

Genetic studies on production efficiency traits in Murrah buffaloes

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Received: 2 November 2009; Accepted: 1 May 2010

ABSTRACT

The present investigation was undertaken on data of Murrah buffaloes from Buffalo Research Centre of the university. Records of 326 Murrah buffaloes distributed over 20 (1987 to 2006) years were analyzed. The overall means were 1937.88 kg, 10.16 kg, 194.12, 6.09 kg/day, 3.98 kg/day and 1.00 kg/day for first lactation milk (FLY), first lactation peak yield (FPY), persistency (P), average milk yield per day of first lactation (AYL), milk yield per day of first calving interval (MCI) and milk yield per day of age at second calving (MSC), respectively. The effect of period of calving was significant on P, AYL and MSC but, the effect of season of calving was nonsignificant on all the traits under study. The summer calvers were excellent for the traits under present study. The effect of age at first calving (linear) was significant on FLY, AYL, MCI and MSC. The effect of AFC (quadratic) on all the production and its efficiency traits were non-significant. The estimates on heritability were low to moderate (0.19 to 0.32). The genetic and phenotypic correlations were high barring some exceptions. High genetic and phenotypic correlations of FPY with production efficiency traits except with persistency indicate that FPY can be used as a selection criterion. MSC can be used as an index trait in selection programme as it is associated with AFC and milk yield.

Key words: Buffaloes, Correlations, First lactation milk yield, Heritability, Production efficiency traits

The milk production of animal depends upon the reproduction activity of the animal. But, in several studies antagonistic genetic and phenotypic correlations between reproduction and the production of the animal were reported (Kumar *et al.* 2000, Dhaka *et al.* 2002, Suresh *et al.* 2004). To obtain a simultaneous improvement in productive and reproductive traits by overcoming this antagonism, it will be useful to use a practical measure that combines these traits that show the overall efficiency of an animal. Milk yield per day of lactation length, milk yield per day of calving interval and milk yield per day of age at second calving may be thought of as combinations of production and reproduction and can be used as selection tool. Economic milk production in animal depends on the peak yield and persistency of the animals. The production efficiency traits help in determining the marketing value of the animal. Therefore, an effort was made to estimate genetic parameters of production efficiency traits in Murrah buffaloes.

MATERIALS AND METHODS

The present study was conducted on data pertaining to

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326 Murrah buffaloes maintained at Buffalo Research Centre (BRC) of the University, over a period of 20 years (1987–2006). The duration of 20 years were divided into 4 periods of 5 years each. The 3 seasons were delineated as summer (March to June), monsoon (July to October) and winter (November to February) on the basis of geo-climatic conditions prevailing in the region. The production efficiency traits recorded were: first lactation milk yield (FLY), first lactation peak yield (FPY), persistency of first lactation milk yield (P) = first lactation milk yield (FLY)/first lactation peak yield (FPY), average yield per day of lactation (AYL) = first lactation milk yield (FLY)/first lactation length (FLL), lactation milk yield per day of first calving interval (MCI) = first lactation milk yield (FLY)/first calving interval (FCI), and lactation milk yield per day of age at second calving (MSC) = first lactation milk yield (FLY)/age at second calving [ASC = age at first calving (AFC) + first calving interval (FCI)]. Bulls with at least 3 progenies were considered for the present study. Lactations shorter than 150 days were excluded from the present study. Abnormal records like abortion, mastitis, chronic illness, physical injuries etc. were also excluded from the present study. The least-squares solutions were obtained using the model taking period, season as fixed effect, sire as random and AFC (linear and quadratic) as covariable given below:

$$Y_{ijkl} = \mu + S_i + h_j + C_k + b_1(Y_{ijkl} - \bar{X}) + b_2(X_{ijkl} - \bar{X})^2 + e_{ijkl}$$

where, Y_{ijkl} , 1th record of individual of i^{th} sire calved in j^{th} period and k^{th} season; μ , overall population mean; s_i , random effect of i^{th} sire; h_j , fixed effect of j^{th} period of calving; C_k , fixed effect of k^{th} season of calving; b_1 and b_2 , linear and quadratic partial regression coefficient of age at first calving on trait(s), respectively; x_{ijkl} , age at first calving; $\bar{x}$, mean of the age at first calving; and e_{ijkl} , error associated with each observation and assumed to be normally and independently distributed with mean zero and variance, σ_e^2 .

