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ORIGINAL ARTICLE

Efficiency of Different Sire Evaluation Methods to Improve Life Time Production Traits in Crossbred Cattle

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Abstract

The performance records of 1170 crossbred daughters of 65 sires maintained during 1970 to 2004 at Instructional Dairy Farm, G. B. Pant University of Agriculture and Technology, Pantnagar, were used to evaluate sires for life time traits. Life time traits included in this study were herd life, productive life, total lactation length, lifetime milk yield, lifetime milk yield / productive life. The breeding value of sires estimated by four methods viz. Daughters average, Least Squares, Simplified Regressed Least Squares and Best Linear Unbiased Prediction methods. The estimated breeding values (EVB's) showed large genetic variation between sires for first lactation traits. The association between the best linear unbiased prediction (BLUP) and other method of Sire evaluation ranging from 0.7433 to 0.9502 (Product moment correlation) and 0.7441 to 0.9380 (Rank correlation) for lifetime traits. All the estimates of simple and rank correlation were highly significant (P<0.01). There were changes in the rank of first few top Sires by different methods of sire evaluation. These results indicated that all sires would not rank same for lifetime traits. However, the rank of sires for different traits revealed that 4.5% of top sires almost had similar rank for life time traits. The EBV's of sire revealed that BLUP method showed small genetic variation in comparison to Daughter's average, Least Squares and Simplified Regressed Least Squares method. Because of its desirable properties, the BLUP method may be considered to be more appropriate than that of Daughter's average, Least Squares and Simplified Regressed Least Squares method.

Key words: Breeding value, Lifetime traits, Rank correlations, Product moment correlation.

1. Introduction

The effectiveness of sire evaluation is the back bone of any breed improvement programme as the contribution of sire path is higher than the dam path for overall genetic improvement for a trait. High selection intensity can be practiced among bulls, as few bulls are needed to breed maximum number of cows. Reports suggested that contribution of sires to produce daughters is more than that of dams to produce daughters, so sire through the selection evaluation programme is more important as majority of genetic improvement can be through the selection of males instead of females. Selection for several traits may bring about overall improvement in milk production. The breeders are using effective statistical techniques for the estimation of breeding values. The breeding value of a dairy sire largely determines its genetic contribution to improvement of the population and therefore, the major trust in dairy cattle improvement programme is to identify potential parents with highest breeding value. An early and accurate appraisal is essential for the maximum annual genetic progress. For computation of breeding value of sire, the various methods based on simple daughter average, daughter dam comparison, herd mate comparison, daughter contemporary herd comparison with and without taking in to account the correction for number of daughter per sire, number of contemporary daughters have been developed and compared. They were initially considered to be effective, but as the genetic assumption for use of herd mate/contemporary comparison become increasingly violated, their

usefulness declined. The primary assumptions were that sires, dams and contemporaries were a random sample from a homogenous population with no genetic trend. Best linear unbiased prediction (BLUP) of genetic values mixed model equations developed by Henderson (1973) is now in maximum use. Further development improved upon the mixed model equation and inverse of the relationship matrix that allows estimation of breeding values with BLUP properties. In India, problem exists in using some techniques of sire evaluation because most of the progeny testing limited to the organized farm with small herd size. This is limited factor in assessing the sire's breeding value and high selection intensity cannot be achieved because of the use of more sires.

2. Materials and Methods

The performance records of 1170 (Sahiwal x Holstein-Friesian, Sahiwal x Jersey, Sahiwal x Red Dane, Sahiwal x Holstein-Friesian x Red Dane, Sahiwal x Red Dane x Jersey, Rathi, x Holstein-Friesian x Jersey, Sahiwal x Holstein-Friesian x Jersey and Sahiwal x Holstein-Friesian x Red Dane x Jersey) daughter of 65 sires, maintained at Instructional Dairy Farm, G.B.P.UA&T, Pantnagar, during 1970 to 2004 were used to estimate sire's breeding value for first lactation traits. After excluding abnormal and incomplete records from the study total 1170 records were considered for the analysis. Each year was divided into three seasons, viz- summer (March to July), rainy (August to October) and winter (November to February) based on climatologically conditions.

