock Census total number of buffalo in the country is 108.7 million. The buffalo constitute around 21.23% of total livestock population of India (Annual Report, 2016-2017). Mehsana is one of the best dairy breed of buffaloes and considered to be regular breeder. Although the breed has contributed significantly in the milk production and had greater role in 'Operation flood' programme initiated to augment milk production in India, but the genetic potential of this breed has not been utilised to the fullest.

Age at first calving and wet average are the economic traits which are of important monetary value in the production of livestock. Age at first

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calving is one of essential traits for bringing improvement in milk production. It considerably affects the productive life of an animal and the number of calves obtained during the life time of that animal. Reduction in AFC is desirable for reducing rearing cost of heifer and for economizing milk production cost. Further, association of wet average with total milk yield and many of the reproduction rate necessitates the study the non-genetic and genetic factor affecting it. The genetic improvement in Mehsana buffaloes can be brought about by understanding the factors that affect these two traits. In the present study, an attempt has been made to estimate the genetic parameters of these traits as well as the non-genetic factors affecting them in Mehsana buffaloes.

MATERIALS AND METHODS

The data for the present study was collected from Dudhsagar Research and Development Association (DURDA), Dudhsagar Dairy, Mehsana for the period from 1986 to 2013. Dudhsagar Research and Development Association (DURDA) is actively engaged with the genetic improvement of buffalos and cows. The Mehsana district Co-operative Milk Producers' Union Limited, with the help of National Dairy Development Board, Anand, is carrying out field progeny testing programme through DURDA in Mehsana buffaloes since 1985. Geographically, the farms are located in Mehsana district (area of over 4500 km^2) in Gujarat, which is situated at the cross point of 23.40ºN latitude and 72.30ºE longitude, at an altitude of 265 meters above mean sea level. The climate of region is tropical and semi-arid maximum temperature recorded is 45ºC and minimum is 15ºC. Average rainfall in the district is around 668 mm and rainy season lasts for approximately 45 days. A total of 12560 lactation records belonging to 7825 buffaloes were utilised for the study. The data were classified according to parity, clusters, periods, seasons and age at first calving group. A total of 74 villages were clustered into three groups based on geographical location. Generally, the production and reproduction performance of Mehsana buffaloes in the present study scattered over 25 years, beginning from 1989. However, considering the contiguous years to have more or less similar effect, the entire data was grouped into the five periods according to year of calving for wet average and year of birth for AFC. Each year was divided into two seasons *viz* breedingseason - 1 (January to June) and breedingseason - 2 (July to December), season of birth and season of calving for both AFC and WA respectively. Classification in to AFC groups were done by taking the mean and standard deviation (SD) of age at first calving and three groups were defined, *viz*. < X-1 SD = <1100 days, X±1 SD = 1101-1678 days, > X+1 SD = 1679 days.

The least squares analysis of variance for unequal sub-class numbers (Harvey, 1990) was used to estimate the effect of non-genetic factors. The statistical model for AFC is $Y_{ijkl} = \mu+A_i+B_j+C_k+e_{ijkl}$ Where; Y_{ijkl} is l^{th} record of buffalo born in i^{th} cluster, j^{th} period and k^{th} season; μ is population mean; A_i is fixed effect of i^{th} cluster where, i is 1, 2 and 3; B_j is fixed effect of j^{th} period of birth where, j varies between 1, 2, 3, 4 and 5; C_k is fixed effect of k^{th} season of birth where, k is 1 and 2; e_{ijkl} is random error assumed to be normally and independently distributed with zero mean and constant variance (NID, 0, σ^2). The statistical model for WA is $Y_{ijklmn} = \mu+A_i+B_j+C_k+D_l+E_m+e_{ijklmn.}$ Where all notations have their usual meaning as mentioned above except, instead of birth, calving is to be considered;

D_l is fixed effect of l^{th} parity where, l is 1, 2 and 3; E_m is fixed effect of m^{th} age at first calving group where, m is 1, 2 and 3. The differences of means between subclasses of cluster, period, season, parity and age group were tested for significance using modified Duncan's Multiple Range Test (Kramer, 1957).

