BREEDING VALUE ESTIMATION USING TEST DAY RECORDS IN MURRAH GRADED BUFFALOES

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ABSTRACT

The present study was carried out using test day yield for sire evaluation in Murrah graded buffalo. A total of 2329 test day lactation records of daughters of 79 sires distributed in 47 villages under field progeny testing programme in Anand milk shed area were utilized. The objective of the study was to estimate the breeding value of sires and to compare various methods of sire evaluation viz. simple daughter's average (D), contemporary comparison (CC), leastsquares (LS), best linear unbiased prediction (BLUP), average information restricted maximum likelihood (AIREML) and random regression (RR) for Predicted First Lactation Yield for 305 day (PFLY305 day) and Test day records of Murrah graded buffaloes in terms of accuracy and efficiency. For PFLY305 and Test Day Milk Yield (TDMY) estimates, AIREML and RR methods were found to have minimum error variance respectively and therefore, found most efficient. LS and BLUP methods had equal error variance for PFLY305. For 305 day fat per cent and Test Day Fat Per cent (TDFP) estimates, the AIREML and RR methods with minimum error variance respectively were found to be most efficient methods. For PFLY305 and TDMY, the rank correlations of D, CC, LS, BLUP, AIREML and most efficient RR methods were 0.47, 0.12, 0.34, 0.47 and 0.16, respectively. All the methods are expected to rank sires with fairly high accuracy. For 305 day fat per cent and TDFP, the rank correlations of D, CC, LS, BLUP, AIREML with most efficient RR methods were 0.14, 0.17, 0.06, 0.03 and 0.12, respectively.

Key words: Murrah graded buffalo, TDMY, TDFY, AIREML, RR

INTRODUCTION

Buffalo milk contributes 51.17 per cent to the total milk production of India (Anonymous, 2012) although constitute only 34.60 per cent of total bovine population. Thus, buffalo milk contributes significantly to the total milk production of India. However, production per animal is comparatively low. So, to increase and to meet the rising demand for milk and milk products in India, the genetic improvement through grading up and selective breeding including progeny testing programme of the indigenous buffalo is the key. Progeny testing is superior to other methods of selection for bringing about improvement in the productivity of buffaloes (Dixit and Sadana, 1999). Selection of sires to be used for breeding under field conditions in India has been practiced to a limited extent on small number of bulls tested under progeny testing programmes in the organized farm conditions and

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to some extent in farmer's herds. However, to make the selection of breeding bulls more effective and efficient, it is essential to conduct progeny testing of as many number of bulls as possible and that too by involving large buffalo population in rural areas (Singh and Tailor, 2013). Grading up of Surti buffalo with Murrah breed was initiated in 1988 by Amul Research and Development Association (ARDA), Amul, Anand. By this time inheritance of Murrah is expected have risen to 87.5 per cent - 91.75 per cent and this is probably the largest population in India. No information is available on sire evaluation using test day yield in Murrah on field records.The main purpose of present study was to estimate the breeding value for TD records and 305 day for milk yield and fat per cent records and also the comparisons of different methods of sire evaluation for Murrah graded buffaloes.

Materials and Methods

First lactation 2522 Test Day (TD) records of 2475 daughters sired by 104 sires born during 1998 to 2007 in 50 different villages of Anand and Kheda districts were obtained. Following information on the buffaloes calved during 2003 to 2012 were recorded. Only the first lactation records were considered in the study. The lactations with no sire information and the sires with less than 10 daughters' records were also eliminated from the study. Records with at least 3 records in each Herd-Year-Season group were only considered for the study. Therefore, 2329 lactation records of daughters of 79 sires distributed in 47 villages were available for analysis for monthly test day milk yield and monthly test day fat per cent traits. First test day yield was recorded from the fifth day after calving and 10 test day records were taken at every 4-week interval. Among these 2329 milk yield records, 2134 having 305 day fat per cent records were also available for the study.

The 305-day milk yield of each animal was calculated using the Test Interval Method (TIM) as described by ICAR (ICAR, 2012).

$$LMY = I_0 M_1 + I_1 \frac{M_1 + M_2}{2} + I_2 \frac{M_2 + M_3}{2} + \ldots + I_{n-1} \frac{M_{n-1} + M_n}{2} + I_n M_n$$

Where, $M_1, M_2, \ldots, M_n$ – test day milk yield, kg;

$I_1, I_2, \ldots I_n$ - the intervals between recording dates, days;

I_0 – the interval between the lactation period start date and the first recording dates, days;

I_n – the interval between the last recording date and the 305th lactation day, days.