Sires were grouped into 8 sires genetic groups (Sahiwal x Holstein-Friesian, Sahiwal x Jersey, Sahiwal x Red Dane, Sahiwal x Holstein-Friesian x Red Dane, Sahiwal x Red Dane x Jersey, Rathi, x Holstein-Friesian x Jersey, Sahiwal x Holstein-Friesian x Jersey and Sahiwal x Holstein-Friesian x Red Dane x Jersey) on the type of inheritance and period of calving divided into 7 periods on the basis of period in which their first daughter was born. Life time traits included in this study were herd life, productive life, total lactation length, lifetime milk yield, lifetime milk yield / productive life.

Breeding values of sires for first lactation traits were estimated by Simple Daughters average as proposed by Edward (1932), Least Squares method as Described by Harvey (1990), Simplified Regressed Least Squares method as described by Harvey (1979) and Best Linear Unbiased Prediction (BLUP) method as proposed by Henderson (1984). The estimated breeding value of sire for each trait was taken as twice the sire genetic group solution plus sire solution within sire genetic group for that trait. The product moment and rank correlation among sire's estimated breeding values of different traits was calculated according to Steel and Torrie (1980).

3. Results and Discussion

The average breeding value estimates for lifetime traits and the range of breeding values obtained by different sire evaluation methods are shown in Table 1.

3.1 Herd Life

The average breeding value for herd life in crossbred bulls was found to be 1626.53 days by Simple Daughter's average method. There were 29 sires whose breeding values were above the average breeding value and 36 sires with breeding values below the average breeding value. The lowest breeding value observed for herd life was 1262.37 days for sire no. 33 and highest breeding value was 2268.00 days for sire no. 67. The difference between highest and lowest breeding values was 1005.63 days. The average breeding value for herd life in crossbred bulls was found to be 1618.15 days by Least Squares method. There were 35 sires whose breeding values were above the average breeding value and 30 sires with breeding values below the average breeding value. The lowest breeding value observed for herd life was 1211.46 days for sire no. 47 and highest breeding value was 2135.56 days for sire no. 67. The difference between highest and lowest breeding values was 924.10 days.

The average breeding value for herd life in crossbred bulls was found to be 1620.72 days by Simplified Regressed Least Squares method. There were 35 sires whose breeding values were above the average breeding value and 30 sires with breeding values below the average breeding value. The lowest breeding value observed for herd life was 1274.72 days for sire no. 47 and highest breeding value was 2025.49 days for sire no. 67. The difference between highest and lowest breeding values was 750.77 days. The average breeding value for herd life in crossbred bulls was found to be 1617.69 days by Best Linear Unbiased Prediction method. There were 33 sires whose breeding values were above the average breeding value and 32 sires with breeding values below the average breeding value. The lowest breeding value observed for herd life was 1348.39 days for sire no. 33 and highest breeding value was 1866.76 days for sire no. 67. The difference between highest and lowest breeding values was 518.37 days.

3.2 Productive Life

The average breeding value for productive life in crossbred bulls was found to be1510.16 days by Simple Daughter's average method.

Table 1: Average Breeding Value (BV) Estimates for Lifetime Traits by Different Methods of Estimations

Traits	Methods	Average BV	No of sire above average	No of sire below average	Max. B.V.	Min. B.V.	Range of B.V.
HL	$\overline{\mathbf{D}}$	1626.53	29	36	2268.00	1262.37	1005.63
	LS	1618.15	35	30	2135.56	1211.46	924.10
	SRLS	1620.72	35	30	2025.49	1274.72	750.77
	BLUP	1617.69	33	32	1866.76	1348.39	518.37
PL	$\overline{\mathbf{D}}$	1510.16	28	37	2153.00	1145.30	1007.70
	LS	1501.86	36	29	2018.20	1092.37	925.83
	SRLS	1504.21	36	29	1908.25	1155.84	752.41
	BLUP	1501.00	32	33	1748.62	1233.86	514.76
TLL	$\overline{\mathbf{D}}$	1306.71	29	36	1939.67	935.52	1004.15
	LS	1301.76	32	33	1837.63	897.70	939.93
	SRLS	1302.95	32	33	1718.64	956.01	762.63
	BLUP	1299.15	31	34	1548.66	1035.43	513.23
LTMY	$\overline{\mathbf{D}}$	9036.66	31	34	11574.33	6579.40	4994.93
	LS	8899.47	32	32	11014.63	5580.68	5433.95
	SRLS	8914.21	34	31	10467.25	6099.47	4367.78
	BLUP	8980.71	29	36	10115.45	8129.97	1985.48
LTMY/PL	$\overline{\mathbf{D}}$	6.72	28	37	9.29	3.29	6.00
	LS	6.68	28	37	9.45	3.40	6.05
	SRLS	6.67	29	36	9.04	4.11	4.93
	BLUP	6.69	29	36	8.20	5.09	3.11

