International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG(USA) Volume 3, Issue 10 - 2016

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2016.03.10.021

Estimation of Breeding Values by Different Sire Evaluation Methods for Selection of Sires in Crossbred Cattle

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Abstract

The records of 1198 crossbred cattle sired by 102 bulls were analysed to estimate breeding values of sires using animal model (DFREML), best linear unbiased prediction (BLUP), least squares methods (LSM) and simple daughter average ($\overline{D}$) sire evaluation. The average breeding value for first lactation milk yield in crossbred bulls was found to be 2781.73 kg by simple daughter's average method ($\overline{D}$), 2779.19 kg by least squares method (LSM),2710.46kg,by best linear unbiased prediction method and 2680.29 kg by REML method. The average breeding value for lifetime milk yield in crossbred bulls was found to be 11630.15 kg. by simple daughter's average method ($\overline{D}$),11127.19 kg by least squares method (LSM),10705.59kg, by best linear unbiased prediction method and 10371.02 kg by REML method. The average breeding value for life time lactation length in crossbred bulls was found to be1392.00days by simple daughter's average method ($\overline{D}$),1110.54 days by least squares method (LSM), 1147.32days,by best linear unbiased prediction method and 1105.17days by REML method. The estimated breeding values of sires estimates for first lactation milk yield by BLUP showed small genetic variation in compare to $\overline{D}$, LSM and REML method. While for life time milk yield and life time lactation length REML showed small genetic variation in compare to $\overline{D}$, LSM and BLUP methods, therefore BLUP and REML was considered as the most efficient methods out of all four methods of sire evaluation used in the present study. Product moment correlation among breeding values of sires estimated by different methods ranged from 0.492 ($\overline{D}$ with REML) to 0.960 (BLUP with DFREML), where as rank correlations of breeding value of sires ranged from 0.566 (LS with REML) to 0.956 (BLUP with REML).The rank of sires for different sire evaluation methods revealed that 4-5% of top sires almost had similar rank for all the methods.

Keywords: Breeding value, First lactation yield, Lifetime milk yield, BLUP, REML

Introduction

The selection in female has limited scope due to insufficient number of replacement stock. In the contrary, intensive selection can be practiced in case of males, as a few males are required for breeding purpose the selection of the superior sires with maximum accuracy is also importance for any breed

improvement programme. Genetic progress in economic characters remains the sole objective of the dairy cattle breeding since most of the traits of economic importance are polygenic in nature, the genetic worth of sire cannot be measured directly, but it can be estimated on the basis of phenotypic performance or observed value of a trait in the sire itself or its relatives in case of sex limited characters such as milk yield. In such situation the evaluation on the basis of progeny performance gives more reliable estimates of the genetic merit of a bull. Thus, the knowledge of genetic properties of traits is the pre-requisite in establishing the selection programme or mating system. In recent years, there are several methods of sire evaluation are used, like simple daughter average, Restricted Maximum Likelihood method, Least square method, Best Linear Unbiased Prediction, Contemporary Daughter Average index, Simple Regressed Least Square could be used to evaluate sires for a single trait i.e. milk yield. Henderson (1986) opined that analysis of variance and covariance may give biased components of variance from selected population, where as Restricted Maximum Likelihood method can give bias free estimate. Simultaneous attention to reproductive traits in addition to milk production is expected to bring about overall improvement in the index value of a sire, so multi trait criteria of sire evaluation using advance statistical technique like Derivative Free Restricted Maximum Likelihood method would be expected to enhance the accuracy of selection of the sire (Meyer,1998) further (Miszal,2004) developed mixed model programme (BLUP 90 Dairy Pack) in animal breeding for genetic evaluation, estimation of breeding value and variance for single and multiple traits. The Best Linear Unbiased Prediction has become the most widely accepted method for genetic evaluation of livestock.

Materials and Methods

Data for the present investigation were collected from history sheet of crossbred cattle at instructional dairy farm of G. B. Pant University of Agriculture and Technology, Pantnagar. The data pertained to 1198 crossbred cattle from 102 sires were distributed over a period of 48 years from 1966 to 2010. Cows with abnormal and incomplete records were excluded from the study. Only the sires having records on at least 5 daughters were included in the present study. The records of only those animals with known pedigree and normal lactation were considered. The lactation records of less than 150 days were considered as abnormal and were not included in the analysis.

