Haryana Vet. (December, 2023) **62(2),** 113-117 ISSN 0033-4359 (P)

Research Article

ESTIMATION OF ESTIMATED BREEDING VALUES FOR PRODUCTION AND FERTILITY PERFORMANCE TRAITS IN MURRAH BUFFALOES

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Received: 13.02.2023; Accepted: 08.06.2023

ABSTRACT

The data of 614 Murrah buffaloes and 169 sires related to production and fertility performance traits were gathered from history-cum-pedigree sheets of buffalo farm, Department of Livestock Production Management, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar. Univariate animal model was used for estimating estimated breeding values of production performance traits viz. 305 days milk yield (305 DMY), peak yield (PY), lactation length (LL), dry period (DP), lactation milk yield (LMY), wet average (WA), milk yield per day of calving interval (MCI) and milk yield per day of age at second calving (MSC) were ranged from -332.72 to 173.87 days, -0.48 to 0.47 kg/day, -41.23 to 29.41 days, -16.88 to 62.77 days, -380.66 to 360.62 kgs, -0.20 to 0.19 kg/day, -0.21 to 0.25 kg/day and -0.27 to 0.36 kg/day, respectively and for fertility traits viz. age at first calving (AFC), service period (SP), conception rate (CR), calving interval (CI), number of services per conception (NSC) and pregnancy rate (PR) were ranged from -32.85 to 44.33 days, -15.61 to 28.42 days, -7.41 to 6.48%, -20.64 to 35.79 days, -0.24 to 0.41 and -0.08 to 0.11%, respectively. Spearman rank correlation and Pearson correlation was negatively correlated between the production and fertility performance traits but it was not unity which indicated that it is possible to have sire which can be best for both kinds of traits and thus, production and fertility performance traits can be improved simultaneously.

Keywords: Breeding value, Fertility traits, Murrah buffaloes, Pearson correlation, Production traits, Spearman correlation

How to cite: Sharma, S., Dhaka, S.S. and Patil, C.S. (2023). Estimation of estimated breeding values for production and fertility performance traits in Murrah buffaloes. *Haryana Vet.* **62(2)**: 113-117.

Murrah is renowned world-famous buffalo breeds of India. Its home tract is Rohtak, Hisar, Jind, Sonepat and Bhiwani districts of Haryana. Due to their high milk yield, Murrah buffaloes have a significant impact on the dairy sector. The objectives of selection in India were mainly based on production traits due to which the fertility traits remained neglected for the long time (Valsalan *et al.*, 2014). By raising culling rates, extending calving intervals, lowering milk output, producing fewer calves per cow per year, and eventually, lowering profit, a decline in reproductive performance raises production costs. Now-a-days, breeding programmes for dairy animals focus on the reproductive and functional characteristics of dairy cows because neglecting fertility lowered a farm's economic return (Komlosi *et al.*, 2010). Economic efficiency of sires are judged from the production and fertility performance of the daughters of those sires. Estimated breeding values (EBVs) of traits determine the genetic merits of animals of each trait. True genetic potential or genetic transmitting ability of animals are reflected by the estimated breeding values (Berry *et al.*, 2011). Ranking of elite sires based on their progeny performances helps in selecting superior quality bulls to produce next generation of high production and fertility performances. However, it has been shown in many studies (Shalaby, 2005; Mostafa *et al.*, 2006) that the production and fertility performance traits had antagonistic relationship with one another. Consequently, the primary goal of this study was to rank the superior and inferior sires according to their EBVs for the production and fertility performance traits. Additionally, the Pearson and Spearman's rank correlations between the EBVs of these traits were drawn in order to ascertain their relationship.

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MATERIAL AND METHODS

Source of data

The data collected from history-cum-pedigree sheets of buffalo farm, Department of Livestock Production Management, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar of 614 Murrah buffaloes and 169 sires related to production and fertility performance traits. Hisar climate is subtropical in nature and is found in a semi-arid area. Hisar is located in a latitude of 29° 10' N, a longitude of 75° 40' E, and an elevation of 215.2 metres. For the purpose of estimating estimated breeding values and elite sires in terms of production and fertility performance attributes, data was gathered during a 24-year period from 1996 to 2019.

Standardization of data

Animals with lactation periods less than 150 days, questionable outliers, and atypical records such as abortion, mastitis, and chronic sickness were excluded from the current study. For research on production qualities, it was necessary for a herd to have at least one lactation completed. This requirement applied to animals whose dates of birth, date of first calving, date of disposal, and subsequent calving were known.

