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Estimation of Genetic Parameters of Lifetime Performance Traits in Murrah Buffaloes

Kapil Dev, S.S. Dhaka*, A.S. Yadav and C.S. Patil

Department of Animal Genetics and Breeding, LUVAS, Hisar, INDIA

**Corresponding author: SS Dhaka; Email: zuludhaka@gmail.com*

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ABSTRACT

The data on 171 Murrah buffaloes sired by 49 pertaining to lifetime performance traits were collected from history cum pedigree sheets maintained at Buffalo Research Centre (BRC), Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar over a period of 20 years from 1990 to 2009. Analysis of variance done by restricted maximum likelihood method of Harvey (1990) using mixed linear regression model with regression effect of age at first calving. The overall least squares means for lifetime milk yield (LTMY), productive life (PL), milk yield per day of productive life (MY/PL), herd life (HL) and milk yield per day of herd life (MY/HL) averaged as 8607.93±481.93 kg, 1161.59±54.17 days, 5.59±0.15 kg/day, 3340.22±120.67 days and 2.55±0.10 kg/day, respectively. The effect of period and season of calving and age at first calving (linear and quadratic) was statistically non-significant on all the lifetime performance traits under study except that significant effect of period of calving on MY/PL. The heritability estimates along with standard errors for different lifetime performance traits were obtained as 0.18±0.10, 0.26±0.17, 0.11±0.04, 0.26±0.20 and 0.29±0.13 for LTMY, PL, MY/PL, HL and MY/HL, respectively. The genetic and phenotypic correlations among lifetime performance traits were positive and high except genetic and phenotypic associationship of HL with MY/HL and MY/PL. Therefore, moderate to high genetic correlations among lifetime traits indicated that selection based on any one of these traits could result into improvement through positive correlated response in all other traits.

Keywords: Genetic factors, Murrah buffalo, Lifetime performance traits

The total Bovine population (Cattle, Buffalo, Mithun and Yak) is 299.9 million numbers in 2012 which shows a decline of 1.57% over previous census. The female Buffalo population has increased by 7.99% over the previous census and the total number of female buffalo is 92.5 million numbers in 2012. The buffalo population has increased from 105.3 million to 108.7 million showing a growth of 3.19%. (Livestock census, 2012). Although the proportion of buffaloes to cattle is 1:2, buffaloes contribute around 57 percent of the total milk production. Economic return from dairy animals depends on lifetime performance. The prediction of expected correlated response to selection based on early performance and development of selection schemes for genetic improvement in lifetime traits are likely to be more beneficial. Buffaloes are generally culled for reproductive failures, low yield, mastitis and other health problems. The genetic worth of buffalo is primarily determined by her lifetime performance. This includes the ability to maintain high level of production for a longer period and more number of calving in her lifetime. Although lactation records are widely used in assessing the genetic merit of buffaloes but selection of dairy sires is invariably based on the first one or two lactation records in most of the breeding programmes (Kuralkar and Raheja, 1997). It is established fact that first lactation yield is a good indicator of lifetime performance but still there is further need to study the relationship between first, later lactations and lifetime performance traits for overall better evaluation of genetic worth of the female individual's own performance and for ranking of sires. Keeping in view, the above facts available through the literature on this species of livestock indicated immense opportunities for the evaluation of genetic parameters and devising appropriate selection indices. The present investigation was undertaken to estimate the phenotypic and genetic parameters of lifetime performance traits in Murrah buffaloes.