The least-squares and maximum likelihood computer program of Harvey (1987) using Henderson's method III (Henderson 1953) were used to estimate the effect of various tangible factors on different traits under study. Duncan's multiple range test as modified by Kramer (1957) was used for making all possible pair-wise comparison of means. Heritability estimates for different traits were obtained by the paternal half-sib correlation method. The standard errors of heritability estimates were obtained by using formula given by Swiger *et al.* (1964). Genetic and phenotypic correlations were calculated from variance-covariance analysis. The standard error of phenotypic correlations was computed using the formula given by Snedecor and Cochran (1968).

RESULTS AND DISCUSSION

The least-squares means and their standard errors for production efficiency traits presented in Table 1 indicated that the means for FLY, FPY, P, AYL, MCI and MSC averaged as 1937.88 kg, 10.16 kg, 194.12, 6.09 kg/day, 3.98 kg/day

and 1.00 kg/day, respectively. Similar least-squares means for AYL and MCI were reported by Kumar *et al.* (2000) in Murrah buffaloes. Lower estimates of MCI and MSC were reported by Murali Dhar and Deshpande (1995) in Murrah buffaloes.

The least-squares analysis of variance showed that the effect of period of calving was statistically significant ($P < 0.05$) on P, AYL and MSC, while season of calving had nonsignificant effect on the traits under study. The performance of fourth period calvers (2001–2006) was better for FLY, FPY, AYL and MSC and that of first period calvers (1987–1991) was better P and MCI (Table 1). Moreover, no definite trend was obtained in different periods of calving for any trait except for FPY where positive trend was obtained. The nonsignificant effect of season in production and production efficiency traits were also reported by Shabadi *et al.* (1993). The performance of summer calvers was better than the other 2 season calvers for all the traits under study except for MCI where monsoon calvers showed better performance that did not differ significantly from summer calvers.

Significant effect of age at first calving (linear) on FLY, AYL, MCI and MSC was obtained. Similar results were obtained by Shabadi *et al.* (1993). The effect of AFC (quadratic) on all the traits under was nonsignificant. The positive regression of AFC on FLY (0.333 ± 0.14), FPY (0.001 ± 0.0001), P (0.001 ± 0.011), AYL (0.0007 ± 0.0003) and MCI (0.0009 ± 0.0003) indicated that with an increase of AFC

Table 1. Least-square means and their standard error for FLY, FPY, P, AYL, MCI and MSC

Effects	Mean±S.E.					
	FLY (kg)	FPY (kg)	P	AYL (kg/day)	MCI (kg/day)	MSC (kg/day)
Overall mean	1937.88±28.56 (326)	10.16±0.26 (326)	194.12±2.42 (326)	6.09±0.069 (326)	3.98±0.06 (240)	1.00±0.02 (240)
<i>Period of calving</i>						
1987–1991	1831.17±133.71 (12)	8.73±0.58 (12)	216.67±20.47 (12)	5.64 ^a ±0.34 (12)	4.73±0.7 (05)	0.99 ^{ab} ±0.10 (05)
1992–1996	1950.37±36.53 (95)	9.66±0.13 (95)	203.29 ^{ab} ±3.71 (95)	6.13 ^{ab} ±0.10 (95)	3.78±0.10 (81)	0.94 ^b ±0.02 (81)
1997–2001	1884.94±64.01 (92)	9.89±0.17 (92)	187.32 ^b ±4.45 (92)	5.80 ^{ab} ±0.1 (92)	3.99±0.13 (70)	0.97 ^{ab} ±0.03 (70)
2001–2006	1976.97±48.25 (127)	10.86±0.63 (127)	190.05 ^b ±4.00 (127)	6.31 ^b ±0.09 (127)	4.15±0.10 (84)	1.10 ^a ±0.03 (84)
<i>Season of calving</i>						
Summer	2003.33±45.57 (106)	10.80±0.76 (106)	197.11±4.29 (106)	6.17±0.09 (106)	4.03±0.12 (72)	1.04±0.03 (72)
Monsoon	1877.37±45.19 (138)	9.84±0.13 (138)	190.15±3.74 (138)	6.02±0.10 (138)	4.04±0.10 (103)	0.99±0.03 (103)
Winter	1955.10±59.79 (82)	9.87±0.16 (82)	196.23±4.70 (82)	6.09±0.12 (82)	3.84±0.11 (65)	0.99±0.03 (65)
<i>Regression</i>						
AFC	0.333±0.14	0.001±0.0001	0.001±0.011	0.0007±0.0003	0.0009±0.0003	–0.0004±0.0001

Means with different superscripts differ significantly; number of observations is in parenthesis.