Genetic parameters (heritability and their genetic correlations) were estimated using paternal half sib correlation method (Becker, 1975). The data adjusted for significant effects of non-genetic factors were used for estimation of heritability. The model used to estimate the heritability was, $Y_{ij} = \mu+S_i+e_{ij}$ Where, Y_{ij} is j^{th} observation on a trait from progeny of i^{th} sire and S_i is effect of i^{th} sire. The standard error of heritability was estimated as per Swiger *et al.* (1964). The repeatability was estimated for WA with maximum three parities using intraclass correlation among repeated records of the same animal. The model was similar to that used for estimation of heritability except that between animal variance was used instead of between sire variance.

RESULTS AND DISCUSSION

The least squares mean for AFC in the present study was obtained as 1383.30±3.50 days in Mehsana buffaloes. The present estimate of AFC in Mehsana buffaloes was close to those reported previously by Prajapati *et al.* (2017); Chaudhary (2016) in Mehsana buffaloes and Jamal *et al*. (2017) in Murrah buffaloes. Whereas, it was higher than the values reported by Gupta *et al*. (2012); Jamuna *et al*. (2015b) in Murrah. On other hand, the LSM for AFC in the current study was lower than those reported by Galsar *et al*. (2016) in Mehsana and Chaudhary (2015) in Murrah buffaloes (Table 1).

The results of analysis of variance showed that season of birth had highly significant (P≤0.01) effect on AFC in the present investigation. The buffaloes born during first season was having significantly higher AFC than those born during the second season. The significant effect of season on AFC is in line with those reported by Galsar *et al.* (2016); Chaudhari (2016) in Mehsana; Gupta *et al.* (2012); Jamal *et al*. (2017) in Murrah buffaloes. Season may influence the expression of performance traits in buffaloes because of wide variation of climatic condition throughout the year.

The cluster of distribution of buffaloes had non-significant effect on AFC however, lowest AFC was observed in first cluster (1377.91±6.64) and highest in second cluster (1393.37±4.52). The variation observed in the AFC in different clusters accounted for the variation in managemental practices and resources available within the village receiving random sires. On the contrary, highly significant (P≤0.01) effect of period of birth on AFC was observed, which was highest in second period and lowest in first period However, there was no significant difference in AFC between 4^{th} and 5^{th} period, which differed significantly from rest of the periods. This finding is analogy with those reported by Galsar *et al.* (2016); Chaudhari (2016) in Mehsana; Gupta *et al.* (2012); Jamal *et al*. (2017) in Murrah buffaloes. The variation observed in different period is the reflection of differences in the feeding and fodder availability during different periods influencing the growth rate and age at first calving in the heifers.

The least squares mean of wet average for Mehsana buffaloes across progeny testing area was estimated to be7.00±0.22 lit. This was close to those reported previously by SDAU (2015) in Banni (simple mean), Jamuna *et al*. (2015a); NDRI, (2017) in Murrah buffaloes.

The parity had highly significant effect on WA and it was observed to be lowest in 1st parity and highest in 3rd parity. This was in equivalence with those reported by Jamuna *et al*. (2015[a]) in Murrah buffaloes. The significant effect of parity may be due to the fact that animals are in the growing stage during their first pregnancy and first lactation and the physiological development in the body of an individual animal in the early ages, which have stabilized in the subsequent lactations. Season of calving also had a highly significant (P≤0.01) effect on WA in the present study. It was significantly lower in buffalo calves born in second season. The present finding of highly significant effect of season of calving on WA was in contradiction with those reported by Jamuna *et al.* (2015[a]) in Murrah buffaloes and Tripathy *et al.* (2017) in Karan-Fries cattle.

Different clusters had highly significant (P≤0.01) influence and WA obtained was highest in cluster-3. Similarly, period of calvingwas also having highly significant (P≤0.01) effect on wet average and it was in equivalence with those reported by Jamuna *et al.* (2015[a]); Tripathy (2015) in Murrah buffaloes and Sahiwal cattle, respectively. Effect of age at first calving group was again found to have highly significant (P≤0.01). It was significantly lower in group-3 (A_3) as compared to those in A_1 and A_2. Jamuna *et al*. (2015[a]) reported similarly significant effect of AFC group on WA in Murrah buffaloes.

