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# COMPARISON OF GENETIC PARAMETERS OF PRODUCTION EFFICIENCY AND FERTILITY TRAITS IN MURRAH BUFFALOES

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**ABSTRACT**
The data pertaining to fertility and production efficiency traits of 536 Murrah Buffaloes were collected from history cum pedigree sheets maintained at Buffalo Research Centre (BRC), Department of Livestock Production Management, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar over a period of 25 years from 1990 to 2014.The fertility traits included Age at First Calving (AFC), First Service Period (FSP), First Calving Interval (FCI), Number of Services Per Conception (NSC) and First Service to Successful Service Period while Production efficiency traits included First Lactation Milk Yield (FLMY), First Peak Yield (FPY), Milk Yield Per Day of Lactation Length, Milk Yield Per Day of Calving Interval and Milk Yield Per Day of Age At Second Calving. The mixed linear model used for analysis included the sire as a random effect and period of calving and season of calving as fixed effects. Heritability and genetic correlations for different traits were estimated by paternal half-sib correlation method using sire components of variance and covariance heritability estimates along with standard errors for different fertility traits viz., AFC, FSP, FCI, NSC and FSSSP were recorded as 0.33 ±0.17, 0.08 ±0.14, 0.02 ±0.13, 0.18 ±0.15 and 0.18 ±0.09, respectively. Whereas, the heritability estimates along with standard errors for different production efficiency traits were 0.26 ±0.18, 0.24 ±0.17, 0.29 ±0.21, 0.30 ±0.21and 0.28 ±0.21 for FLMY, FPY, MLL, MCI and MSC, respectively.

**KEY WORDS:** Fertility traits, Heritability, Murrah buffalo, Non- genetic factors, Production traits

## INTRODUCTION

World milk production has doubled in the last few decades. The last few years have also witnessed a consistent increase in the organized production of milk from buffalo. Milk and its dairy derivatives are cherished and relished by young and old alike. Buffalo farming is now an almost worldwide phenomenon. Among the livestock sector, cattle and buffalo find pre-eminent position in India's economy and it has been about 14.34% of world cattle population and 57.77% of world buffalo population (FAO, 2015). The genetic worth of buffalo is primarily determined by both fertility and production efficiency traits. This includes the ability to maintain high level of production for a longer period and more number of calving in her lifetime. Selection objectives for dairy cattle in India have historically emphasized only on milk production and has not given due credence for female fertility traits, which are considered as the second major reason for involuntary culling (Nehra 2011). There are many non-genetic factors, which influence the phenotypic expression of performance traits of buffaloes, including test day milk yield records. Therefore, the present study was undertaken to investigate the influence of various non-genetic factors on performance traits and to suggest suitable management practices, selection and breeding strategies for genetic improvement of Murrah buffaloes.

## MATERIALS & METHODS

The data related to fertility and production efficiency traits was collected from history cum pedigree sheets maintained at Buffalo Research Centre (BRC), Department of Livestock Production Management, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar over a period of 25 years from 1990 to 2014. Hisar, situated in semi-arid region and climatic condition is sub-tropical in nature. Geographically, Hisar is situated at 29° 10' N latitude, 75° 40' E longitude and 215.2 meters altitude. The normal lactation was considered as the period of milk production by a buffalo for at least 100 days, the milk production in lactation was recorded a minimum of 500 kg and the buffalo calved and dried under normal physiological conditions were included in the present study. On standardization and normalization of traits, the number of buffaloes involved in the analysis of reproduction and production traits. The fertility traits included Age at First Calving (AFC), First Service Period (FSP), First Calving Interval (FCI), Number of Services Per Conception (NSC) and First Service to Successful Service Period (FSSSP = Date of Successful service – Date of first service) while Production efficiency traits included First Lactation Milk Yield (FLMY), First Peak Yield (FPY), Milk Yield Per Day of Lactation Length (MLL= FLMY/FLL), Milk Yield Per Day of Calving Interval (MCI = FLMY/FCI) and Milk Yield Per Day of Age At Second Calving (MSC = FLMY/AFC+FCI). The non-genetic factors *viz.* season and period of calving were considered in the study. Depending on the meteorological factors, feed and fodder availability, the year was classified into four seasons viz., summer (April to June), monsoon (July to September), autumn (October to November) and winter (December to March) based on prevalent climatic conditions in the region. Generally there would be difference in performances of buffaloes from period to period due to differential fodder, feed availability, managemental practices and other environmental components. However, that variation might not be significant enough to detect effect of each year separately. Therefore, the total duration of the study was classified into five periods with five year interval based on period of calving of buffaloes as age at first calving in Murrah buffaloes mostly varies from 31/2-4 years.