There were 28 sires whose breeding values were above the average breeding value and 37 sires with breeding values below the average breeding value. The lowest breeding value observed for productive life was 1145.30 days for sire no. 33 and highest breeding value was 2153.00 days for sire no. 67. The difference between highest and lowest breeding values was 1007.70 days. The average breeding value for productive life in crossbred bulls was found to be 1501.86 days by Least Squares method. There were 36 sires whose breeding values were above the average breeding value and 29 sires with breeding values below the average breeding value. The lowest breeding value observed for productive life was 1092.37 days for sire no. 47 and highest breeding value was 2018.20 days for sire no. 67. The difference between highest and lowest breeding values was 925.83 days.

The average breeding value for productive life in crossbred bulls was found to be 1504.21 days by Simplified Regressed Least Squares method. There were 36 sires whose breeding values were above the average breeding value and 29 sires with breeding values below the average breeding value. The lowest breeding value observed for productive life was 1155.84 days for sire no. 47 and highest breeding value was 1908.25 days for sire no. 67. The difference between highest and lowest breeding values was 752.41 days. The average breeding value for productive life in crossbred bulls was found to be 1501.00 days by Best Linear Unbiased Prediction method. There were 32 sires whose breeding values were above the average breeding value and 33 sires with breeding values below the average breeding value. The lowest breeding value observed for productive life was 1233.86 days for sire no. 33 and highest breeding value was 1748.62 days for sire no. 67. The difference between highest and lowest breeding values was 514.76 days.

3.3 Total Lactation Length

The average breeding value for total lactation length in crossbred bulls was found to be 1306.71 days by Simple Daughter's average method. There were 29 sires whose breeding values were above the average breeding value and 36 sires with breeding values below the average breeding value. The lowest breeding value observed for total lactation length was 935.52 days for sire no. 33 and highest breeding value was 1939.67 days for sire no. 67. The difference between highest and lowest breeding values was 1004.15 days. The average breeding value for total lactation length in crossbred bulls was found to be 1301.76 days by Least Squares method. There were 32 sires whose breeding values were above the average breeding value and 33 sires with breeding values below the average breeding value. The lowest breeding value observed for total lactation length was 897.70 days for sire no. 47 and

highest breeding value was 1837.63 days for sire no. 67. The difference between highest and lowest breeding values was 939.93 days.

The average breeding value for total lactation length in crossbred bulls was found to be 1302.95 days by Simplified Regressed Least Squares method. There were 32 sires whose breeding values were above the average breeding value and 33 sires with breeding values below the average breeding value. The lowest breeding value observed for total lactation length was 956.01 days for sire no. 47 and highest breeding value was 1718.64 days for sire no. 67. The difference between highest and lowest breeding values was 762.63 days. The average breeding value for total lactation length in crossbred bulls was found to be 1299.15 days by Best Linear Unbiased Prediction method. There were 31 sires whose breeding values were above the average breeding value and 34 sires with breeding values below the average breeding value. The lowest breeding value observed for total lactation length was 1035.43 days for sire no. 33 and highest breeding value was 1548.66 days for sire no. 67. The difference between highest and lowest breeding values was 513.23 days.

