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Breeding value estimation and efficiency of sire evaluation methods in Holstein Friesian cattle

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Abstract

The breeding values of 15 Holstein Friesian sires were estimated from the Lactation milk yield and Peak yield by applying three sire evaluation methods *viz.*, simple regressed least squares (SRLS), best linear unbiased prediction (BLUP) and restricted maximum likelihood methods (REML). The restricted maximum likelihood method had lowest error variance and highest coefficient of determination for both lactation milk yield and peak yield and it was considered to be the most efficient method. For actual lactation milk yield, the SRLS method was second best efficient method followed by BLUP method based on error variance and coefficient of determination.

Keywords: Simple regressed least squares, BLUP, REML, Sire evaluation, HF Cattle

Introduction

Main criteria of enhancing the genetic potential of animals for any trait in a herd is to use proven sires to transmit superior genetic potential as the sire path contributes more than the dam path in the overall genetic improvement of a trait due to higher intensity of selection. Sire evaluation is one of the most important aspects of breed improvement programs which involve the estimation of breeding value of the bulls on the basis of first lactation 305-day milk yield of their daughters. The success of the program depends on how early and accurately young bulls can be evaluated for breeding value. There are different methods of sire evaluation *viz.*, Simple daughters average index, Least squares method (LSM), Simple regressed least squares (SRLS), Best linear unbiased prediction (BLUP), Derivative free restricted maximum likelihood (DFREML) and Restricted maximum likelihood (REML) for single as well as multiple traits models, which were studied and compared by different workers (Banik and Gandhi, 2010; Raja, 2010; Dongre and Gandhi, 2014; Abbas *et al.*, 2016; and Lodhi *et al.*, 2016) [3, 12, 4, 1, 8]. The present study was, carried out to estimate the breeding values of sires using SRLS, BLUP and REML methods for actual lactation milk yield and peak yield in Holstein Frisian cattle and to compare their efficiency to identify the most effective method of sire evaluation.

Materials and Methods

The performance records of 123 daughters belonging to 15 sires were collected from the pedigree sheets and daily milk record registers of Holstein Friesian cows maintained at Dodla dairy farm, Pulivendula, Kadapa district of Andhra Pradesh. The traits included in the study were lactation milk yield and peak yield. The records of the animals with known pedigree and normal lactation were considered for this study. Culling, disposal in middle of lactation, abortion, stillbirth and other pathological conditions which may affect the lactation yield were excluded from the analysis. The records of animals with lesser than 300 kg of milk yield and a lactation length of lesser than 100 days were discarded.

Statistical Analysis

All the 15 Holstein Friesian sires were evaluated on the basis of actual lactation milk yield and peak yield using three methods of sire evaluation, *viz.* Simple regressed least squares method (Harvey, 1990) [5], Best linear unbiased prediction (Henderson, 1975) [6] and Restricted maximum likelihood method (Meyer, 1998) [9]. The effectiveness of different sire evaluation methods was judged by using error variance, coefficient of determination (R^2 -value), coefficient of variation (%), rank correlations and product moment correlations.

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Results and Discussion

Breeding values

The breeding values of 15 Holstein Friesian sires estimated from first lactation milk yield and peak yield by applying three sire evaluation methods were presented in Table 1. The average breeding value estimated for actual lactation milk yield was 3360.61 kg, 4318.98 kg and 2997.22 kg obtained by

SRLS, BLUP and REML methods, respectively. Whereas, the average breeding value for peak yield was found to be 24.40 kg, 23.27 kg and 20.61 kg for SRLS, BLUP and REML methods, respectively. Similar findings were reported by Banik and Gandhi (2006)^[2] while estimating breeding values in Sahiwal cattle.

Table 1: Average expected breeding values (EBVs) of H.F sires using lactation milk yield & Lactation Peak yields by different sire evaluation methods

Sire evaluation method	Average EBV (Kg)	No. of sires above average	No. of sires below average	Maximum EBV (Kg)	Minimum EBV (Kg)
For actual lactation milk yield					
SRLS	3360.61	7 (46.67%)	8 (53.33%)	5655.57	338.60
BLUP	4318.98	9 (60%)	6 (40%)	6252.11	2094.47
REML	2997.22	10 (66.67%)	5 (33.33%)	4839.43	147.70
For lactation Peak Yield					
SRLS	24.40	9 (60%)	6 (40%)	30.88	17.07
BLUP	23.27	7 (46.67%)	8 (53.33%)	26.78	20.31
REML	20.61	10 (66.67%)	5 (33.33%)	23.85	17.60