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 fertility and production efficiency traits. The following statistical model was used to explain the underlying biology of the traits included in the study:

$$\mathbf{Y_{ijkl} = \mu + S_i + P_j + S_k + e_{ijkl}}$$

Where, $Y_{ijkl}$, $l^{th}$record of individual calved in $i^{th}$ season and $j^{th}$ period pertaining to $k^{th}$ sire; μ, overall population mean; $S_i$, fixed effect of $i^{th}$ season of calving; $P_j$, fixed effect of $j^{th}$ period of calving; $S_{k,}$ random effect of $k^{th}$ sire and $e_{ijkl,}$ random error associated with each and every observation and assumed to be normally and independent distributed with mean zero and variance $\sigma^2$ e . The differences of means between subclasses of periods and seasons were tested for significance using Duncan's Multiple Range Test (Kramer, 1957). Heritability estimates for different reproduction traits were obtained from sire component of variances using paternal half-sib correlation method. The standard errors of heritability estimates were obtained using the formula given by Swiger *et al.* (1964). Genetic correlations among different traits were calculated from sire components of variances and co-variances and standard errors were estimated using the formula given by Robertson (1959). Phenotypic correlations among various traits were calculated from total variances and covariances and their standard error were computed using the formula given by Snedecor and Cocharan (1968).

## RESULTS

The overall least squares means for AFC, FSP, FCI, NSC, FSSSP FLMY, FPY, MLL, MCI and MSC were 1418.78±13.52 days, 159.61±2.67 days, 466.10±2.72 days, 1.84±0.04, 40.84±0.89 days, 2041.27±32.78 kg, 10.55±0.25 kg/day, 6.59±0.09 kg/day, 4.40±0.07 kg/day and 1.08±0.01 kg/day, respectively. The effect of season of calving was statistically non-significant on AFC, NSC, FLMY, MLL, MCI, FSP, NSC, FSSSP and FPY except FSP and FCI. The effect of period of calving was statistically significant on AFC, NSC, FLMY, MLL, MCI and MSC while non-significant on FSP, FCI, NSC, FSSSP and FPY. The heritability estimates along with standard errors for different fertility traits viz., AFC, FSP, FCI, NSC and FSSSP were recorded as 0.33±0.17, 0.08±0.14, 0.02±0.13, 0.18±0.15 and 0.18±0.09, respectively. Whereas, the heritability estimates along with standard errors for different production efficiency traits were 0.26±0.18, 0.24±0.17, 0.29±0.21, 0.30±0.21and 0.28±0.21 for FLMY, FPY, MLL, MCI and MSC, respectively (Table 1) .

**TABLE 1.** Estimates of heritability, genetic (below diagonal) and phenotypic correlations (above diagonal) between fertility and production efficiency traits