MATERIALS AND METHODS

The data on 171 Murrah buffaloes pertaining to lifetime performance traits were collected from history cum pedigree sheets maintained at Buffalo Research Centre (BRC), Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar over a period of 20 years from 1990 to 2009 were analysed to study the genetic parameters. Animals having lactation shorter than 100 days, suspected outliers on the basis of histograms and abnormal records like abortion, mastitis and chronic illness were excluded from present study. Completion of minimum of three lactations and maximum of five lactations for studying lifetime traits were considered for those animals that have the information of their date of birth, date of first calving, date of disposal and subsequent calving. Traits included were lifetime milk yield (LTMY) in kg, productive life (PL) in days, milk yield per day of productive life (MY/PL) in kg/day, herd life (HL) in days and milk yield per day of herd life (MY/HL) in kg/day. Assuming that there is not much variation in adjacent years, entire period of twenty four years was divided into five equal periods from 1990-1993, 1994-1997, 1998-2001, 2002-2005 and 2006-2009. However, for lifetime traits, period from 2010-2013 was excluded from the study due to inadequate number of observations available for these traits. Each year was further delineated into 4 seasons of calving according to the prevailing agro-climatic conditions in the region viz., Summer (April to June), Rainy (July to September), Autumn (October to November) and Winter (November to March). In order to overcome non-orthogonality of the data due to unequal subclass frequencies, least squares and maximum likelihood computer program of Harvey (1990) was utilized to estimate the effect of various tangible factors on early performance traits. The following statistical model will be used to explain the underlying biology of the traits included in the study.

$$\mathbf{Y_{ijkl} = \mu + c_i + h_j + c_k + b_l(A_{ijkl} - \bar{A}) + b_2 (A_{ijkl} - \bar{A})^2 + e_{ijkl}}$$

Where, $\mathbf{Y_{ijkl}}$ = l^{th} record of individual calved in i^{th} season, j^{th} period pertaining to k^{th} sire, **μ=** is the overall population mean, $\mathbf{c_{i}}$= is the fixed effect of i^{th} season of calving, h_j= is the fixed effect of j^{th} period of calving, $\mathbf{c_k}$ = is the random effect of k^{th} sire, $\mathbf{b_1}$&$\mathbf{b}_2$ = are linear and quadratic partial regression coefficients of age at first calving on traits(s), respectively, $\mathbf{A}_{ijkl}$ = is the age at first calving, $\bar{\mathbf{A}}$ = is the mean for age at first calving, $\mathbf{e}_{ijkl}$ = is the random error associated with each and every observation and assumed to be normally and independently distributed with mean zero and variance $\boldsymbol{\sigma}^2$ e.

Paternal half-sib correlation method was used to estimate heritability of the traits under study. The standard error of heritability was obtained from the formula given by Swiger *et al.* (1964). The genetic correlations among different traits were estimated from sire component of variance and covariance as:

$$\text{Genetic correlations } r_{g_i g_j} = \frac{\sigma_{s_{ij}}}{\sigma_{s_i}\sigma_{s_j}}$$

The standard error of genetic correlations were obtained by using the formula of Robertson (1959) as:

$$S.E.\left(r_{g_i g_j}\right) = \frac{\left(1 - r_{g_{ij}}^2\right)}{\sqrt{2}}\sqrt{\frac{S.E.\left(h_i^2\right) \times S.E.\left(h_j^2\right)}{h_i^2 h_j^2}}$$

Where h_i^i and h_j^i are heritabilities of *i* and *j* traits, respectively.

The phenotypic correlations were obtained from sire and within sire components of variances and covariances as:

$$\text{Phenotypic correlations } \left(r_{p_i p_j}\right) = \frac{\sigma_{s_{ij}} + \sigma_{e_{ij}}}{\left(\sigma_{s_i} + \sigma_{e_i}\right)\left(\sigma_{s_j} + \sigma_{e_j}\right)}$$

The standard errors of phenotypic correlations were computed by the following formula given by Panse and Sukhatme (1967):

$$S.E.\left(r_{P_i P_j}\right) = \sqrt{\frac{1 - r^2{}_{P_i P_j}}{n - 2}}$$

Table 1: Analysis of variance for lifetime performance traits

Source	D.F.	Mean squares				
		LTMY	PL	MY/PL	HL	MY/HL
Sire	48	6164955.41	68981.86	0.77	489420.29	0.37
Period	4	3781198.49	57081.20	1.87*	436184.35	0.16
Season	3	1572071.11	4078.74	1.55	574609.26	0.15
AFC (Linear)	1	4594128.32	28479.79	0.0004	1858731.74	0.14
AFC (Quadratic)	1	9479766.17	290166.06	0.07	57971.98	0.71
Remainder	113	8918320.56	112681.02	0.58	559155.11	0.33

Where, * $p<0.05$

LTMY = Lifetime Milk Yield, PL = Productive Life, MY/PL = Milk Yield per day of Productive Life, HL = Herd Life and MY/HL= Milk Yield per day of Herd Life

