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Comparison of test-day and lactation models of sire evaluation in Murrah buffalo

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ABSTRACT

The aim of the study was to investigate efficiency of test-day model (TDM) compared to lactation model (LM) for genetic evaluation of Murrah buffalo bulls. Use of TDM instead of LM is of more interest in genetic evaluation because of variability of lactation days in dairy animals. Data pertaining to first lactation monthly test-day milk yield (FLMTDMY) and first lactation 305-days or less milk yield (FL305DMY) of 1,105 Murrah buffalo during 1993 to 2010 were collected and adjusted against significant environmental influences. It was found that test-day 6 milk yield (FLMTD6MY) had the highest genetic and phenotypic correlation with FL305DMY. An attempt is being made in the present investigation to compare the estimated breeding values (EBVs) of Murrah bulls through best linear unbiased prediction for FL305DMY and FLMTD6MY. The rank correlations between 2 traits were highly statistically significant indicating that FLMTD6MY is equally effective to discriminate amongst sires.

Key words: Best linear unbiased prediction, Lactation model, Murrah buffalo, Test-day model

India is regarded as a treasure house of the world's best buffalo germplasm (Gupta *et al.* 2011). The buffalo is not only a better source of milk but also provides meat and draught power. Indian buffalo contributes 17% of world milk production and 48% of Asian milk production (FAO 2012). Network Project on Buffalo Improvement was initiated to envisage and undertake progeny testing for improvement of buffalo breeds at various farms in different parts of the country. In India test bulls are evaluated based on their daughters first lactation 305-days or less milk yield without taking into account variation in lactation days though the variation in lactation length is reflected in persistency. Genetic evaluation of dairy bulls for milk production based on individual monthly test-day yields rather than 305-days or less milk yield has a number of benefits (Jamrozik and Schaeffer 1997). Patil *et al.* (2012) reported average monthly test-day milk yields in Murrah buffalo. Because of variability of lactation days in dairy animals, the use of test-day models (TDM) instead of lactation model (LM) is of more interest in genetic evaluation. Information on test-day is lacking in Murrah buffaloes and hence, the present study was carried out.

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MATERIALS AND METHODS

In the present study, information was collected from 7 sets of progeny testing under Network Project on Murrah buffalo Improvement. In 7 sets of progeny testing 95 (11, 12, 15, 14, 15, 16, and 12) Murrah bulls were evaluated. Lactation records of 1,105 Murrah buffaloes during 1993 to 2010, were collected from the history-cum pedigree sheets and milk yield registers maintained at the National Dairy Research Institute, Karnal (NDRI); Central Institute for Research on Buffalo, Hisar (CIRB); Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana (GADVASU) and Choudhary Charan Singh Haryana Agricultural University, Hisar (CCSHAU).

Sires were evaluated on the basis of first lactation 305-days or less milk yield (FL305DMY) and first lactation monthly test-day 6 milk yield (FLMTD6MY) in the present study. First test-day yield was recorded from the fifth day after calving and 11 test-day milk records were taken at every one month interval. The records of the buffaloes with normal lactation were considered for this study. Data of buffaloes with a minimum of 500 kg of milk production in at least 100 days of lactation, calving and drying under normal physiological conditions were included in the analysis. The buffaloes showing abortion, dystocia and other reproductive disorders were not included in the study. To ensure the normal distribution of records, the outliers were removed and data within the range of mean±3 standard deviation was only considered for the study. Hence after standardization and normalization, records of 832 Murrah buffaloes were retained for analysis.

The data were adjusted for significant non-genetic factors for buffaloes calved in different farms, years and seasons of calving using fixed linear models. Since the data were non-orthogonal, the least-squares technique suggested by Harvey (1990) was used to estimate the effect of non-genetic factors, and the means were compared using Duncan's multiple range test (Kramer 1957). The model considered was as follows:

$$Y_{ijkl} = \mu + P_i + S_j + F_k + e_{ijkl}$$

where, Y_{ijkl} is the l^{th} observation in K^{th} farm, j^{th} season and i^{th} year of calving; μ the overall mean; P_i the fixed effect of i^{th} year of calving; S_j the fixed effect of j^{th} season of calving; F_k the fixed effect of the k^{th} farm; and e_{ijkl}, the random error~NID (0, σ^2e).

The genetic and phenotypic correlations were calculated from the analysis of variance and covariance among sire groups (Becker 1975). Genetic and phenotypic correlations between FL305DMY and different FLMTDMYs were used to select particular FLMTDMY for daily milk recording.