Traits under study

The production performance traits included under this study were 305 days milk yield (305 DMY), peak yield (PY), lactation length (LL), dry period (DP), lactation milk yield (LMY), wet average (WA), milk yield per day of calving interval (MCI) and milk yield per day of age at second calving (MSC), all traits were studied up to third lactation and fertility performance traits were age at first calving (AFC), service period (SP), conception rate (CR), calving interval (CI), number of services per conception (NSC) and pregnancy rate (PR) up to 3 calving.

Statistical analysis

The procedure of animal genetic evaluation, has been developed in a standardized way, from using simple least squares methods to maximum likelihood method of separating variation into its component sources. Currently, analysis of variance component for continuous traits are mainly on the basis of mixed model, and for inference maximum likelihood or related methods are utilised. For estimation of breeding values, animal models including mixed-models have become the choice. These techniques offer the best linear unbiased prediction (BLUP) of breeding values and calculate the genetic and environmental influences while accounting for the relationship among animals. (Kennedy *et al.*, 1988; Meyer, 1989).

Univariate animal model

Animal model which includes only a single trait for study, is the simplest model used in animal breeding. Breeding value is fitted for each animal. When animals have only one trait, with only fixed and additive genetic effects, and no other random effects (maternal or dominance), such model is known as single trait animal model. These models, analyze one trait at a time. Univariate/Single trait animal model is as follows:

$$\text{Model: } y = X \quad \pm Za \pm e$$

Where, y = n × 1 vector of observations for each trait; X = Incidence matrix that relates data to the unknown vector of fixed effects ; Z = Incidence matrix that relates unknown vector of direct (a) breeding values, to y; e = Unknown vector that contains random residuals due to environmental effects peculiar to individual records.

The model uses standard assumptions and definitions. Additive direct effects were assumed to be normally distributed with means 0 and variance A $^{2}_{a}$, where, $^{2}_{a}$ is the direct additive genetic and A is the numerator relationship matrix.

Spearman's rank correlation and Pearson correlation between the estimated breeding values of the production and fertility performance traits was estimated using IBM SPSS version 23 software.

RESULTS AND DISCUSSION

The mean of production and fertility performance traits under univariate animal model using WOMBAT software have been depicted in Table 1 and 2. The means for production performance traits *viz.* 305 DMY, PY, LL, DP, LMY, WA, MCI and MSC were 2148.05 kg, 10.74 kg/day, 319.19 days, 117.88 days, 2288.8 kg, 7.12 kg/day, 4.84 kg/day and 1.33 kg/day, respectively. Likewise, the mean values of fertility traits *viz.* AFC, SP, CR, CI, NSC and PR were 1361.21 days, 186.73 days, 59.75 %, 493.36 days, 2.23 and 0.22%, respectively.

The estimated breeding values of production performance traits *viz.* 305 DMY, PY, LL, DP, LMY, WA, MCI and MSC were ranged from -332.72 to 173.87 kg, -0.48 to 0.47 days, -41.23 to 29.41 days, -16.88 to 62.77 days, -380.66 to 360.62 kg, -0.20 to 0.19 kg/day, -0.21 to 0.25 kg/day and -0.27 to 0.36 kg/day, respectively and for fertility traits *viz.* AFC, SP, CR, CI, NSC and PR were ranged from -32.85 to 44.33 days, -15.61 to 28.42 days, -7.41 to 6.48 %, -20.64 to 35.79 days, -0.24 to 0.41 and -0.08 to 0.11 %, respectively. High EBV value of milk yield was reported by Ahmad (2007) in Nili-Ravi buffaloes which was between -922 to +2954 kg and in Mehsana buffaloes by Saha *et al.* (2014) which were ranged between -422.59 to 456.61 kg. Lower estimates of range of EBVs were obtained by Shalaby *et al.* (2013) in Friesian cattle were 685 kg for TMY, 18 days for DP, 8.15 day for LL, 48.20 day for SP and 1.05 month for CI, respectively.The results reported by Oudah and Zainab (2010) for TMY and LL were 559 kg and 9.85 day, respectively.