The total duration of the present study was divided into 10 equal periods of five years each. Each year was divided into three seasons namely winter (November-February), Summer (March–June), and Rainy (July – October). In order to classify the data for different genetic groups periods and seasons of calving were considered for all the traits. The traits considered in the present study were age at first calving, first service period, first lactation period, first dry period, first calving interval, first lactation milk yield, lifetime milk yield and life time lactation yield. Records on various first lactation and lifetime traits of crossbred cattle being in non-orthogonal nature were analyzed by Least Squares Analysis (LSA) technique of fitting constants for the estimation of genetic parameters as well as to examine the simultaneous effects of different genetic and non-genetic factors affecting any traits.

Statistical Analysis:

As the data in the present study were non-orthogonal in nature with unequal subclass numbers, they were subjected to least squares analysis of variance without interactions using different models to examine the effect of genetic as well as non-genetic factors on various first lactation traits as per standard procedures of Harvey (1990). The model was based on the assumption that different components fitting in the model were linear, independent and additive. While sire was treated as random effect, the other genetic and non-genetic factors (genetic group, season and period) were taken as fixed effects in the model. Breeding value of sires for first lactation traits were estimated by simple daughter average ($\overline{D}$) as proposed by Edward (1932), least square method as described by Harvey (1990), best linear unbiased prediction by Henderson (1975) and DFREML version 3.0-β by Mayer (1998). The effectiveness of different sire evaluation methods was judged by the estimated breeding value of sires as taken twice the sire genetic group solution plus sire solution within sire genetic group for that trait. After estimation of breeding value of sires the sires were given ranks as per their genetic merit. Spearman's rank correlations (Steel and Torrie, 1960) and product moment correlations between breeding values of sires derived by various methods were also used to judge the effectiveness of different methods.

Results and Discussion

In the present study, the breeding values of sires were estimated, evaluated and ranked on the basis of breeding value of their progeny by four different sire evaluation methods and presented in Table-1. The average breeding value for first lactation milk yield in crossbred bulls was found to be 2781.73 kg. by simple daughter's average method ($\overline{D}$). There were 34 sires whose breeding values observed above the average breeding value and 34 sires with breeding values below the average breeding value. The lowest breeding values observed for first lactation milk yield was 1718.25 for sire no.56and highest breeding value was 3681.90 kg for sire no. 29. The difference between highest and lowest breeding value was 4550.75 kg.

Table 1. Average breeding value estimates for first lactation milk yield by different method of estimation.

Traits	Sire evaluation method	Average breeding value	Minimum breeding value	Maximum breeding value	Number of sires over average	Number of sires below average breeding value	Range of Breeding Value
First Lactation Milk Yield	$\overline{D}$	2781.73	1718.25	6269.00	34	34	4550.75
	LSM	2779.19	1872.09	3907.69	27	41	2035.60
	REML	2710.46	2241.94	3166.45	32	36	924.51
	BLUP	2680.29	2309.49	3064.53	32	36	755.04
Life Time Milk yield	$\overline{D}$	11630.15	4747.20	78344.00	21	47	73596.0
	LSM	11127.19	1893.22	28213.54	26	42	26320.32
	REML	10371.02	9125.58	11536.10	20	48	2410.52
	BLUP	10705.59	9084.72	13268.20	27	41	4183.48
Life Time Lactation Length	$\overline{D}$	1392.00	584.33	1828.86	11	57	1244.53
	LSM	1110.54	531.93	2465.75	24	44	1933.82
	REML	1105.17	835.12	1365.55	31	37	530.43
	BLUP	1147.32	133.94	1316.34	38	30	1182.40

The average breeding value for life time milk yield in crossbred bulls was found to be 11630.15 kg. There were 21 sires whose breeding values observed above the average breeding value and 47 sires with breeding values below the average breeding value. The lowest breeding values observed for life time milk yield was 4747.20 for sire no.25and highest breeding value was 78344.00 kg for sire no.33. The difference between highest and lowest breeding value was 73596.00 kg. The average breeding value for life time lactation length in crossbred bulls was found to be 1392.00days. There were 11 sires whose breeding values observed above the average breeding value and 57 sires with breeding values below the average breeding value. The lowest breeding values observed for life time lactation length was 584.33days for sire no.79and highest breeding value was 1828.86days kg for sire no.68. The difference between highest and lowest breeding value was 1244.53days.