The data were grouped into different classes based on village clusters (herds), periods (years) of birth and calving, seasons and age at first calving. The total of 47 villages were clustered into six groups based on village average milk yield with an assumption that the variation in the village milk production average is due to the management practices and resources available within the village receiving random sires. Year to year difference were expected to be small and hence the years were grouped into periods on the basis of distribution of sires in such a manner that there were minimum overlapping of sires over the period. The total duration of years from 1998 to 2007 were classified into five periods based on year of birth (1998-99, 2000-01, 2002-03, 2004-05 and 2006-07) and year of calving (2004-05, 2006-07, 2008-09 and 2010-12). Moreover, on the basis of prevailing climatic condition, a year was divided into three seasons viz. Winter (November-February), Summer (March-June) and Monsoon (July-October) to account for within year environmental effects. In the present study, the breeding values were estimated by different methods viz. simple daughter's average (D) method (Edward, 1932), contemporary comparison (CC) method (Jain and

Malhotra, 1971), Least square analysis (Harvey, 1987), Best Linear Unbiased Prediction (BLUP) method (Mrode and Thompson, 2005), Average Information Restricted Maximum Likelihood (AIREML) Method (Thompson *et al.* 2005) for PFLY305 and 305 day fat per cent, while Random Regression (RR) Method (Kaygisiz, 2013) for TDMY and TDFP.

In the contemporary comparison (CC) method, the contemporaries of a cow are considered to be the daughters of the other sires performing at the same time period in the same herd group. The sire constant *(S_i)* obtained by LS technique (Harvey, 1987) was used in getting the sire index as estimated by following formula: $I = [\frac{2nh^2}{4+(n-1)h^2}]S_i$

Under BLUP method, the sire effects were obtained by using single trait model. For this purpose the LS estimates of variance components from the corresponding model were used. The BLUP and AIREML evaluations were based on an animal model which utilized information from all the known relationships. The BLUP and AIREML evaluations were obtained under single trait animal model. AFC was taken as co-variable to the FMY305 and Fat per cent. The data were analysed using BLUPF90 Dairy PAK, Version3 (Duangjinda *et al.*, 2007).

$y = Xb + Za + e$ Where, y = observational matrix of traits, b = vector of fixed effects, a = vector of random effects, X and Z = design matrices for fixed and random effects respectively, e = residual random effects vectorIt is assumed that var $\begin{pmatrix} a \\ e \end{pmatrix}$ = $\begin{pmatrix} A\sigma_a^2 & 0 \\ 0 & I\sigma_e^2 \end{pmatrix}$

Where, A = matrix of additive genetic relationships between individuals, I = identity matrix σ_a^2 and σ_e^2 are additive and residual genetic variances

For AIREML, the data were analyzed using DMU, a package analyzing multivariate mixed models (Madsen and Jensen, 2013). The same single trait model described in the method for BLUP was used for AIREML. For test day records the random regression method (Kaygisiz, 2013) was used and the model for random regression as follows:

$$Y_{ijkl} = \mu + c_i + d_k + a_j + pe_j + b_1 x_{1ijk} + b_2 x_{2ijk} + e_{ijkl}$$

Where, Y_{ijkl} – milk yield and fat per cent records from a single TD, μ - population mean, c_i – i. effect of calving year, d_k – k. effect of calving season, a_j – j. animal's random additive genetic effect, pe_j – j. effect of random permanent of the cow during lactation, x_{1ijk} – age of calving, as a co-variable (linear), x_{2ijk} - DIM / c, as a co-variable, where c is a constant set to 305 – d (Ptak and Schaffer, 1993) e_{ijkl} – random error, residual effects.

The effectiveness of different sire evaluation methods was judged by various components of variances viz. within sire variance or error variance, the lowest error variance was considered to be the most efficient and most appropriate. Relative efficiency (RE) of method II with respect to method I (most efficient method) was calculated by the following equation:

$$cent) = \frac{error\ variance\ of\ method\ I}{error\ variance\ of\ method\ II} \times 100$$

Another method, Spearman's rank correlation which is the correlation between breeding values of sires derived by various methods was used to judge the effectiveness of different methods. The rank correlation was estimated as per Steel and Torrie (1960). The significance of rank correlation was tested by t-test.

$$r_s = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

Steel and Torrie (1960)

Where, r = Rank correlation coefficient, n = Number of sires under evaluation, d_i = Difference of rank between paired items under two methods.