RESULTS AND DISCUSSION

The overall least squares means for LTMY, PL, MY/PL, HL and MY/HL averaged as 8607.93±481.93 kg, 1161.59±54.17 days, 5.59±0.15 kg/day, 3340.22±120.67 days and 2.55±0.10 kg/day, respectively (Table 2). The overall least squares means of LTMY for present investigation was higher than the findings of Kuralkar and Raheja (1997), Godara (2003), Singh and Barwal (2012), Thiruvenkadan *et al.* (2015) in Murrah buffaloes. However, higher averages for LTMY are also available in the literature (Dutt *et al.*, 2001). On the other hand, higher estimates of PL was reported by Chander (2002) and Thiruvenkadan *et al.* (2015) in Murrah buffalo. Lower estimate was reported by Godara (2003). This might be partly attributed to the varying herdlife span, number of observations and type of data recorded. The value of MY/PL is in close confirmation with Chander (2002). The higher values for HL were obtained by Dutt *et al*. (2001). On the contrary, lower values was reported by Chander (2002) and Thiruvenkadan *et al.* (2015). The value of MY/HL is in congruence with the findings of Kuralkar and Raheja (1997) and Dutt *et al.* (2001).

The effect of period of calving was statistically non-significant on all the lifetime performance traits under study except for MY/PL where it was significant (Table 1). However, significant effect of period of calving on LTMY, PL and HL was reported by Dutt and Taneja (1994). The period wise least squares mean of LTMY and MY/PY indicated that it was the highest in buffaloes calved during third period 9265.45±824.07 kg and 5.71±0.22 kg/day, respectively. Likewise, it was the lowest 7825.44±999.39 kg and 4.86±0.27 kg/day, respectively for these traits in buffaloes calved during fourth period. The periodwise least square means for PL and HL indicated that it was the highest for second period calvers 1312.22±161.04 days and 3506.63±358.73 days, respectively. Likewise, it was the lowest for PL (1110.34±120.61 days) during fifth period calvers and for HL (3006.06±250.24 days) during fourth period calvers. The periodwise least square means for MY/HL was the highest (2.76±0.29 kg/day) for first period calvers and the lowest (2.52±0.21 kg/day) for fifth period calvers. Moreover, the averages for first to third and fifth period did not differ significantly among themselves for MY/PL but its values for first, third and fifth period differed significantly from those calved during fourth period. However, no definite trend was obtained in the means for these lifetime performance traits over different periods. The differences in these lifetime performance traits over different periods could be due to differential availability of green fodder, climatic conditions and management practices being followed at the farm.

The effect of season of calving was statistically non significant on all the lifetime performance traits. Non-significant effect of season of calving on LTMY, HL and MY/HL reported under the present study is in consonance with those reported earlier by Dutt *et al.* (2001). Seasonwise least-squares means for LTMY, PL and MY/PL indicated that the performance of buffaloes calved during autumn season (October to November) was the best that did not differ significantly from those calved during summer,

Table 2: Least square means along with standard errors for different lifetime performance traits