Rank and Product – moment correlation

The rank and product moment correlations among merit of sires for production efficiency traits like lactation milk yield and peak yield by various sire evaluation methods were presented in Table 2. The rank correlations estimated from different methods were very high and it ranged from 0.823 (SRLS x BLUP) to 0.966 (SRLS x REML) for lactation milk yield and peak yield respectively and are statistically highly significant ($P < 0.01$). Product - moment correlations between estimated sire merit calculated by different methods were also very high and ranged from 0.694 for peak yield (BLUP x

REML) to 0.909 for lactation milk yield (BLUP x REML). Rank and product moment correlations among sire merit calculated by various sire evaluation procedures for lactation milk yield and peak yield revealed that rank correlations were comparatively higher than those of product moment correlations. Rank correlations closer to unity for lactation milk yield (0.950) and peak yield (0.966) suggested that REML method may be considered as most efficient method. Similar findings were also reported by Banik and Gandhi (2006)^[2], Kumar *et al.*, 2008^[7], Moges *et al.*, 2009^[10].

Table 2: Spearman Rank correlations and Product – moment correlations among estimated sire merits for actual lactation milk yield and peak yield

Variable	SRLS x BLUP	SRLS x REML	BLUP x REML
	Spearman Rank Correlation		
LMY	0.823**	0.861**	0.950**
PY	0.826**	0.966**	0.830**
Product - Moment Correlation			
LMY	0.814**	0.858**	0.909**
PY	0.827**	0.798**	0.694**

(** Significant at 1% level)

Comparison of different sire evaluation methods

The accuracy of all the three methods used in the present study were judged for their effectiveness using error variance, coefficient of determination (R^2 -value), coefficient of variation (%) and are presented in Table 3. The sire evaluation method with lowest error variance was considered the most efficient and appropriate method. Higher the coefficient of determination (R^2 -value), higher will be the accuracy. Lesser the coefficient of variation more will be the stability of the method.

Within sire variance/Error variance

REML method had lowest error variance for both actual first lactation milk yield (892095 kg²) and peak yield (16.65 kg²) and therefore, it was considered to be the most efficient out of all the three sire evaluation methods. The SRLS was second efficient method with the error variance for actual first lactation milk yield (1787355.08 kg²) and peak yield (19.36 kg²). The BLUP method had 1811716 kg² and 19.57 kg² error variance for actual first lactation milk yield and peak yield respectively.

Coefficient of determination

The REML method showed highest coefficient of determination for actual first lactation milk yields (68.6%) and peak yields (21.62%). SRLS method was the next best method actual first lactation milk yields (51.7%) followed by BLUP method (43.9%). For peak yield, BLUP method was found to be the second best method (19.3%) followed by SRLS (13%) method. The highest coefficient of determination by REML method showed that this method was the most accurate method for sire evaluation for both the traits.

Coefficient of variation

The coefficient of variation (CV) for actual first lactation milk yield was found to be low in SRLS method (46.2%) and followed by BLUP (46.5%) and lastly REML (61.5%). For peak yield, coefficient of variation was lowest in SRLS (21.26%), followed by REML (21.32%), BLUP (23.34%). The coefficient of variation (CV) findings revealed that the SRLS method was the most stable method for both actual first lactation milk yield and peak yield. The results of the present study were in accordance with the results given by Banik and

Gandhi (2006) ^[2]; Mukherjee *et al.*, 2007 ^[11] and Dongre and Gandhi (2014) ^[4].

Table 3: Comparison of different sire evaluation methods for their effectiveness for actual lactation milk yield & Peak Yield

Lactation Milk yield			
Methods	Error variance (Kg ²)	Coefficient of determination (%)	Coefficient of Variation (%)
SRLS	1787355.08	51.70	46.20
BLUP	1811716.00	43.90	46.50
REML	892095.00	68.60	61.50
Peak Yield			
Method	Error variance (Kg ²)	Coefficient of determination (%)	Coefficient of Variation (%)
SRLS	19.36	13.00	21.26
BLUP	19.57	19.30	23.34
REML	16.65	21.62	21.32

Conclusion

The REML method was found to be the most efficient and accurate method of sire evaluation based on error variance and coefficient of determination in H.F cattle for actual lactation milk yield and peak yield records. Therefore, preference should be given to use REML method for both the traits followed by, SRLS method for actual lactation milk yield and BLUP method for peak yield for sire evaluation in Holstein Friesian cattle.

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