Inheritance of production and fertility performance traits was antagonistic to each other as sires which performed better for production traits *viz.* 222 and 275 were least accountable for fertility traits (Table 3, 4, 5 and 6). Sire no. 275 exhibited high estimated breeding value of production traits valued as 163.51 kg for 305 DMY, 0.47 kg/day for PY, 26.31 days for LL, -8.48 days for DP, 360.62 kg for LMY, 0.19 kg/day for WA, 0.18 kg/day for MCI and 0.36 kg/day for MSC, respectively but low in fertility traits valued as 13.02 days for SP, 16.99 days for CI and -0.04% for PR, respectively. In similar manner, sire number code 193, 212, 222 and 275 performed and exhibited top ten ranks in their production performance but did not meet up the ends and lied in bottom ten ranks for fertility performance traits. Similarly, sire no. 273 had low estimated breeding value for production performance traits valued as -333.72 kg for 305 DMY, -0.48 kg/day for

Table 1. Sum model values for production traits

Particulars	305 DMY	PY	LL	DP	LMY	WA	MCI	MSC
No. of animal IDs in data file	614	614	614	614	614	614	614	614
No of sires	169	169	169	169	169	169	169	169
No of sires with records & progeny in data	166	166	166	166	166	166	166	166
No of dams with progeny in data	128	128	128	128	128	128	128	128
Mean	2148.05	10.74	319.19	117.88	2288.8	7.12	4.84	1.33
Standard Deviation	619.22	2.09	67.07	12.44	730.88	1.78	1.51	0.59
Minimum	584.3	4.5	100	101	584.3	1.8	0.1	0.2
Maximum	4406	17.3	528	256	4667	13.2	9.52	4.83

Table 2. Sum model values for fertility traits

Particulars	AFC	SP	CR	CI	NSC	PR
No. of animal IDs in data file	614	614	614	614	614	614
No of sires	169	169	169	169	169	169
No of sires with records & progeny in data	166	166	166	166	166	166
No of dams with progeny in data	128	128	128	128	128	128
Mean	1361.21	186.73	59.75	493.36	2.23	0.22
Standard Deviation	221.56	104.76	30.17	106.33	1.26	0.19
Minimum	960	22	16.67	307	1	0.4
Maximum	2535	519	100	825	6	0.95

Table 3. Top ten sires with estimated breeding value of production traits

Rank	Sire No.	EBV (305 DMY)	Sire No.	EBV (PY)	Sire No.	EBV (LL)	Sire No.	EBV (DP)	Sire No.	EBV (LMY)	Sire No.	EBV (WA)	Sire No.	EBV (MCI)	Sire No.	EBV (MSC)
1	206	173.87	275	0.47	222	29.41	121	-16.88	275	360.62	275	0.19	200	0.25	275	0.36
2	275	163.51	212	0.24	206	28.37	165	-15.12	206	262.03	256	0.14	257	0.24	241	0.13
3	222	154.00	181	0.24	275	26.31	245	-13.12	222	197.1	181	0.12	275	0.18	136	0.11
4	212	141.06	186	0.21	279	25.25	246	-12.12	193	196.56	259	0.11	214	0.15	137	0.11
5	195	139.21	187	0.21	209	21.22	152	-12.10	171	180.18	207	0.11	138	0.12	244	0.11
6	193	136.88	222	0.21	202	19.21	200	-11.56	212	160.45	138	0.11	165	0.11	192	0.10
7	171	128.99	257	0.20	136	19.18	188	-10.88	157	158.57	232	0.1	206	0.11	206	0.10
8	201	116.53	256	0.20	137	15.16	273	-9.11	279	152.01	233	0.1	195	0.09	196	0.10
9	207	110.98	163	0.18	277	15.11	275	-8.48	201	137.92	195	0.1	182	0.09	222	0.08
10	257	109.17	162	0.16	207	13.11	198	-7.82	136	132.4	242	0.09	162	0.08	209	0.08

Table 4. Bottom ten sires with estimated breeding value for production traits

Rank	Sire No.	EBV (305 DMY)	Sire No.	EBV (PY)	Sire No.	EBV (LL)	Sire No.	EBV (DP)	Sire No.	EBV (LMY)	Sire No.	EBV (WA)	Sire No.	EBV (MCI)	Sire No.	EBV (MSC)
1	273	-332.72	273	-0.48	115	-41.23	140	62.77	273	-380.66	273	-0.20	140	-0.21	273	-0.27
2	150	-185.62	135	-0.34	114	-40.56	173	59.72	150	-262.55	135	-0.19	104	-0.19	255	-0.11
3	122	-171	239	-0.3	177	-39.62	102	59.22	135	-216.51	106	-0.14	273	-0.18	254	-0.11
4	135	-170.42	220	-0.21	273	-38.55	233	58.38	170	-206.26	140	-0.13	224	-0.18	140	-0.1
5	170	-153.83	192	-0.19	135	-36.89	232	58.38	104	-178.42	150	-0.11	122	-0.15	189	-0.1
6	239	-149.52	189	-0.18	188	-35.69	241	56.61	239	-172.47	129	-0.1	150	-0.14	104	-0.09
7	211	-144.71	250	-0.18	128	-32.45	145	56.44	122	-171.86	239	-0.1	173	-0.14	170	-0.09
8	104	-138.27	121	-0.17	246	-31.25	115	56.22	267	-159.23	189	-0.09	267	-0.12	267	-0.09
9	267	-111.09	150	-0.16	245	-28.14	114	56.22	188	-143.03	202	-0.09	189	-0.11	106	-0.09
10	177	-109.05	122	-0.15	150	-24.15	224	55.88	231	-134.57	112	-0.09	102	-0.10	211	-0.08