RESULTS AND DISCUSSION

The sires were evaluated for PFLY 305, TDMY, 305 day fat per cent and TDFP. A total of 79 sires were evaluated under PFLY305 and TDMY traits while 68 sires were evaluated for 305 day fat per cent and TDFP.

PFLY305 and TDMY

The information on sire evaluation viz. top ten sires and their breeding values under various methods are presented in Table 1. For PFLY305, the estimated average of 1511.64 liters was used for D, CC, BLUP, AIREML methods, and 1511.64 liters for LS method. Under all the methods about half of the sires (range: 49.37 per cent to 55.70 per cent) were above and the other half (range: 44.30 per cent to 50.63 per cent) were below the population mean. It was observed that sire no. 185 was top ranked under D and CC methods; sire no. 193 was top ranked under LS method, sire no. 256 was top ranked under BLUP and AIREML; sire no. 251 top ranked under RR method.

305 day Fat Per cent and TDFP

The information on sire evaluation viz. top ten sires and their breeding values under various methods are presented in Table 2.For 305 day fat per cent, the estimated average of 7.25 per cent was used for D, CC, BLUP, AIREML, LS and 7.06 for RR method. Under all the methods about half of the sires (range: 36.76 per cent to 80.88 per cent) were above and the other half (range: 19.12 per cent to 63.24 per cent) were below the population mean. It was observed that sire no. 318 was top ranked under D no. 323 under CC methods, no. 204 were top ranked under LS method, sire no. 313 was under BLUP and AIREML methods and no. 229 was top ranked under RR method.

Efficiency of Sire Evaluation Methods

An efficient method of sire evaluation should have minimum error variance and the error variance of various sire evaluation methods for PFLY305 and TDMY and 305 day fat per cent and TDFP traits are presented in Table 3. For PFLY305, TDMY, 305 day fat per cent and TDFP traits, AIREML and RR were found to have minimum error variance and therefore, were most efficient. LS and BLUP methods had equal error variance for PFLY305.

Relative accuracy of sire evaluation methods with respect to most efficient method

The relative accuracy of a method with respect to the most efficient method as well as between other methods was estimated in terms of rank correlation coefficients.

PFLY305 and TDMY

For PFLY305 and TDMY, the rank correlations between different methods of sire evaluation are presented in Table 4. The values of rank correlations of D, CC, LS, BLUP and AIREML with most efficient RR method were 0.47, 0.12, 0.34, 0.15 and 0.16, respectively. These estimates of rank correlation were significant ($P < 0.01$) for D, LS, and BLUP and non-significant for CC and AIREML. All the methods are expected to rank sires with fairly high accuracy.

305 day Fat Per cent and TDFP

For 305 day fat per cent and TDFP, the rank correlations between different methods of sire evaluation are presented in Table 4. The values of rank correlations of D, CC, LS, BLUP and AIREML with most efficient RR method were 0.14, 0.17, 0.06, 0.03 and 0.12, respectively. These estimates of rank correlation were significant ($P < 0.01$). All the methods are expected to rank sires with low accuracy.

The results of the present study are comparable with those reported by Haile *et al.* (2010), Mukherjee *et al.* (2007), Banik and Gandhi (2006), Raja and Gandhi (2012) and Chaudhari (2013) with high rank correlation values among all methods. The Restricted Maximum Likelihood (REML) method of estimation of breeding values is the best method of sire ranking.

Another criterion used for judging the relative accuracy was to select top ranking ten sires under each method and to find the number of common sires as compared to the most efficient method. All 10 sires were common under AIREML, whereas 8 sires under BLUP and 2 to3 sires under RR method for PFLY305 and TDMY. 10 sires were common under AIREML, whereas 4 sires under BLUP and 3 sires under RR method for 305 day fat per cent and TDFP. The maximum numbers of common sires for methods of BLUP and AIREML for all traits might be due to similarity of model as compared to other methods viz. D, CC and LS where no regression coefficient applied.

