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Effectiveness of various sire evaluation methods in ranking Mehsana bulls based on FL305MY and TMY under field progeny testing programme

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Buffaloes in India have a place of pride in all respects, viz. production, productivity and population in the world, diversity, service to the underprivileged, clean draft power, sure-footed transport, rich food/nutrition, support to a host of industries and livelihoods etc. Mehsana is one of the world's best dairy type buffalo with superior genetic potential for milk production. Dudhsagar Research and Development Association (DURDA), Dudhsagar Dairy, Mehsana, is involved in breeding and improvement programme for Mehsana buffaloes in Gujarat by undertaking field progeny testing programme since 1985. The accurate measurement of the milk production of individual buffalo is of major interest in dairy genetic improvement programs (Parmar *et al.* 2018). It is expected that demand for milk in India is likely to increase to besides 200 million tonnes by 2021–22. To meet the growing demand, it is necessary to improve the native breeds through proper breeding system besides identification of high genetic merit bull for healthy semen production in field. Keeping the above facts in view, the present study was undertaken to assess the breeding values of sires by least squares (LS) technique, BLUP Sire model and BLUP Animal model based on first lactation milk yield under field progeny testing programme as well as effectiveness of different sire evaluation methods by studying their efficiency to discriminate amongst Mehsana buffalo bulls.

The first lactation monthly test-day milk yield data of Mehsana buffaloes that calved between 1989 and 2013 at the farms located in the field progeny testing areas of Dudhsagar Research and Development Association were used. Villages (74) were clustered into 3 groups based on the geographical location. The duration of 25 years was classified in to 5 periods each of 5 years. Each year of calving was further classified into 3 seasons, viz. winter (November to February), summer (March to June), rainy (July to October). Only the sires having records on at least 10 daughters were included in the present study.

First lactation milk yield was calculated using two approaches. First, test-day recordings were used to generate FL305MY using the formula as recommended by Department of Animal Husbandry and Dairying (DAHD 2009), Government of India. Second approach was to calculate total first lactation milk yield (TMY) as per the procedure suggested by the International Committee for Animal Recording (ICAR 2014).

Three different sire evaluation methods, viz. least-squares analysis of variance (Harvey 1979) to estimate the breeding values for bulls; best linear unbiased prediction sire model (BLUP-SM), where (co)variance components were estimated by best linear unbiased prediction animal model (BLUP) in WOMBAT genetic analysis tool (Meyer 2007) and best linear unbiased prediction animal model (BLUP-AM) were employed. The single trait animal model was considered for estimation of breeding values.

The effectiveness of sire evaluation methods was judged by using various criteria, viz. within sire variance (or error variance) and rank correlations. The method with the lowest error variance was considered as the most efficient method. Spearman's rank correlation between the ranks based on breeding values of sires derived by 2 methods was estimated. Higher rank correlation between the sire evaluation methods indicated higher degree of similarity of ranking by 2 methods.

Sire evaluation involves the estimation of breeding value of the bulls on the basis of first lactation 305-days milk yield of their daughters with a rationale to minimise the generation interval. The average expected breeding value of Mehsana buffalo bulls by LS method for FL305MY was 2,284.02 litres (Table 1), which ranged from 2,767.52 litres 1,987.10 litres. The breeding values of as many as 81 sires (44.51%) were more than the average expected breeding value. Similarly, the expected breeding value by best linear

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Table 1. Average breeding value (BV) estimates of sires for first lactation 305-day milk yield and total milk yield by different methods

Trait	Sire evaluation method	Average BV (Litre)	Number of sires above average	Number of sires below average	Maximum BV (Litre)	Minimum BV (Litre)	Range of BV (Litre)
FL305MY	LS	2284.03	81 (44.51%)	101 (55.49%)	2767.52	1987.10	780.42
	BLUP-SM	2242.11	81 (44.51%)	101 (55.49%)	2713.44	1946.15	767.29
	BLUP-AM	2256.81	81 (44.51%)	101 (55.49%)	3072.86	1737.13	1335.73
TMY	LS	1913.74	83 (45.61%)	99 (54.39%)	2345.03	1598.74	746.29
	BLUP-SM	1870.57	85 (46.71%)	97 (53.29%)	2283.84	1553.61	730.23
	BLUP-AM	1891.24	87 (47.81%)	95 (52.19%)	2590.17	1347.00	1243.17

Table 2. Relative efficiencies of different sire evaluation methods for different first lactation traits in Mehsana buffaloes

Trait	Method	Error variance	Relative efficiency (%)
FL305MY	LSM	1591471963.00	67
	BLUP-SM	1577000000.00	68
	BLUP-AM	1071570000.00	100
TMY	LSM	1642950151.00	53
	BLUP-SM	1361890000.00	64
	BLUP-AM	875461000.00	100

unbiased prediction sire model (BLUP-SM) was 2,242.11 litres, which ranged from 2,713.44 to 1,946.15 litres. The average expected breeding value of Mehsana buffalo bulls obtained by both LSM and BLUP-SM was higher than those previously reported by Singh *et al.* (2014) and Chaudhari *et al.* (2015) in Murrah buffaloes. The average expected breeding value obtained by BLUP-AM for FL305MY was 2,256.81 litres, which ranged from 3,072.86 to 1,737.13 litres. The obtained breeding value was higher than those reported by Singh *et al*. (2014) and Yadav and Singh (2015) in Murrah buffaloes. Number of sires above and below the average expected breeding value was similar with all the methods used and it was same as estimated by the least squares method (Table 1).