Among genetic parameters, the estimate of heritability for AFC was calculated to be 0.11±0.02, which was low but significantly differ from zero. The present finding of low estimate of heritability for AFC was in conformity with those reported by Chaudhary, (2016) in Mehsana and Barros *et al.* (2016) in Murrah. The heritability estimate for wet average (WA) was found to be 0.34±0.03, which was significantly different from zero (P≤0.01). Jamuna *et al*. (2015[b]) reported lower heritability for the same trait in Murrah buffaloes. Moreover, comparatively higher estimates of heritability for WA than the present estimate was reported by Tripathy *et al.* (2017) in Karan Fries cattle (Table 2).

Repeatability tells about the probability at which the repetition of the trait in an individual is expected in future. WA being the repeatable trait, as the repeatability was also estimated for this and it was found to be0.44±0.06, which is high and significantly different from zero. High repeatability estimate implies that early selection of the buffaloes will be reliable on basis of wet average. The phenotypic correlation ($r_{g)}$ between WA and AFC was estimated as 0.44±0.11whichis positive, high and highly significant. This implicate that these two traits are positively correlated which is undesirable hence, care must be taken while using both these traits simultaneously as selection criteria.

CONCLUSION

The effect of period and season of birth on age at first calving and season, period, parity, age at first calving group on the wet average suggested that traits should be adjusted for non-genetic factors. The high heritability of WA showed the importance of including this trait in the future selection programme when genetic improvement is sought. The genetic and phenotypic correlations between WA and AFC were on higher side but undesirable, suggesting that care should be taken while using wet average as selection criteria, as it may increase AFC too. The high repeatability (0.44±0.06) estimates of WA suggest that buffaloes could be selected for this trait based on early

Table 1. Least squares means with their standard errors and coefficient of variations for age at first calving and wet average in Mehsana buffaloes.

Traits	AFC(days)	WA(lit)
μ	1383.30±3.50 (21.8,7870)	7.00±0.22 (22.3,12524)
Parity		**
1	-	6.26±0.21 (20.8,7870)
2	-	7.20±0.30 (21.3,3153)
3	-	7.56±0.39 (20.5,1501)
Season	**	**
1	1396.12±5.05 (22.6,1386)	7.14±0.33 (22.5,2140)
2	1370.47±4.43 (21.6,6484)	6.87±0.20 (22.2,10384)
Cluster	NS	**
1	1377.91±6.64 (21.9,1835)	7.02±0.31 (21.9,2825)
2	1393.37±4.52 (21.7,4068)	6.85±0.24 (22.1,6501)
3	1378.61±6.43 (22.0,1967)	7.14±0.30 (22.7,3198)
Period	**	**
1	1267.54±8.29 (20.9,1159)	6.93±0.40[a](20.2,1502)
2	1462.96±7.49 (24.5,1498)	6.95±0.31[a] (22.0,2572)
3	1352.81±6.52 (21.9,1916)	6.96±0.28[a] (23.0,3515)
4	1426.46±6.27[a] (21.0,2104)	6.91±0.27[a] (23.0,3694)
5	1406.71±8.28[a] (19.7,1193)	7.26±0.44[b] (20.4,1241)
AFC group		**
1	-	7.05±0.33 (21.9,2166)
2	-	7.05±0.22 (22.3,8543)
3	-	6.91±0.36 (22.7,1815)

Figures within parentheses are the coefficient of variation and number of observations; ** = P≤0.01; * = P≤0.05; NS: non-significant. Superscripts may be read column wise for each effect for mean comparison. Similar superscript shows that the means do not differ significantly.

Table 2. Heritability and repeatability of traits in Mehsana buffaloes.

	AFC	WA
AFC	**0.11±0.02****	0.43±0.91
WA	0.44±0.11**	**0.34±0.03**** 0.44±0.06**

** = P≤0.01; Above diagonal = genetic correlations;
below diagonal = phenotypic correlations;
diagonal= heritability (bold) and repeatability.

lactation records.

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