



## Animal Model Versus Conventional Methods of Sire Evaluation in Sahiwal Cattle

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**ABSTRACT :** A total of 1,367 first lactation records of daughters of 81 sires, having 5 or more progeny were used to evaluate sires by 3 different methods viz., least squares (LS), best linear unbiased prediction (BLUP) and derivative free restricted maximum likelihood (DFREML) method. The highest and lowest overall average breeding value of sires for first lactation 305 days or less milk yield was obtained by BLUP (1,520.72 kg) and LS method (1,502.22 kg), respectively. The accuracy, efficiency and stability of different sire evaluation methods were compared to judge their effectiveness. The error variance of DFREML method was lowest (191,112 kg<sup>2</sup>) and its coefficient of determination of fitting the model was highest (33.39%) revealing that this method of sire evaluation was most efficient and accurate as compared to other methods. However, the BLUP method was most stable amongst all the methods having coefficient of variation (%) very near to unadjusted data (18.72% versus 19.89%). The higher rank correlations (0.7979 to 0.9568) between different sire evaluation methods indicated that there was higher degree of similarity of ranking sires by different methods ranging from about 80 to 96 percent. However, the DFREML method seemed to be the most effective sire evaluation method as compared to other methods for the present set of data. (**Key Words :** Animal Model, BLUP, Milk Yield, Sahiwal Cattle, Sire Evaluation)

### INTRODUCTION

The effectiveness of sire evaluation is the backbone of any breed improvement programme as the contribution of sire path is higher than the dam path for the overall genetic improvement for a trait. In addition to this, very intense selection can be practised in case of males, as few males are required for breeding purpose. So, one of the main criteria of enhancing the genetic potential of animals in a herd is to use proven sires to transmit superior genetic potential for higher milk production. During the past, different methods like least squares (LS) and best linear unbiased prediction (BLUP) have been used to evaluate sires of indigenous breeds (Parekh and Singh, 1989; Gandhi and Gurnani, 1991; Sahana, 1996; Deb et al., 1998), still the application of latest and complex method of sire evaluation like derivative free restricted maximum likelihood (DFREML) in Indian breeds is scanty. However with the advancement of computational facilities, complex methodologies like

DFREML as described by Meyer (1989) have been used during last few years for sire evaluation in different countries. On the other hand, this method has been used scarcely in India (Jain and Sadana, 2000). Hence, this investigation was planned to evaluate Sahiwal sires by this method and to compare the effectiveness of DFREML method with other conventional methods of sire evaluation in Sahiwal cattle.

### MATERIALS AND METHODS

Data on 1,367 first lactation records of Sahiwal cows, progeny of 81 sires, spread over a period of 37 years (1966-2002), maintained at National Dairy Research Institute, Karnal and Government Livestock Farm, Chak Ganjaria, Lucknow were analyzed. Sires having five or more progeny were evaluated on the basis of first lactation 305 days or less milk yield by 3 methods viz. least squares (LS), best linear unbiased prediction (BLUP) and DFREML. Methodologies like least squares analysis as described by Harvey (1987) were used. BLUP as proposed by Henderson (1975) and DFREML version 3.0-β as suggested by Meyer (1998) was used. The seasons and periods of calving were used as fixed effects, age at first calving was used as covariable and sires were considered as random effect.

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**Table 1.** Average breeding values (BV) estimates of sires for first lactation 305 days or less milk yield by different methods

Sire evaluation methods	Average BV	Number of sires above average BV	Number of sires below average BV	Maximum BV	Minimum BV	Difference
LSQ	1,502.27	41	40	2,247.90 (49.63)	830.41 (44.72)	1,417.49
BLUP	1,520.72	41	40	2,391.52 (57.26)	736.69 (51.56)	1,654.83
DFREML	1,503.99	40	41	1,911.74 (27.11)	856.12 (43.08)	1,055.62

Figures in the parentheses indicate percent above and below the average breeding value.

**Table 2.** Number of sires with 20, 15, 10 and 5 percent and higher breeding value than the average breeding value from different methods

Sire evaluation methods	20%	15%	10%	5%
LSQ	3 (3.70)	6 (7.41)	14 (17.28)	27 (33.33)
BLUP	10 (12.35)	17 (20.99)	25 (30.86)	34 (41.98)
DFREML	3 (3.70)	7 (8.64)	17 (20.99)	28 (34.57)

Figures in the parentheses indicate the percentage.

The effectiveness of different sire evaluation methods was judged by using the various criteria like within sire variance or error variance, coefficient of determination (%), coefficient of variation (%) and rank correlations. The most efficient method had the lowest error variance. Higher the coefficients of determination ( $R^2$ -Value) from fitting a model, higher the accuracy. The sire evaluation method, which retains the coefficient of variation (CV %) of the population near to the CV (%) unadjusted data was the most stable method. Higher (near to unity) rank correlation amongst the sires from different sire evaluation methods revealed higher degree of similarity of ranking from different methods.

## RESULTS AND DISCUSSION

The overall least squares population mean for first lactation 305 days or less milk yield was  $1,503.99 \pm 13.83$  kg. The average breeding value of sires from different methods ranged from 1,502.27 kg (LS) to 1,520.72 kg (BLUP). By least squares method (LS), the average breeding value of sires for first lactation 305 days or less milk yield was 1,502.27 kg (Table 1), which was lower than the estimates reported by Gandhi and Gurnani (1991) and Singh (1992) in the same breed. Forty one sires out of 81 sires (50.62%) had breeding value above average breeding value, while 40 sires (49.38%) were having breeding values below the average breeding value. The highest breeding value was observed as 2,247.90 kg, which was 49.63 percent higher than the average breeding value, whereas the lowest breeding value was observed as 830.41 kg, which was 44.72 percent lower than the average breeding value. The difference of breeding values between the upper and lower estimates was 1,417.49 kg. Out of total 81 sires, three (3.70%) had breeding value 20 percent and above than the overall average breeding value (Table 2).