| Traits | AFC | FSP | FCI | NSC | FSSSP | FLMY | FPY | MLL | MCI | MSC |
|---|---|---|---|---|---|---|---|---|---|---|
| AFC | 0.33 ±0.17 | -0.04 ±0.07 | -0.03 ±0.08 | -0.05 ±0.07 | -0.03 ±0.08 | -0.05 ±0.05 | 0.10* ±0.07 | -0.06 ±0.06 | -0.05 ±0.06 | -0.34** ±0.08 |
| FSP | -0.18 ±0.06 | 0.08 ±0.14 | 0.95** ±0.09 | -0.06 ±0.09 | -0.04 ±0.10 | 0.16** ±0.07 | -0.08 ±0.02 | -0.04 ±0.07 | -0.17** ±0.07 | 0.08 ±0.07 |
| FCI | 0.05 ±0.16 | 0.96 ±0.14 | 0.02 ±0.13 | -0.06 ±0.09 | -0.03 ±0.10 | 0.16** ±0.07 | -0.07 ±0.08 | -0.04 ±0.07 | -0.20** ±0.07 | 0.07 ±0..07 |
| NSC | -0.22 ±0.15 | -0.06 ±0.18 | -0.14 ±0.19 | 0.18 ±0.15 | 0.72** ±0.06 | 0.03 ±0.07 | 0.05 ±0.07 | -0.08 ±0.06 | 0.06 ±0.06 | 0.05 ±0.06 |
| FSSSP | -0.11 ±0.18 | 0.10 ±0.22 | 0.05 ±0.22 | 0.60 ±0.13 | 0.18 ±0.09 | 0.02 ±0.08 | 0.02 ±0.09 | 0.02 ±0.08 | 0.03 ±0.08 | 0.03 ±0.08 |
| FLMY | -0.11 ±0.13 | -0.05 ±0.15 | -0.37 ±0.15 | 0.29 ±0.14 | 0.11 ±0.18 | 0.26 ±0.18 | 0.28** ±0.05 | 0.93** ±0.01 | 0.93** ±0.01 | 0.95** ±0.04 |
| FPY | -0.12 ±0.14 | -0.38 ±0.16 | -0.40 ±0.17 | 0.34 ±0.15 | 0.15 ±0.19 | 0.40 ±0.12 | 0.24 ±0.17 | 0.30** ±0.05 | 0.30** ±0.05 | 0.26** ±0.06 |
| MLL | -0.14 ±0.13 | -0.15 ±0.15 | -0.15 ±0.15 | 0.34 ±0.14 | 0.14 ±0.17 | 0.98 ±0.01 | 0.44 ±0.11 | 0.29 ±0.21 | 0.93** ±0.02 | 0.90** ±0.05 |
| MCI | -0.11 ±0.13 | -0.21 ±0.15 | -0.22 ±0.15 | 0.33 ±0.14 | 0.10 ±0.18 | 0.98 ±0.01 | 0.45 ±0.11 | 0.99 ±0.04 | 0.30 ±0.21 | 0.91** ±0.05 |
| MSC | -0.34 ±0.12 | -0.09 ±0.15 | -0.08 ±0.15 | 0.33 ±0.14 | 0.15 ±0.17 | 0.97 ±0.01 | 0.40 ±0.11 | 0.97 ±0.09 | 0.96 ±0.01 | 0.28 ±0.21 |

Where (* $P<0.05$) and (** $P<0.01$)

Genetic and phenotypic correlations among fertility traits depicted in Table 1 revealed that the relationships of AFC with other fertility traits was in negative direction ranging from -0.22 to -0.11 for genetic correlations and -0.05 to -0.03 for phenotypic correlations except genetic correlations with FCI (0.05). Similarly, genetic and phenotypic correlations among production efficiency traits were all positive and moderate to high ranging from 0.40 to 0.99 (genetic correlations) and 0.26 to 0.95 (phenotypic correlations). Genetic and phenotypic correlations between fertility and production efficiency traits indicated that AFC had low and negative phenotypic and genetic correlations with all production efficiency traits (ranging from -0.14 to -0.05) except moderate and negative relationship with

MSC (-0.34) and positive and significant phenotypic correlations with FPY (0.10). Also, FLMY had low and negative genetic correlations with AFC and FSP while moderate negative genetic association ship with FCI (-0.37). Likewise, FLMY had low, positive and significant (P<0.01) phenotypic correlations with FSP and FCI to the tune of 0.16 and 0.16, respectively.