CONCLUSION

The AIREML and RR model incorporating PFLY305 and 305 day fat per cent and TDMY and TDFP traits in the models having lowest error variance was more efficient for sire selection in Murrah graded buffaloes. The results of present study revealed that the ranking of sires could be judged based on error variance. AIREML and RR models having lowest error variance in comparison to other methods of sire evaluation, hence the most efficient methods of sire evaluation in Murrah graded buffaloes.

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Table 1: Ten top ranking sires for PFLY305 and TDMY estimated by different methods of sire evaluation:

For PFLY305											For TDMY	
Rank	Sire	BV	Sire	BV	Sire	BV	Sire	BV	Sire	BV	Sire	BV
D			CC		LS		BLUP		AIREML		RR	
1	185	146.91	185	84.55	193	296.14	256	6.15	256	34.69	251	91.30
2	187	132.23	187	68.16	245	134.28	252	5.28	252	30.82	272	85.09
3	190	128.88	190	60.91	320	132.55	193	4.59	193	29.07	302	75.16
4	191	111.63	191	55.28	283	128.28	265	4.39	265	25.73	277	69.40
5	192	103.72	192	50.81	318	124.42	271	4.28	271	25.57	323	62.16
6	193	101.87	193	44.83	252	121.08	283	4.24	283	25.05	271	60.27
7	194	99.85	194	39.35	265	117.68	245	3.66	245	22.64	284	54.19
8	196	95.69	196	33.31	200	117.20	254	2.94	254	16.90	285	44.33
9	200	94.40	200	31.39	215	111.16	318	2.67	318	16.31	283	38.59
10	204	91.55	204	31.11	271	103.26	215	2.33	215	14.26	265	37.01

Table 2: Ten top ranking sires for 305 day fat per cent and TDFP estimated by different methods of sire evaluation

For 305 day Fat Per cent											For TDFP	
Rank	Sire	BV	Sire	BV	Sire	BV	Sire	BV	Sire	BV	Sire	BV
D			CC		LS		BLUP		AIREML		RR	
1	318	1.20	323	1.35	204	4.89	313	0.100	313	0.010	229	9.14
2	328	1.02	301	1.23	217	4.15	217	0.090	217	0.092	244	9.12
3	246	1.02	194	1.21	313	4.04	272	0.083	272	0.083	223	8.95
4	247	1.02	279	0.93	206	3.99	285	0.083	285	0.082	254	8.77
5	260	0.85	330	0.90	212	3.96	258	0.082	258	0.082	241	8.27
6	259	0.69	258	0.58	320	3.91	275	0.066	275	0.066	217	5.86
7	190	0.65	248	0.52	192	3.56	320	0.064	320	0.064	320	4.30
8	255	0.60	285	0.43	207	3.36	283	0.060	283	0.060	193	4.12
9	282	0.59	282	0.37	238	3.19	238	0.054	238	0.054	240	3.86
10	229	0.58	225	0.35	331	2.34	204	0.051	204	0.051	245	3.54

Table 3: Relative efficiency of different sire evaluation methods for different first lactation traits in Murrah graded buffalo

Trait	Method	Error Variance
PFLY305	LS	103047.9999
	BLUP	101859.7209
	AIREML	99170.98777
305 Fat per cent	LS	5.441460473
	BLUP	5.366201677
	AIREML	5.336485204
TDMY	RR	99122.97
TDFP	RR	0.231630119

Table 4: Rank correlation (below the diagonal) between different methods and number of common sires (above diagonal) out of top ten sires for PFLY305, TDMY and for 305 day fat per cent, TDFP

For PFLY305 and TDMY							For 305 day fat per cent and TDFP						
Method	D	CC	LS	BLUP	AIREML	RR	Method	D	CC	LS	BLUP	AIREML	RR
D		10	1	1	1	0	**D**		1	0	0	0	1
CC	0.12		1	1	1	0	**CC**	0.06		0	2	2	0
LS	0.34	0.18		8	8	2	**LS**	0.08	0.08		4	4	0
BLUP	0.47	0.20	0.34		10	3	**BLUP**	0.09	0.08	0.14		10	3
AIREML	0.16	0.13	0.43	0.65		3		0.09	0.03	0.28	0.92		3
RR	0.47	0.12	0.34	0.15	0.16		**RR**	0.14	0.17	0.06	0.03	0.12	

Note: All correlations were significantly (P < 0.01) different from zero