The breeding values of the Mehsana bulls under study for TMY by LS, BLUP-SM and BLUP-AM were 1,913.74, 1,870.57 and 1,891.24 litres, respectively (Table 1). Similarly, range of these estimates was 2,345.03 to 1,598.74, 2,283.84 to 1,553.61 and 2,590.17 to 1,347.00 litres, respectively, by LS, BLUP-SM and BLUP-AM methods. The number of bulls having breeding values more than the average breeding value was highest by BLUP-AM followed by BLUP-SM and LSM.

The sire evaluation method/model which gave the lowest error variance was considered to be most efficient and taken as the base for efficiency estimation of other methods. BLUP-AM method had lowest error variance both for FL305MY and TMY as compared to other methods of sire evaluation, indicating it as most efficient methods (Table 2). The relative efficiency of LSM and BLUP-SM method for FL305MY were 67 and 68%, respectively. Similarly, the relative efficiency of LSM and BLUP-SM method for TMY was 53 and 64%, respectively. Singh *et al.* (2014) and Dash *et al*. (2014) also found BLUP-AM method to be more efficient than other methods in Murrah buffaloes and in Holstein Friesians Crossbred respectively.

The values of rank correlation coefficients of LSM and BLUP-SM methods with most efficient BLUP-AM method were 0.954 and 0.953, respectively. Similarly, for TMY, the values of rank correlation coefficients of LSM and BLUP-SM with BLUP-AM method were 0.920 and 0.922, respectively. These estimates of rank correlation coefficients for both the traits studied were highly significant (P≤0.01). As such these two methods are expected to rank sires with similar accuracy as compared to the most efficient method. However, the magnitude of the coefficients of rank correlation indicated that in comparison to BLUP-AM, relative accuracy was highest for LSM followed by BLUP-SM methods (Table 3). The present findings regarding the ranking of different sire evaluation methods was in agreement with the reports of Singh *et al.* (2014), Chaudhari *et al.* (2015) and Kumar *et al.* (2015) in Murrah buffaloes.

Based on these results, it was concluded that the breeding values of Mehsana buffalo bulls for first lactation milk yield by all the 3 methods were higher than those documented for Murrah buffaloes by various workers. This suggests that Mehsana buffaloes have higher genetic potential for milk production. BLUP-AM method was relatively more efficient, accurate and stable with lowest genetic variation than other methods of sire evaluation. Hence this model is recommended for genetic evaluation of Mehsana buffalo

Table 3. Rank correlations between breeding values of Mehsana buffalo bulls for FL305MY and TMY by different methods

Method	LSM	BLUP-SM	BLUP-AM
		FL305DMY	
LSM	1	1.000**	0.954**
BLUP-SM		1	0.953**
BLUP-AM			1
		TMY	
LSM	1	0.984**	0.920**
BLUP-SM		1	0.922**
BLUP-AM			1

**Significant (P≤0.01).

bulls. The rank correlation coefficients among breeding value of sires by all the methods are expected to rank sires with fairly high accuracy. The results appear to promise further improvement in milk production through the use of progeny tested bulls in the years to come and use of top ranking sires under field conditions appears to promise substantial improvement in the milk yield of Mehsana buffaloes.

SUMMARY

First lactation records of 8,072 Mehsana buffaloes, progeny of 182 bulls, spread over a period of 25 years (1989–2013) maintained under field progeny testing programme of DURDA, Dudhsagar Dairy, Mehsana, Gujarat, India were used to estimate the breeding values of Mehsana buffalo bulls for first lactation milk yield (FL305MY and TMY) by least squares, BLUP-SM and BLUP-AM methods. The effectiveness of different sire evaluation methods was compared using error variance and rank correlations among the estimated breeding values of sires. The average breeding values for FL305MY by LS, BLUP-SM and BLUP-AM were 2284.02, 2242.11 and 2256.81 litres, respectively. The corresponding values for TMY were 1913.74, 1870.57 and 1891.24 litres, respectively. BLUP-AM method had lowest error variance for both FL305MY and TMY as compared to LS and BLUP-SM methods making it as the most efficient method. The rank correlation coefficients indicated that all the methods could rank the sires with fairly high accuracy with highest relative accuracy for BLUP-AM.

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