PY, -38.55 days for LL, -380.66 kg for LMY, -0.20 kg/day for WA, -0.18 kg/day for MCI and -0.27 kg/day for MSC whereas high estimated breeding values for fertility traits valued as -15.01 days for SP, 6.48% for CR, -18.25 days for CI and -0.24 for NSC. For instance, sire number code 220, 245, 246 and 273 were top ranked for their fertility abilities but lied in bottom position in terms of production performance traits.

Spearman's rank correlation between EBVs of production and fertility performance traits has been shown in Table (7). 305 DMY, PY, LL, LMY had purely negative Spearman's rank correlation with all fertility traits viz. AFC, SP, CR, CI, NSC and PR. However, negative Spearman's rank correlation between 305 DMY/CI (-0.19)

Table 5. Top ten sires with estimated breeding value of fertility traits

Rank	Sire No.	EBV (AFC)	Sire No.	EBV (SP)	Sire No.	EBV (CR)	Sire No.	EBV (CI)	Sire No.	EBV (NSC)	Sire No.	EBV (PR)
1	209	-32.85	245	-15.61	273	6.48	165	-20.64	273	-0.24	245	0.11
2	232	-29.17	246	-15.58	165	5.92	245	-19.75	165	-0.20	246	0.1
3	233	-29.17	273	-15.01	110	4.86	246	-19.64	245	-0.17	188	0.09
4	121	-26.88	188	-14.94	245	4.76	273	-18.25	246	-0.14	162	0.07
5	165	-23.22	165	-14.06	246	4.74	188	-18.13	138	-0.11	194	0.06
6	107	-22.94	152	-10.32	198	3.79	200	-13.71	198	-0.11	165	0.06
7	112	-22.53	150	-9.01	199	3.79	135	-13.3	199	-0.11	267	0.05
8	213	-22.34	162	-8.94	194	3.34	152	-12.79	188	-0.11	200	0.05
9	220	-20.55	200	-8.52	175	2.83	160	-11.93	110	-0.1	119	0.05
10	251	-19.22	198	-8.41	162	2.74	162	-11.43	162	-0.09	149	0.05

Table 6. Bottom ten sires with estimated breeding value for fertility traits

Rank	Sire No.	EBV (AFC)	Sire No.	EBV (SP)	Sire No.	EBV (CR)	Sire No.	EBV (CI)	Sire No.	EBV (NSC)	Sire No.	EBV (PR)
1	259	44.33	222	28.42	222	-7.41	222	35.79	222	0.41	211	-0.08
2	104	34.04	211	16.44	133	-6.87	173	20.83	122	0.25	133	-0.04
3	177	31.53	173	15.99	140	-5.05	211	20.01	133	0.22	222	-0.04
4	279	29.99	102	15.47	211	-4.21	140	19.15	141	0.21	275	-0.04
5	182	29.73	140	14.53	113	-3.8	102	19.12	173	0.15	279	-0.04
6	212	29.01	133	14.01	122	-3.25	133	17.65	140	0.13	173	-0.04
7	193	28.29	275	13.02	141	-3.17	275	16.99	113	0.11	187	-0.03
8	202	27.56	145	11.53	227	-3.01	145	15.03	187	0.11	186	-0.03
9	170	26.68	262	10.74	226	-3.01	141	14.49	186	0.11	212	-0.03
10	115	26.6	261	10.74	173	-2.82	122	12.63	227	0.1	122	-0.03

Table 7. Spearman's rank correlations and Karl Pearson correlations of estimated breeding values of production and fertility performance traits

