



Comparison of different methods of sire evaluation in Sahiwal cattle

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Received: 30 May 2011; Accepted: 9 August 2011

Key words: Accuracy of evaluation, Breeding value, Sahiwal cattle, Sire evaluation

Sire evaluation is one of the most important aspects of dairy breed improvement programme as the contribution of sire path is higher than the dam path for overall genetic improvement of a trait. Thus, the primary aim of an animal breeder is to develop appropriate methodology for sire evaluation to bring about fastest possible genetic improvement in desirable traits. There are several methods of sire evaluation, viz. least squares method (LSM), simple regressed least squares (SRLS) and best linear unbiased prediction (BLUP) and derivative-free restricted maximum likelihood (DFREML). However the efficiency of the methods in predicting the expected breeding value of the sires varies. Hence, the present study was undertaken to study the efficiency of estimating the expected breeding values of Sahiwal sires by the above 4 different methods.

The data on 586 Sahiwal cows born to 50 Sahiwal sires maintained at National Dairy Research Institute, Karnal, over a period of 47 years (1961–2007) were used for the present study. The records of the animals with known pedigree and normal lactation were considered for this study. Sires with 5 or more daughters were evaluated on the basis of first lactation 305-day or less milk yield (FL305DMY) by 4

methods, viz. LSM, SRLS, BLUP and DFREML as described by Harvey (1987), Harvey (1979), Henderson (1973) and Meyer (1998), respectively. The effectiveness of different sire evaluation methods was judged by using various criteria, viz. within sire variance or error variance, coefficient of variation (%), coefficient of determination (%) and rank correlations.

The results on the average expected breeding values, number of sires above and below the average breeding value and the max and min expected breeding values are given in Table 1. The average breeding value of 50 Sahiwal sires evaluated on the basis of first lactation 305-day or less milk yield estimated by LSM, SRLS, BLUP and DFREML methods were 1769.63, 1769.36, 1787.34 and 1800.08 kg, respectively (Table 1). Among the 4 methods used, the DFREML method gave the maximum overall average breeding value for the Sahiwal sires for first lactation 305-day or less milk yield. The breeding values estimated by LSM and SRLS were higher than the estimates reported by Banik and Gandhi (2007) and Kathiravan (2009) in the same breed. The BLUP method also gave higher estimate than the average breeding values reported by Banik and Gandhi (2006), Kumar

Table 1. Average expected breeding value (EBV) for first lactation 305-day or less milk yield by different single trait methods in Sahiwal sires

Sire evaluation methods	Average EBV	Number of sires above average EBV	Number of sires below average EBV	Maximum EBV	Minimum EBV
LSM	1769.63	27 (54.00)	23 (46.00)	2469.41 (39.54)	1056.36 (40.31)
SRLS	1769.36	27 (54.00)	23 (46.00)	2408.51 (36.12)	1086.40 (38.60)
BLUP	1787.34	27 (54.00)	23 (46.00)	2098.28 (17.40)	1301.82 (27.16)
DFREML	1800.08	27 (54.00)	23 (46.00)	2359.92 (31.10)	866.51 (51.86)

LSM, Least squares method; SRLS, simple regressed least squares method; BLUP, best linear unbiased prediction method; DFREML – derivative free restricted maximum likelihood method; figures in the parentheses indicate per cent above and below the average breeding value.

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(2007) and Kathiravan (2009) in Sahiwal cattle. This method gave the lowest range of breeding value (796.46 kg) among the different methods of sire evaluation used indicating that this method was discriminating amongst sires to the minimum extent. Deulkar and Kothekar (1999) also reported similar

Table 2. Effectiveness of different sire evaluation methods for first lactation 305-day or less milk yield in Sahiwal cattle

Sire evaluation methods	Error variance (Efficiency)	Relative efficiency*	Coefficient of determination (%)	Coefficient of variation (CV%)
First lactation 305-day or less milk yield				
LSM	332412.20 kg ²	48.41	15.70	33.02
SRLS	331321.78 kg ²	48.57	16.01	33.83
BLUP	345714.33 kg ²	46.55	26.50	32.66
DFREML	160916.26 kg ²	100.00	66.53	35.25

* Relative efficiency with respect to most efficient method *i.e.* DFREML

LSM, Least squares method; SRLS, simple regressed least squares method; BLUP, best linear unbiased prediction method; DFREML – derivative free restricted maximum likelihood method.

type of results in Sahiwal cattle. On the contrary, Banik and Gandhi (2007) reported that the range of breeding values estimated by BLUP method was the highest (1655 kg) among the different methods and this method discriminated amongst the bulls to the highest extent in Sahiwal cattle. The DFREML method showed highest difference (1493.42 kg) between the max and min breeding values indicating that this method was the best in discriminating amongst bulls to the highest extent as compared to other methods.