3.4 Lifetime Milk Yield

The average breeding value for lifetime milk yield in crossbred bulls was found to be 9036.66 kg by Simple Daughter's average method. There were 31 sires whose breeding values were above the average breeding value and 34 sires with breeding values below the average breeding value. The lowest breeding value observed for lifetime milk yield was 6579.40 kg for sire no. 69 and highest breeding value was 11574.33 kg for sire no. 68. The difference between highest and lowest breeding values was 4994.93 kg. The average breeding value for lifetime milk yield in crossbred bulls was found to be 8899.47 kg days by Least Squares method. There were 33 sires whose breeding values were above the average breeding value and 32 sires with breeding values below the average breeding value. The lowest breeding value observed for lifetime milk yield was 5580.68 kg for sire no. 69 and highest breeding value was 11014.63 kg for sire no. 60. The difference between highest and lowest breeding values was 5433.95 kg.

The average breeding value for lifetime milk yield in crossbred bulls was found to be 8914.21 kg by Simplified Regressed Least Squares method. There were 34 sires whose breeding values were above the average breeding value and 31 sires with breeding values below the average breeding value. The lowest breeding value observed for lifetime milk yield was 6091.47 kg for sire no. 69 and highest breeding value was 10467.25 kg for sire no. 60. The difference between highest and lowest breeding values was 4367.78 kg. The average breeding value for lifetime milk yield in crossbred bulls was found to be 8980.71 kg by Best Linear Unbiased Prediction method. There were 29 sires whose breeding values were above the average breeding value and 36 sires with breeding values below the average breeding value. The lowest breeding value observed for lifetime milk yield was 8129.97 kg for sire no. 41 and highest breeding value was 10115.45 kg for sire no. 67. The difference between highest and lowest breeding values was 1985.48 kg.

3.5 Lifetime Milk Yield / Productive Life

The average breeding value for lifetime milk yield / productive life in crossbred bulls was found to be 6.72 kg/day by Simple Daughter's average method. There were 28 sires whose breeding values were above the average breeding value and 37 sires with breeding values below the average breeding value. The lowest breeding value observed for lifetime milk yield /productive life was 3.29 for sire no. 67 and highest breeding value was 9.29 for sire no. 14. The difference between highest and lowest breeding values was 6.00 kg/day. The average breeding value for lifetime milk yield / productive life in crossbred bulls was found to be 6.68 kg/day by Least Squares method. There were 28 sires whose breeding values were above the average breeding value and 37 sires with breeding values below the average breeding value. The lowest breeding value observed for lifetime milk yield / productive life was 3.40 for sire no. 67 and highest breeding value was 9.45 for sire no. 47. The difference between highest and lowest breeding values was 6.05 kg/day.

The average breeding value for lifetime milk yield / productive life in crossbred bulls was found to be 6.67 by Simplified Regressed Least Squares method. There were 29 sires whose breeding values were above the average breeding value and 36 sires with breeding values below the average breeding value. The lowest breeding value observed for lifetime milk yield / productive life was 4.11 for sire no. 67 and highest breeding value was 9.04 for sire no. 47. The difference between highest and lowest breeding values was 4.93 kg/day. The average breeding value for lifetime milk yield / productive life in crossbred bulls was found to be 6.69 kg/day by Best Linear Unbiased Prediction method. There were 29 sires whose breeding values were above the average breeding value and 36 sires with breeding values below the average breeding value. The lowest breeding value observed for lifetime milk yield / productive life was 5.09 for sire no. 28 and highest breeding value was 8.20 for sire no. 47. The difference between highest and lowest breeding values was 3.11 kg/day.