Traits	Correlation	AFC	SP	CR	CI	NSC	PR
305 DMY	Spearman	-0.12	-0.16	-0.18	-0.19*	-0.15	-0.29**
	Pearson	0.09	0.24**	-0.22*	0.26**	0.21*	-0.20*
PY	Spearman	-0.15	-0.13	-0.14	-0.16	-0.12	-0.25*
	Pearson	0.12	0.23*	-0.22*	0.25**	0.20*	-0.24*
LL	Spearman	-0.05	-0.38**	-0.32**	-0.39**	-.28**	-0.35**
	Pearson	-0.03	0.43**	-0.36**	0.44**	0.36**	-0.37**
DP	Spearman	-0.24**	0.68**	0.46**	0.68**	0.47**	0.43**
	Pearson	-0.1	0.66**	-0.51**	0.67**	0.48**	-0.46**
LMY	Spearman	-0.11	-0.25**	-0.27**	-0.29**	-0.23*	-0.39**
	Pearson	0.09	0.35**	-0.31**	0.37**	0.29**	-0.34**
WA	Spearman	-0.26**	0.12	0.01	0.09	-0.01	-0.06
	Pearson	0.19*	-0.02	-0.04	0.01	0.08	-0.05
MCI	Spearman	-0.30**	0.39**	0.18*	0.38**	0.17	0.17
	Pearson	0.15	-0.36**	0.22*	-0.36**	-0.21*	0.20*
MSC	Spearman	0.22**	-0.09	-0.12	-0.11	-0.08	-0.19*
	Pearson	-0.19*	0.22*	-0.18*	0.22*	0.19*	-0.19*

Where *P<0.05, **P<0.01

and PY/PR (-0.25) was significant (p<0.05) and highly significant (p<0.01) between 305 DMY/PR (-0.29). LL had highly significant (p<0.01) and negative Spearman's rank correlation with all fertility performance traits ranging from -0.28 to -0.39 except with AFC (-0.05) which was negative and non-significant. Furthermore, DP was the only production performance trait which had positive and highly significant (p<0.01) Spearman's rank correlation with all fertility traits varying from 0.43 to 0.68 except AFC (-0.24) with which it was negative and highly significant (p<0.01). Like LL, LMY also had negative and highly significant (p<0.01) Spearman's rank correlation with all fertility traits except AFC (-0.11) and with NSC, it was negative and significant at p<0.05. Moreover, WA had shown highly significant (p<0.01) and negative Spearman's rank correlation with AFC only. MCI was found to have highly significant (p<0.01) relationship with SP (0.39) and CI (0.35) but negative and highly significant (p<0.01) relationship with AFC (-0.30). MSC had positive and highly significant (p<0.01) relationship with AFC (0.22). conclusively, most of the production performance traits had antagonistic relationship with fertility performance traits.

Thereby, selection for production performance traits would compromise the improvement rate in fertility performance traits. Pearson correlation between EBVs of production and fertility performance trait is depicted in Table 7. 305 DMY, PY, LL, DP and LMY had positive low (0.20) to moderate (0.67). Pearson correlation with SP, CI and NSC and negative relationship with CR and PR ranging from -0.20 to -0.51. WA and MSC had significant positive (0.19) and negative (-0.19) relationship with AFC. MCI had significant (p<0.05) and positive Pearson correlation with CR (0.22) and PR (0.20) and negative and highly significant (p<0.01) relationship with SP (-0.36) and CI (-0.36). CR and PR had negative relationship with all production performance trait ranging from -0.02 to 0.66 except MCI whereas SP, CI and NSC had positive relationship with all production performance traits ranging from 0.20 to 0.67 except with MCI. AFC was non-significant correlation with all production performance traits except with WA (0.19) and MCI (-0.19). Here, improvement in production performance traits seem to effect mainly CR and PR negatively whereas it goes in hand with other fertility trait viz. SP, CI and NSC and nearly unaffected with AFC. The above results were in frame with the results of Kadarmideen *et al.* (2003), Shalaby (2005) and Oudahand Khalefa (2010) in Holstein Friesian cattle. Divya *et al.* (2014) reported high and positive Spearman's rank correlations between the rankings on the basis of estimated breeding values (EBVs) of FL 305 DMY from single trait (FL 305 DMY only) animal model with 2 traits (FL 305 DMY-AFC, FL 305 DMY-FCI and FL 305 DMY-FSP) and 3 traits (FL 305 DMY-AFC-FCI) animal models were 0.86, 0.92, 0.94 and 0.82, respectively in Karan Fries cattle. Saha *et al.* (2014) obtained high rank correlation (76.81%) between models applied to milk production in Mehsana buffaloes. Ghiasi *et al.* (2021) reported high and positive (>0.94) Spearman rank correlation coefficients between breeding value of composite milk and fertility traits (CMF) with SP, CI, and TMY but moderate (0.64) with NSC.

CONCLUSION

From the above study, it can be concluded that the sire's elite in production performance traits outskirts in fertility performance traits indicated that improvement in these traits was related antagonistically. Although, Spearman rank correlation and Pearson correlation was negatively correlated between the production and fertility performance traits but it was not unity which indicated that it is possible to have sire which can be best for both kinds of traits and thus, production and fertility performance traits can be improved simultaneously.

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