The estimates, viz. error variance, relative efficiency, coefficient of determination (%) and coefficient of variation (%) were used for comparing the effectiveness of different sire evaluation methods for first lactation 305-day or less milk yield and are presented in Table 2. The derivative free restricted maximum likelihood (DFREML) method had lowest error variance (160916.26 kg²) for first lactation 305-day or less milk yield and therefore, it was considered to be the most efficient out of all the 4 sire evaluation methods. Similar to the present findings, Banik and Gandhi (2007), Kumar (2007) and Mukherjee *et al.* (2007) reported that DFREML method was the more efficient compared to LSM and BLUP methods of sire evaluation.

The DFREML method showed highest coefficient of determination (66.53%) as compared to the other methods revealing that this method was the most accurate (Table 2). The BLUP (26.50%) was the second best method followed by SRLS (16.01%) and LSM (15.70%) methods. Similar to the present findings, Banik and Gandhi (2007) reported that DFREML method was most efficient followed by BLUP, SRLS and LSM methods.

The coefficient of variation was used as the criterion to compare the stability of different sire evaluation methods for first lactation 305-day or less milk yield. The alteration of CV with respect to unadjusted data was lowest in DFREML, (35.25%) followed by SRLS (33.83%), LSM (33.02%) and lastly BLUP (32.66%). These findings revealed that the DFREML method was the most stable method followed by SRLS and LSM; while the BLUP method was the least stable method. Similar to the present findings, Gandhi and Gurnani (1991) reported that BLUP method was the least stable method of sire evaluation in Sahiwal cattle.

Table 3. Rank correlations among expected breeding values of sires for first lactation 305-day or less milk yield estimated by different methods

Breeding methods	LSM	SRLS	BLUP	DFREML
LSM	1.0000	0.9990**	0.9608**	0.9566**
SRLS		1.0000	0.9657**	0.9620**
BLUP			1.0000	0.9871**
DFREML				1.0000

LSM, Least squares method; SRLS, simple regressed least squares method; BLUP, best linear unbiased prediction method; DFREML, derivative free restricted maximum likelihood method; **, significant at 1% level.

The Spearman's rank correlation was measured using the ranks of 50 Sahiwal sires based on their breeding values estimated by four different sire evaluation methods for first lactation 305-day or less milk yield and the results are presented in Table 3. The rank correlations of breeding value of sires estimated from different methods of sire evaluation were very high ranging from 0.9566 (DFREML with LSM) to 0.9990 (LSM with SRLS) and were statistically highly significant ($P < 0.01$). Similar to present findings, Banik and Gandhi (2007), Kumar (2007) and Mukherjee *et al.* (2007) reported high rank correlations between DFREML, LSM, SRLS and BLUP methods suggesting that these methods were more or less similar for ranking of dairy sires and could be used to estimate the breeding values for first lactation 305-day or less milk yield. The high rank correlations obtained in the present study revealed that ranking of sires on the basis of breeding values estimated by any of the above methods could result in similar ranking to the extent of 96 to 99%.

SUMMARY

The comparison of different methods of sire evaluation on the basis of first lactation 305-day or less milk yield showed that the DFREML was most accurate, and efficient method to estimate the breeding value of sires with highest coefficient of determination and lowest error variance. This

method was most stable among the 4 different methods used as it altered the coefficient of variation of the unadjusted data to a min extent and discriminated amongst the bulls to the max extent. The rank correlation coefficients amongst breeding values by different sire evaluation methods exhibited a higher degree of similarity (96–99%) in the ranking of sires. Based on the above discussions the DFREML method was adjudged as the most efficient and accurate method of sire evaluation amongst the methods used. However, very high correlations between the rankings of sires by different methods suggested that any of the 4 methods can be used for evaluation of sires for first lactation 305-day or less milk yield.

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