Under best linear unbiased prediction (BLUP), the average breeding value of sires for first lactation 305 days or less milk yield was 1,520.72 kg. There were 41 and 40

sires (50.62% and 49.38%, respectively) out of a total of 81 sires whose breeding value for first lactation 305 days or less milk yield were below and above the average breeding value (Table 1). The highest estimate of breeding value was 2,391.52 kg, which was 57.26 percent higher than the average breeding value and the lowest one was 736.69 kg, which was 51.56 percent lower than the average breeding value. The difference between these two extreme breeding values was highest (1,654.83 kg) indicating that this method discriminated amongst bulls to the highest extent as compared to other methods. Ten sires (12.35%) out of total 81 sires had breeding value 20 percent and above the average breeding value of the sires.

The evaluation of breeding value of sires by derivative free restricted maximum likelihood (DFREML) method gave the average breeding value as 1,503.99 kg (Table 1). Forty (49.38%) out of 81 sires showed higher breeding values whereas, 41 (50.62%) sires showed lower breeding values than the average breeding value. The highest breeding value was estimated as 1,911.74 kg, which was 27.11 percent higher than the average breeding value. The lowest breeding value was 856.12 kg, which was 43.08 percent lesser than the average breeding value. The difference between highest and lowest breeding values was 1,076.24 kg. Three sires (3.70%) showed breeding value over and above 20 percent as compared to overall average breeding value (Table 2).

The within sire variance or error variance of DFREML method was lowest ( $191,111.83 \text{ kg}^2$ ) and, therefore, it was considered to be most efficient out of all the three sire evaluation methods (Table 3). The Least Squares method was second efficient method after DFREML on the basis of this criterion. Maximum error variance ( $251,747.19 \text{ kg}^2$ ) was found in BLUP method, so it was least efficient method. The relative efficiency (%) of different methods was estimated in comparison to most efficient method i.e. DFREML. The relative efficiency of LS and BLUP methods was 78.11% and 75.91%, respectively in comparison with DFREML method (Table 3). On the

**Table 3.** Relative efficiency, Coefficient of determination ( $R^2$ -value) and Coefficient of variation (CV) of different methods of sire evaluation

Sire evaluation methods	Error variance (kg <sup>2</sup> ) (Efficiency)	Relative efficiency* DFREML (%)	$R^2$ -value (%)	CV (%)
LSQ	244,659.84	78.11	11.07	13.95
BLUP	251,747.19	75.91	24.54	18.72
DFREML	191,111.83	100.00	33.39	12.93

\* Relative efficiency with respect to most efficient (DFREML) method.

contrary, the LS method was found to be more efficient than the BLUP method (Tajane and Rai, 1990; Deb et al., 1998). However, none of these workers used DFREML method of sire evaluation.

The DFREML method showed the highest coefficient of determination (33.39%) as compared to other methods revealing that this method of sire evaluation was most accurate as compared to other methods (Table 3). BLUP (24.54%) was found to be second best method. Least squares method showed much lower coefficient of determination (11.07%). On the other hand, Gandhi and Gurnani (1991) revealed that LS method was most accurate (15.34%  $R^2$ -square value) followed by BLUP method (14.06%  $R^2$ -value) in Sahiwal sire evaluation.

The alteration of CV with respect to unadjusted data (19.89%) was lowest in BLUP (18.72%), followed by least squares (13.95). These findings depicted that BLUP method was the most stable method. On the other hand Gandhi and Gurnani (1991) reported that BLUP method was the least stable method of sire evaluation in Sahiwal cattle.

The rank correlations of breeding value of sires estimated from different methods of sire evaluation were very high ranging from 0.7979 (BLUP with DFREML) to 0.9568 (LS with DFREML) and were statistically highly significant ( $p < 0.01$ ). LS method showed very high and statistically highly significant ( $p < 0.01$ ) rank correlations with BLUP and DFREML methods (0.8496 and 0.9568, respectively). Dempfle (1977), Vij and Tiwana (1988), Sahana (1996), Deulkar and Kothekar (1999), Singh and Singh (1999) and Gaur et al. (2001) also found higher rank correlations (0.8201, 0.862, 0.8448, 0.88, 0.815 and 0.96, respectively) between LS and BLUP methods of sire evaluation; while much higher rank correlations (0.9846) between these two methods was reported by Gandhi and Gurnani (1991). BLUP method had a highly significant ( $p < 0.01$ ) rank correlation (0.7979) with DFREML method. This estimate was lower than the estimate of rank correlation of LS with DFREML.

## CONCLUSIONS

The comparison of different methods of sire evaluation based on single trait (first lactation 305 days 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. BLUP method was most stable method and discriminated amongst bulls to the maximum extent. The rank correlation coefficients amongst breeding values by different methods of sire evaluation do exhibited a notable degree of similarity (80-96%) in ranking of sires. It was concluded that DFREML method was most efficient and accurate method of sire evaluation as compared to the other methods. Its higher rank correlations with other methods revealed that animal model was most effective method for sire evaluation amongst all methods in Sahiwal cattle.

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