The estimated overall average breeding value of sires by least squares method (LSM) for first lactation milk yield was found to be 2779.19 kg. There were 27 sires whose breeding value observed above the average breeding value and 41 sires with breeding value below the average breeding value. The lowest breeding value observed for first lactation milk yield was 2241.94 kg for sire no.64 and highest breeding value was 3166.45kg for sire no. 97. The difference between highest and lowest breeding values was 2035.60 kg. The average breeding value for life time milk yield in crossbred bulls was found to be 11127.19 kg. There were 26 sires whose breeding values observed above the average breeding value and 42 sires with breeding values below the average breeding value. The lowest breeding values observed for life time milk yield was 1893.22kg for sire no.102 and highest breeding value was 28213.54 kg for sire no.94. The difference between highest and lowest breeding value was 26320.32 kg. The average breeding value for life time lactation length in crossbred bulls was found to be 1110.54 days. There were 24 sires whose breeding values observed above the average breeding value and 44 sires with breeding values below the average breeding value. The lowest breeding values observed for life time lactation length was 531.93days for sire no.25and highest breeding value was2465.75days kg for sire no.88. The difference between highest and lowest breeding value was 1933.82days.

The average breeding value for first lactation milk yield using best linear unbiased prediction was estimated as 2710.46kg. The breeding value ranged from 3643.90 kg above the average breeding value to 2241.94 kg below the average breeding value. Thirty two sires out of 68 sires had breeding value above the average breeding value, while 36 were having breeding value below the average breeding value. The difference between highest and lowest breeding values was 755.04 kg. The average breeding value for life time milk yield in crossbred bulls was found to be10371.02 kg. There were 20 sires whose breeding values observed above the average breeding value and 48 sires with breeding values below the average breeding value. The lowest breeding values observed for life time milk yield was 9125.58 for sire no.92nd highest breeding value was 11536.10 kg for sire no.94. The difference between highest and lowest breeding value was 4183.48 kg. The average breeding value for life time lactation length in crossbred bulls was found to be 1105.17days. There were 24 sires whose breeding values observed above the average breeding value and 44 sires with breeding values below the average breeding value. The lowest breeding values observed for life time lactation length was 584.33days for sire no.48and highest breeding value was 1828.86days kg for sire no.43. The difference between highest and lowest breeding value was1182.40days.

The estimated average breeding value of sires by REML for first lactation milk yield was found to be 2680.29 kg. Out of 68 sires 32 sires had breeding value above the overall average breeding value (Table-2) and 36 sires had the breeding value below the average breeding value. The lowest breeding value observed for first lactation milk yield was 2309.49 kg. and highest breeding value was 3064.53. The difference between highest and lowest breeding values was 924.51kg. The average breeding value for life time milk yield in crossbred bulls was found to be 10705.59 kg. There were 27 sires whose breeding values observed above the average breeding value and 41 sires with breeding values below the average breeding value. The lowest breeding values observed for life time milk yield was 9084.72 for sire no.103 and highest breeding value was 13268.20 kg for sire no.14. The difference between highest and lowest breeding value was 2410.52 kg. The average breeding value for life time lactation length in crossbred bulls was found to be 1147.32days. There were 38 sires whose breeding values observed above the average breeding value and 30 sires with breeding values below the average breeding value. The lowest breeding values observed for life time lactation length was 133.944days for sire no.43and highest breeding value was 1316.34days kg for sire no.14. The difference between highest and lowest breeding value was530.43days.

Table 2. Spearman's rank (above diagonal) and product moment correlation (below diagonal) for first lactation milk yield among different sire evaluation methods.

Traits / Methods	FLMY			
	Methods			
	$\overline{D}$	LSM	BLUP	REML
$\overline{D}$	-	0.745**	0.664**	o.631**
LSM	0.599**	-	0.566**	0.575**
BLUP	0.664**	0.566**	-	0.956**
REML	0.631**	0.575**	0.956**	-

**Correlation is significant at the 0.01 level

The estimated breeding values of sire's estimates for first lactation milk yield by BLUP showed small genetic variation in compare to $\overline{D}$, LSM and REML method. While for life time milk yield and life time lactation length REML showed small genetic variation in compare to $\overline{D}$, LSM and BLUP methods, therefore BLUP and REML was considered as the most efficient methods out of all four methods of sire evaluation used in the present study. Gaur *et al.* (2001), Dahia *et al.* (2002), Bajetha (2006) and Dubey *et al.* (2006) reported BLUP as best sire evaluation method when compared with other procedures of sire evaluation.

Large genetic variation was also observed between the estimated breeding values of sires by Dalal *et al.* (1999), Dubey *et al.* (2006) in crossbred cattle, Banik and Gandhi (2006) in Sahiwal Cattle; Kumar *et al.* (2008) on Karan fries cattle and Moges *et al.* (2009), Singh and Singh (2011), Singh *et al.* (2014) and Dubey and Singh (2014) in crossbred cattle.