The estimated breeding values of sires estimated for lifetime trait by BLUP method showed small genetic variation in compare to $\overline{D}$, LS and SRLS methods. Because of its desirable properties, the BLUP method was considered to be more appropriate than the other three methods. From the foregoing discussion it is indent that best linear unbiased prediction method of Sire evaluation is the most efficient one for estimating the breeding value of sires. The results obtained in the present study are in conformation to the reports of Tajane and Rai (1990) ranked Sahiwal and Holstein Friesian sires using LS and BLUP method and reported that BLUP method was the best method. Raheja (1992) also evaluated Sahiwal sires using $\overline{D}$, LS and BLUP methods and reported that LS and BLUP methods were the most accurate method, but LS to be more accurate than BLUP when variance is not known. Gaur and Raheja (1995) reported that LS was more accurate than the BLUP method. Deulkar and Kothekar (1999) reported that $\overline{D}$ method was equally good when compared with LS and BLUP methods. However, Dhaka and Raheja (2000), Dubey *et al.* (2014) and Dahia *et al.* (2005) reported that EBVs estimated by BLUP method showed small genetic variation in comparison to Least Squares method because of its derivable properties. Bajetha (2006) and Dubey *et al*. (2006); Moges *et al.* (2009); Singh and Singh (2011); Dubey *et al.* (2014) and Singh *et al.* (2014) also reported BLUP as best procedure in comparison to other procedures of sire evaluation.

3.6 Comparison of Sire Evaluation Methods

Accuracy of the methods of sire evaluation with respect to the most efficient best linear unbiased prediction (BLUP) 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 lifetime traits. The product moment correlations between the breeding values of sires are presented in Table 2 and the rank correlations between the rankings of sires by various methods are presented in Table 3. Perusal of the results indicate association between the best linear unbiased prediction (BLUP) and other method of sire evaluation ranging from 0.7433 to 0.9502 (Product moment correlation) and 0.7441 to 0.9380 (Rank correlation) for lifetime traits. All the estimates of simple and rank correlation were highly significant (<0.01). Similar results were also reported by Pundir and Raheja (1994) in Hariana and Sahiwal cattle, Deulkar and Kothekar (1999) in Sahiwal and Dalal *et al.* (1999) in Hariana cattle. Deulkar and Kothekar (1999) and Dubey (2004) observed that the product moment correlations among lifetime performance traits were medium to very high except with LTMY/PL.

Table 2: Product Moment Correlations among Sire Breeding Value for Various Lifetime Traits by Different Methods.

Method	LS	SRLS	BLUP
HL			
$\overline{\mathbf{D}}$	0.9097	0.9129	0.8397
LS		0.8456	0.8798
SRLS			0.9073
PL			
$\overline{\mathbf{D}}$	0.9113	0.9122	0.8465
LS		0.8399	0.8843
SRLS			0.9080
TLL			
$\overline{\mathbf{D}}$	0.9051	0.9015	0.8424
LS		0.8506	0.8767
SRLS			0.9318
LTMY			
$\overline{\mathbf{D}}$	0.9068	0.8769	0.7433
LS		0.8395	0.8756
SRLS			0.8782
LTMY/PL			
$\overline{\mathbf{D}}$	0.9133	0.9149	0.9237
LS		0.9056	0.9210
SRLS			0.9502

Table 3: Rank Correlations among Sire Breeding Value for Lifetime Traits by Different Methods.

Method	LS	SRLS	BLUP
HL			
$\overline{\mathbf{D}}$	0.8423	0.8883	0.7594
LS		0.8759	0.8241
SRLS			0.8550
PL			
$\overline{\mathbf{D}}$	0.8501	0.8872	0.7677
LS		0.8762	0.8358
SRLS			0.8526
TLL			
$\overline{\mathbf{D}}$	0.8473	0.8441	0.7540
LS		0.8803	0.8406
SRLS			0.9017
LTMY			
$\overline{\mathbf{D}}$	0.8427	0.8587	0.7441
LS		0.8796	0.8398
SRLS			0.8589
LTMY/PL			
$\overline{\mathbf{D}}$	0.8394	0.8491	0.8879
LS		0.8861	0.8501
SRLS			0.9380

Table 4: Sires Of Top 10 Ranks On The Basis Of Estimated Breeding Values Of Sires For Lifetime Traits By Different Methods.