Table 2. Heritabilities, genetic and phenotypic correlations for production efficiency traits

	FLY	FPY	P	AYL	MCI	MSC
FLY	0.32±0.19	0.71±0.10	0.58±0.14	0.45±0.17	0.67±0.12	0.54±0.13
FPY	0.56**±0.05	0.19±0.11	-0.15±0.21	0.82±0.07	0.83±0.08	0.63±0.12
P	0.74**±0.04	-0.13±0.06	0.20±0.20	-0.27±0.21	0.001±0.22	0.03±0.22
AYL	0.48**±0.05	0.66**±0.04	0.07±0.06	0.19±0.23	0.70±0.11	0.62±0.13
MCI	0.54**±0.05	0.52**±0.06	0.25**±0.06	0.61**±0.05	0.26±0.18	0.70±0.11
MSC	0.76**±0.04	0.48**±0.02	0.53**±0.05	0.45**±0.06	0.56**±0.05	0.27±0.19

Figures above diagonal are estimates of genetic correlations; figures along the diagonal are estimates of heritability; figures below the diagonal are estimates of phenotypic correlations; *P<0.05; **P<0.01.

by one day there will be a corresponding increase by 0.3333 kg, 0.001 kg, 0.001 kg, 0.0007 kg/day and 0.0007 kg/day of FLY, FPY, P, AYL and MCI, respectively. The regression of AFC on MSC (-0.0004 ± 0.0001) indicated that with an increase of one day of AFC there will be corresponding decrease in MSC by 0.0007 kg/day.

Heritability: The estimates of heritability were low to moderate and ranged from 0.19 to 0.32 (Table 2). The heritability estimates were 0.32 ± 0.19 , 0.19 ± 0.11 , 0.20 ± 0.20 , 0.19 ± 0.23 , 0.26 ± 0.18 and 0.27 ± 0.19 for FLY, FPY, P, AYL, MCI and MSC, respectively. Similar estimates of heritability for AYL, MCI and MSC were reported by Murali Dhar and Deshpande (1995) and Dhaka *et al.* (2002). Similar estimates of heritability for persistency were reported by Muir *et al.* (2004). Lower estimates of heritability for persistency and MSC were reported by Macciotta *et al.* (2006) and Kandasamy *et al.* (1991), respectively. Lower estimates of heritability for FLY, AYL and MCI were reported by Kuralkar and Raheja (1997). Dutt and Taneja (1994) reported higher estimates of heritability for FLY, AYL and MCI. These low to moderate estimates of heritabilities for production efficiency traits indicated that there are limiting scope for improvement in these traits through individual selection and it requires information from other relatives and improvement in managerial practices to improve these traits.

Genetic correlations: The genetic correlations ranged from -0.27 (P with AYL) to 0.83 (FPY with MCI). The genetic correlations of FLY with other traits were high ranging from 0.54 to 0.71 . The genetic correlations of FPY with other traits were high except with persistency, where, negative genetic correlation was obtained (-0.15). Negative genetic correlations between P and FPY indicated that high peak yields are not persistent producers. Furthermore, MSC had high positive genetic correlation with all traits under study except with persistency (0.03). Higher estimates of genetic correlation of MSC with FLY, AYL and MCI were reported by Kandasamy *et al.* (1991). High genetic correlations of FLY with FPY, P, AYL, MCI and MSC indicate that selection based on any one of these traits would result in improvement in desirable direction through positive correlated response in all other traits.

Phenotypic correlations: The phenotypic correlations

ranged from -0.13 (FPY with P) to 0.76 (FLY with MSC). The phenotypic correlations of all production efficiency traits were high and significant barring few exceptions. The phenotypic correlations of FLY with other traits were high, positive and significant ranging from 0.48 to 0.76 . Also, phenotypic correlations of MSC with other traits were high, positive and significant. Positive and significant phenotypic correlations of AYL and MCI with FPY were reported by Suresh *et al.* (2004).

High genetic and phenotypic correlations of FPY with other production and production efficiency traits except with persistency indicate that FPY can be used as a selection criterion. Milk yield per day of age at second calving had moderate estimates of heritability and considerably high positive genetic and phenotypic correlations with all production efficiency traits under study. Therefore, selection based on MSC would result in improvement in desirable direction through positive correlated response in all the traits under study. Milk yield per day of age at second calving can be used as an index traits in selection programme as it is associated with AFC and milk yield, which is an important trait that determines the economic merit.

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