Ind.var.	Obs.	LTMY	PL	MY/PL	HL	MY/HL
Overall	171	8607.93±481.93	1161.59±54.17	5.59±0.15	3340.22±120.67	2.55±0.10
			Period of calving			
1990-93	12	9033.89^{a}±1467.02	1194.78^{a}±164.90	5.56^{a}±0.38	3172.73^{a}±367.33	2.76^{a}±0.29
1994-97	44	9185.85^{a}±1432.67	1312.22^{a}±161.04	5.10^{ab}±0.38	3506.63^{a}±358.73	2.65^{a}±0.28
1998-01	38	9265.45^{a}±824.07	1250.35^{a}±92.634	5.71^{a}±0.22	3421.55^{a}±206.34	2.75^{a}±0.16
2002-05	45	7825.44^{a}±999.39	1121.50^{a}±112.34	4.86^{b}±0.27	3006.06^{a}±250.24	2.59^{a}±0.20
2006-09	32	8445.66^{a}±1073.03	1110.34^{a}±120.61	5.69^{a}±0.29	3302.88^{a}±268.68	2.52^{a}±0.21
			Season of calving			
Summer	68	8208.81^{a}±386.95	1158.07^{a}±55.97	5.66^{a}±0.17	3203.79^{a}±146.97	2.64^{a}±0.12
Monsoon	48	8568.98^{a}±451.00	1152.58^{a}±63.18	5.59^{a}±0.19	3460.50^{a}±163.01	2.50^{a}±0.13
Autumn	27	8862.71^{a}±472.45	1178.61^{a}±56.83	5.88^{a}±0.21	3452.01^{a}±193.42	2.56^{a}±0.15
Winter	28	8791.21^{a}±588.99	1157.09^{a}±58.69	5.21^{a}±0.22	3244.60^{a}±197.56	2.50^{a}±0.16
			Regression			
AFC (Linear)		1.07 ± 1.50	0.084 ± 0.17	-0.00001 ± 0.0004	0.68 ± 0.37	-0.00019 ± 0.00028
AFC (Quad.)		-0.01 ± 0.007	-0.001 ±. 0007	0.000000 ± 0.000001	-0.0005 ± 0.0017	-0.000001 ± 0.000001

Means subscribed by different letters differed significantly among themselves.

Table 3: Estimates of heritability (diagonals), genetic (below diagonals) and phenotypic (above diagonals) correlations among lifetime performance traits

TRAITS	LTMY	PL	MY/PL	HL	MY/HL
LTMY	0.18±0.10	0.90**±0.08	0.59**±0.13	0.79**±0.22	0.74**±0.15
PL	0.88±0.08	0.26±0.17	0.42**±0.24	0.80**±0.19	0.20±0.24
MY/PL	0.87±0.13	0.57±0.24	0.11±0.04	0.35**±0.24	0.56**±0.09
HL	0.50±0.22	0.67±0.19	0.07±0.24	0.26±0.20	0.20±0.24
MY/HL	0.70±0.15	0.49±0.24	0.83±0.09	0.25±0.24	0.29±0.13

Where ** ($p<0.01$)

LTMY = Lifetime Milk Yield, PL = Productive Life, MY/PL = Milk Yield per day of Productive Life, HL = Herd Life and MY/HL= Milk Yield per day of Herd Life

winter and monsoon calvers. However, season effect was non-significant for HL and MY/HL, it was the highest for monsoon calvers and summer season calvers, respectively. The effect of age at first calving (linear and quadratic) was non-significant on all the lifetime performance traits. Similarly, non-significant effect of AFC on LTMY was reported by Godara (2003) and on MY/PL and MY/HL by Thiruvenkadan *et al.* (2015).

The heritability estimates along with standard errors for different lifetime performance traits were to the tune of 0.18±0.10, 0.26±0.17, 0.11±0.04, 0.26±0.20 and 0.29±0.13 for LTMY, PL, MY/PL, HL and MY/HL, respectively (Table 3). The present finding pertinent to LTMY, PL and MY/PL were in congruence with Kuralkar and Raheja (1997), Godara (2003) and Bashir *et al.* (2007). Critical appraisal of heritability estimates for various lifetime performance traits revealed that it was low to moderate for all lifetime performance traits indicating that progeny testing coupled with performance of collateral relatives will help in improvement of these traits.

The genetic and phenotypic correlations among lifetime performance traits were positive and high except genetic and phenotypic associationship of HL with MY/HL and MY/PL. The genetic and phenotypic correlations of HL with MY/HL were moderate (Table 3). The similar results were also reported by Chander (2002), Bashir *et al.* (2007), Kuralkar and Raheja (1997) and Thiruvenkadan *et al.* (2015). High genetic correlations among lifetime traits indicated that selection based on any one of these traits could result into improvement through positive correlated response in all other traits.

CONCLUSION

The study revealed that selection would be more effective if lifetime performance traits be included in selection criteria. The low to moderate estimates of heritability and moderate to high genetic and phenotypic correlations indicated that life-time milk yield, productive life and herd life was better representative trait(s) among all lifetime performance traits. These results also suggested that selection of relatives on the basis of lifetime milk yield, productive life and herd life would lead to positive genetic responses and high genetic gain.

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