In general, EBV's for sires did not showed any systematic trend of first lactation yield. In the present investigation the estimated breeding values of sires for first lactation yield, life time milk yield and life time lactation length showed large variation between EBV'S of sires which revealed more genetic variation in the herd.

This might be due to fact that this herd had no. of genetic groups and animals with low production might have not been culled form the herd.

Accuracy of the methods of sire evaluation was determined by comparing the simple Pearson's (Product moment correlations and spearman rank) correlation of breeding values of sires estimated by various sire evaluation methods for first lactation milk yield. Product moment correlations between breeding values of sires and rank correlations by various methods are presented in Table-2. The simple correlations and rank correlations among all the four methods of sire evaluation were high and statistically highly significant (P<0.01) suggesting that all the methods of sire evaluation were equally effective to discriminate amongst sires on the basis of first lactation milk yield (Table-2). Product moment correlation among breeding values of sires estimated by different methods ranged from 0.492 ($\overline{D}$ with REML) to 0.960 (BLUP with DFREML), where as rank correlations of breeding value of sires ranged from 0.566 (LS with REML) to 0.956 (BLUP with REML). These findings agreed with the reports of Dalal *et al.* (1999), Gaur *et al.* (2001), Dubey *et al.* (2006), Banik and Gandhi (2006), Bajetha (2006), , Kumar *et al.* (2008) and Moges *et al.* (2009).

Top 10 sires ranked on the basis of estimated breeding values of sires for first lactation milk yield, life time milk yield and life time lactation length by all four methods are presented in Table-3. The top10 sires ranked on the basis of first lactation milk yield revealed that sire no. 74 ranked Ist by $\overline{D}$, sire no. 22 by LSM, sire no. 94 by REML and sire no. 88 by BLUP methods. Sire no 14 ranked IInd by $\overline{D}$ and sire no. 14 by LSM, REML and sire no. 96 by BLUP methods, respectively. These results indicated that all sires would not rank same for all the methods. The top10 sires ranked on the basis of life time milk yield milk yield revealed that sire no. 97 ranked Ist by $\overline{D}$, sire no. 33 by LSM, sire no.14 by REML and sire no. 43 by BLUP methods. Sire no 14 ranked IInd by $\overline{D}$ and sire no. 94 by LSM, sire no.100 by REML and sire no. 45 by BLUP methods, respectively. The top10 sires ranked on the basis of life time lactation length revealed that sire no. 14 ranked Ist by $\overline{D}$, sire no. 94 by LSM, sire no. 68 by REML and sire no. 14 by BLUP methods. Sire no.97 ranked IInd by $\overline{D}$ and sire no. 88 by LSM, and REML and sire no.30 by BLUP methods, respectively.

Table 3. Sires of top 10 ranks on the basis of estimated breeding values of sires for first lactation milk yield by different methods.

Rank No.	$\overline{D}$			LSM			REML			BLUP		
	FLMY	LTMY	LTLL	FLMY	LTMY	LTLL	FLMY	LTMY	LTLL	FLMY	LTMY	LTLL
1.	74	97	14	22	33	94	94	14	68	88	43	14
2.	14	14	97	14	94	88	14	100	88	96	45	30
3.	97	102	22	97	88	96	88	88	96	95	88	45
4.	102	22	65	65	14	92	71	30	92	92	30	100
5.	22	40	40	40	68	14	43	43	54	100	14	19
6.	100	38	21	21	96	99	100	66	56	98	71	66
7.	71	100	78	78	92	98	30	95	52	94	96	96
8.	78	18	66	8	95	95	66	5	14	99	100	88
9.	40	31	102	52	98	19	99	4	58	97	19	4
10.	79	35	8	49	99	24	5	19	43	91	99	33

However, the rank of sires for different sire evaluation methods revealed that 4-5% of top sires almost had similar rank for all the methods. Similar results were also reported by Dalal *et al.* (2002), Bajetha (2006), Dubey *et al.* (2006) and Moges *et al.* (2009),Singh and Singh(2011),Singh *etal*.(2014) and Dubey and Singh (2014) in crossbred cattle.

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Quick Response Code	Website: www.ijarbs.com Subject: Veterinary Sciences
DOI:10.22192/ijarbs.2016.03.10.021	

How to cite this article:
Geeta Lodhi, C.V. Singh, R.S. Barwal, B.N. Shahi and D.S. Dalal. (2016). Estimation of Breeding Values by Different Sire Evaluation Methods for Selection of Sires in Crossbred Cattle. Int. J. Adv. Res. Biol. Sci. 3(10): 45-50.
DOI: http://dx.doi.org/10.22192/ijarbs.2016.03.10.021