Rank 0f Sires	$\overline{D}$					LS				
	HL	PL	TLL	LTMY	LTMY/PL	HL	PL	TLL	LTMY	LTMY/PL
1	67	67	67	68	14	67	67	67	60	47
2	56	56	56	21	47	56	56	56	68	62
3	68	68	68	52	33	20	20	20	38	14
4	20	20	20	55	51	68	68	29	24	60
5	46	46	29	38	62	28	28	15	34	51
6	21	21	15	60	38	29	29	45	31	61
7	29	30	46	20	34	15	15	68	52	33
8	15	15	45	34	16	21	21	28	55	48
9	28	28	21	16	31	46	46	12	61	52
10	19	19	19	14	48	19	19	32	51	43
	SRLS					BLUP				
1	67	67	67	60	47	67	67	67	67	14
2	56	56	56	38	14	56	56	56	38	47
3	20	20	20	24	62	20	20	15	60	33
4	28	28	29	34	33	46	46	45	55	62
5	29	15	15	31	51	15	15	20	61	31
6	15	29	45	55	61	28	28	29	34	61
7	19	68	28	52	48	45	45	46	52	52
8	46	19	12	68	60	29	29	68	68	34
9	68	46	68	61	52	68	68	28	28	51
10	21	21	32	51	31	19	19	12	31	16

3.7 Ranking of Sires

Simple daughter average method, least squares methods, simplified regressed least squares and best linear unbiased prediction methods are used for the estimation of sire's merits for first lactation and lifetime traits. Estimation breeding value of sire and their ranks are presented in Tables 4. The top 10 sires ranked on the basis of herd life revealed that all the 4 method ranked sire No. 67 as rank Ist, sire No. 56 as rank IInd while sire No. 20 ranked IIIrd by LS, SRLS and BLVP. sire No. 68 ranked IIIrd by D for herd life.

Top 10 sires ranked on the basis of productive life revealed that sire No. 67 and sire No. 56 ranked as Ist and IInd respectively, by all the 4 sire evaluation methods. Sire No. 20 ranked IIIrd by LS, SRLS and BLUP while sire No. 68 by D method. Top 10 sires ranked on the basis of total lactation length revealed that sire No. 67 and sire No. 56 ranked Ist and IInd respectively, by all 4 method. Sire No. 20 ranked IIIrd by LS, SRLS and BLUP while sire No. 68 by D method.

The top 10 sires ranked on the basis of lifetime milk yield revealed that sire No. 60 ranked Ist by LS and SRLS, sire No. 68 by D and sire No. 67 by BLUP method. Sire No. 38 ranked IInd SRLS and BLUP, sire No. 21 by D and sire 68 by LS methods. While sire No.52, 38, 24 and 60 ranked IIIrd by D, LS, SRLS and BLUP methods respectively. The top 10 sires ranked on the basis of lifetime milk yield/productive life revealed that sire No. 14 ranked Ist by D and BLUP and sire No. 47 by LS and SRLS. Sire No. 47 ranked IInd by D and BLUP, sire No. 62 by LS and sire No. 14 by SRLS method. Sire No. 33 ranked IIIrd by D and BLUP, sire No. 14 by LS and sire No. 62 by SRLS method for LTMY/PL.

There were changes in the rank of first few top sires by different methods of sire evaluation. There results indicated that all sires would not rank same for lifetime traits. However, the rank of sires for different traits revealed that 4.5% of top sires almost had similar rank for life time traits. There results suggested that to improve lifetime productivity major culling of bulls of cow should be done on the basis of their daughter's

first lactation milk yield. Since results are also observed by Pundir and Raheja (1994); Deulkar and Kathekar (1999); Dalal *et al*. (1999); Bajeetha (2006); Dubey *et al*. (2006); Moges *et al*. (2009); Singh and Singh (2011); Dubey *et al*. (2014) and Singh *et al*. (2014) also reported same trend on the basis of life time performance traits.

4. Conclusion

There results indicated that the estimated breeding values (EBV'S) of sires had very high and significant product moment correlations and rank correlations among all lifetime traits estimated by all the methods. These estimates indicating that there was higher degree of similarly (about 85- 90%) in ranking of sires by different methods. However, the ranks of sires for different traits revealed that 4-5% top sires had similar rank for all life time traits. The EBV's of sire revealed that BLUP method showed small genetic variation in comparison to Daughter's average, Least Squares and Simplified Regressed Least Squares method. Because of its desirable properties, the BLUP method may be considered to be more appropriate than that of other methods.

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