The EBVs of Murrah buffalo bulls were estimated for FL305DMY and FLMTDMY by best linear unbiased prediction (Henderson 1975). The EBVs of Murrah buffalo bulls were estimated set-wise and subsequently bulls were ranked in respective set.

The breeding value of sires was estimated by BLUP using the model 8 analysis in LSMLMW and MIXMDL package of Harvey (1990) as per the following general mix model:

$$Y = Xb + Za + e$$

where, Y, is an observational matrix of trait (FL305MY/ FLMTD6MY); b, is a vector of fixed effects (years, seasons and farms); a, is a vector of random effect (animal); X and Z, are design matrices for fixed effects and random effects respectively.

The Spearman's rank correlation method (Steel and Torrie 1960) was used to judge the effectiveness of test-day and lactation models of sire evaluation. To compare two models, Spearman's rank correlations were estimated using ranks of bulls based on EBVs for

FLMTD6MY and FL305DMY. Two models were compared for the 7 sets separately and significance of rank correlations were tested.

RESULTS AND DISCUSSION

The data were adjusted for significant non-genetic factors. The least-squares analysis of variance (Table 1) showed that farm had significant effect on FLMTDMY and FL305DMY. Season of calving had nonsignificant effect on all the traits except for FLM305DMY, FLMTD2MY, FLMTD3MY, FLMTD10MY and FLMTD11MY. Year of calving had significant effect on FLMTD1MY, FLMTD3MY, FLMTD4MY, FLMTD5MY, FLMTD8MY and FLMTD11MY. Genetic correlation among FLMTDMYs with FLM305DMY ranged between 0.14 (test-day10) and 0.99 (test-day6). Phenotypic correlations of FLMTDMYs with FLM305DMY obtained as 0.21 (test-day1) to 0.78 (test-day 6) in Murrah buffaloes. First lactation monthly test-day 6 milk yield (FLMTD6MY) had the highest genetic (0.99±0.04) and phenotypic (0.78±0.02) correlation with FL305DMY. Record of FLMTD6MY of daughter can be taken in 5 months only instead of 10 months with FL305DMY. It is also easy to record FLMTD6MY as compared to FL305DMY.

In this study, high estimate of genetic correlation between test-day yield and 305-days lactation yield was found. Similar findings were reported by others; Chakraborty *et al.* (2010) studied correlation between FLMTDMYs and FLM305DMY and reported highest genetic correlation between FLMTD6MY and FLM305DMY; Geetha (2005) reported that the genetic correlations among monthly test-day milk yields ranged between 0.25 and 0.99 and monthly test-day milk yields with 305-day milk yield ranged between 0.25 and 1.00 in Murrah buffaloes. In another study Rana (2008) reported that the genetic correlations among test-day milk yields and 305-day milk yield were close to unity and phenotypic correlations among test-day milk yields and 305-day milk yield were quite high and positive (0.60 to 0.99) in Murrah buffaloes. Kaygisiz (2013) reported that correlation between breeding values for test-day and 305-day milk yield were estimated as 0.92 (P<0.01) for Holstein cows. Kaygisiz (2013) suggested that use of TD milk yield for genetic evaluations permits researchers to gain more advantages. The high genetic correlation between test-day yield and 305-days lactation yield imply that both traits could genetically be considered as expression of the same trait. Use of test-day record is easier and advance than

Table 1. Analysis of variance (M. S. values) for 305-day milk yield and 11 test day records

Source of variation	305 days	TD1	TD2	TD3	TD4	TD5	TD6	TD7	TD8	TD9	TD10	TD11
Farm	276626**	42.5**	64.3**	56.9**	51.5**	43.1**	48.8**	32.9**	23.4**	15.7**	10.0**	16.6**
	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Season of calving	847463*	1.14	10.7**	17.7**	1.25	1.04	0.14	2.93	0.99	4.7	16.7**	17.2**
	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Year of calving	225600	10.2**	4.10	7.67**	8.2**	8.9**	3.9	2.62	5.83*	3.48	3.7	5.2**
	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)
Error	233779	3.16	3.70	3.34	3.4	3.58	3.15	3.15	2.82	2.64	2.49	2.18
	(814)	(752)	(814)	(814)	(814)	(814)	(805)	(790)	(759)	(709)	(610)	(465)

Figures in parentheses indicate respective degrees of freedom. * Significant at (P < 0.05). ** Significant at (P < 0.01).

Table 2. Rank of sires on the basis of estimated breeding values for first lactation 305-days or less milk yield

Set 1	Rank	Set 2	Rank	Set 3	Rank	Set 4	Rank	Set 5	Rank	Set 6	Rank	Set 7	Rank
392	4	93	8	993	8	1319	5	1485	13	1135	13	1419	7
896	2	759	4	1023	1	1341	2	1491	6	1153	1	1727	10
3098	1	761	3	1061	5	1360	8	1524	15	1667	11	1746	9
3108	3	829	1	1084	12	1363	11	1536	12	1706	16	1749	3
3117	6	1241	6	1131	3	1434	10	1555	10	1713	10	1796	1
3125	11	1253	5	1153	2	1437	6	1573	11	1717	6	2121	11
3127	10	1290	10	1165	9	1446	14	1641	5	1836	7	2133	12
3206	5	3551	2	1171	13	1451	2	1666	7	1922	8	2184	5
3294	7	3638	7	1315	6	1506	3	1749	14	1933	4	2331	4
3462	9	3689	11	1354	4	1538	13	1798	8	1944	14	2363	6
3567	8	3736	12	3865	14	4071	4	4244	4	2028	9	4807	8
		3750	9	3924	11	4090	7	4245	9	4506	3	4915	2
				3930	10	4124	1	4371	2	4523	5		
				3949	15	4188	9	4393	1	4619	2		
				3966	7			4395	3	4637	15		
										4640	12		

Table 3. Rank of sires on the basis of estimated breeding values for first lactation monthly test day-6 milk yield

Set 1	Rank	Set 2	Rank	Set 3	Rank	Set 4	Rank	Set 5	Rank	Set 6	Rank	Set 7	Rank
392	3	93	5	993	9	1319	9	1485	15	1135	16	1419	6
896	4	759	6	1023	1	1341	3	1491	10	1153	3	1727	11
3098	2	761	2	1061	7	1360	6	1524	14	1667	8	1746	8
3108	1	829	8	1084	14	1363	14	1536	12	1706	15	1749	9
3117	7	1241	7	1131	3	1434	13	1555	6	1713	9	1796	1
3125	11	1253	4	1153	2	1437	7	1573	7	1717	4	2121	10
3127	9	1290	12	1165	6	1446	11	1641	4	1836	7	2133	12
3206	5	3551	3	1171	13	1451	1	1666	9	1922	10	2184	5
3294	8	3638	1	1315	4	1506	2	1749	13	1933	6	2331	2
3462	10	3689	9	1354	5	1538	12	1798	2	1944	13	2363	7
3567	6	3736	11	3865	12	4071	5	4244	8	2028	14	4807	4
		3750	10	3924	11	4090	8	4245	11	4506	1	4915	3
				3930	10	4124	10	4371	1	4523	2		
				3949	15	4188	4	4393	3	4619	5		
						3966	8	4395	5	4637	12		
										4640	11		

lactation record as in this case only 1 or 2 particular day (test-day) record is required instead of taking all day records up to 305-days of lactation.

In the present study, EBVs of sires based on FL305DMY and FLMTD6MY were estimated by BLUP methods and then sires were ranked subsequently (Tables 2,3). Comparison of 2 models of sire evaluation was done by comparing the spearman's rank correlations between ranks of sires based on EBVs for FL305DMY and FLMTD6MY. The rank correlations between corresponding ranks (Table 4) based on FL305DMY and FLMTD6MY ranged from 0.473 (in set 4) to 0.950 (in set 3). The rank correlations between 2 traits for sire evaluation were highly statistically significant in 6 sets indicating that both traits of sire evaluation were equally effective to discriminate amongst sires.

Use of test-day milk yields offered a better modeling opportunity and more accurate in genetic evaluation. Also,

Table 4. Spearman's rank correlations for the ranks between first lactation 305-days or less milk yield and first lactation monthly test day-6 milk yield

Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7
0.918**	0.608*	0.950**	0.473	0.779**	0.861**	0.783**

*Significant at ($P < 0.05$) ** Significant at ($P < 0.01$)

test-day milk yields in farm should be taken into consideration for selection of the buffalo for milk yield. The test-day models have been suggested as the method of choice for the analysis of milk yield traits to maximize the use of all available information. This method becomes even more important in smaller herd size and without well-established milk recording schemes. In fact, the test-day model appears to be a better alternate of 305-day lactation model because early selection on the basis of test-days could reduce generation interval. It could economize the genetic evaluation of dairy animals and improve accuracy of evaluation. Estimation of breeding value based on test-day milk yield would offer a solution to handle complex situation like lack of necessary infrastructure for daily milk recording and hence cost of recording could be reduced substantially.

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