## DISCUSSION

The results revealed that the heritability estimates for all the fertility traits was found to be low ranging from 0.02 ±0.13 (FCI) to 0.18 (NSC and FSSSP) except for AFC which was moderate (0.33 ±0.17). Similar estimates for AFC were also reported by Wakchaure *et al*. (2008). On the other hand, lower estimates for AFC were reported by Seno *et al*. (2010). The heritability estimates for FSP was obtained as 0.08±0.14. Similar result was also reported by Kumar (2000). However, slightly higher estimates were reported by Kumar *et al*. (2005) and Singh and Barwal (2012). Contrarily, Chakraborty *et al*. (2010) and Kapil Dev *et al.* (2015) reported moderate estimates of heritability for FSP. The heritability estimates obtained for FCI as 0.02±0.13. Similar result was also reported by Kumar (2000). However, slightly higher heritability estimates for FCI were reported by Chakraborty *et al*. (2010), Thiruvenkadan *et al.* (2010), Seno *et al.* (2010), Singh and Barwal (2012) and Thiruvenkadan *et al*. (2014). Moreover, moderate estimates of heritability for FCI were also reported by Singh and Barwal (2012) and Kapil Dev *et al.* (2015). The heritability estimates for NSC and FSSSP were obtained as 0.18±0.15 and 0.18±0.09, respectively. Similarly, lower heritability estimates for FSSSP was reported by Ghaisi *et al*. (2011), Divya *et al*. (2014) and Zink et al. (2012). However, higher estimate was reported by Jeniton *et al*. (2011) in Sahiwal cattle. As for Production efficiency traits heritability estimate for FLMY was found to be 0.26 ±0.13 which is in consonance with reports of Singh and Barwal (2012) and Chakraborty *et al.* (2010). However, slightly higher estimates for heritability of FLMY were reported by Kapil Dev *et al.* (2015). On the other hand, lower estimate of heritability for FLMY was reported by Pareek and Narang (2014).The heritability estimates for FPY was obtained as 0.24±0.17. Similar results were also reported by Chander (2002). However higher estimates for FPY were reported by Pareek and Narang (2014). On the other hand, lower heritability estimates were reported by Chakraborty *et al.* (2010).The heritability estimates for MLL was obtained as 0.29 ±0.21. Likewise, moderate estimates of heritability were reported by Godara (2003) and Kapil Dev *et al.* (2015). On the other hand, a lower estimate of heritability was reported by Chakraborty *et al.* (2010). The heritability estimates for MCI obtained as 0.30 ±0.21 is in accordance with the heritability estimates reported by Dhaka *et al.* (2002) in Hariana cattle and Chakraborty *et al.* (2010) in Murrah buffalo. The heritability estimate for MSC was obtained as 0.28 ±0.21 which is in approximation with the estimates for MSC reported by Dhaka *et al.* (2002) in Hariana Cattle and Chakraborty *et al.* (2010).

### Genetic Correlation:

The perusal of genetic and phenotypic correlations between fertility and production efficiency traits indicated that AFC had low and negative phenotypic and genetic correlations with all the production efficiency traits except moderate and negative relationship with MSC and positive and significant phenotypic correlations with FPY. Furthermore, FLMY had low and negative genetic correlations with AFC and FSP while moderate negative genetic associationship with FCI. Also, FLMY had low, positive and significant (P<0.01) phenotypic correlations with FSP and FCI. Moreover, MSC had negative moderate genetic and phenotypic correlations with AFC, low negative genetic correlations with FSP and FCI and low positive and non-significant phenotypic correlations with FSP, FCI, NSC and FSSSP. In addition to this, NSC and FSSSP had positive genetic and phenotypic correlations with all production efficiency traits except negative phenotypic association between NSC and MLL. Similarly, Thiruvenkadan *et al.* (2015) also reported antagonistic correlation between fertility and production efficiency traits. Critical appraisal of heritability estimates, genetic and phenotypic correlations between fertility and production efficiency traits, it may be inferred that selection based on milk yield per day of age at second calving, that had moderate estimates of heritability (0.28) and appreciably high genetic and phenotypic correlations with production efficiency traits, would not only improve production performance but also take care of reproductive performance. 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 trait in selection programme as it is associated with AFC and milk yield, which is an important trait that determines the economic merit.

## CONCLUSION

Milk yield per day of age at second calving had moderate estimates of heritability (0.28) and appreciably high genetic and phenotypic correlations with production efficiency traits. 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 trait in selection programme as it is associated with AFC, FCI and FLMY, which is an important trait that determines the economic worth.

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## REFERENCES

Barman, R.S.D. (2009) Studies on non-genetic factors affecting first lactation and life time performance traits in Murrah buffaloes. M.V.Sc. thesis., H.A.U. India.

Chakraborty, D., Dhaka, S.S., Pander, B.L., Yadav, A. S and Danpat, A. (2010) Genetic studies on 305 day and test day records in Murrah buffaloes. *Indian Journal of Animal Sciences*, **80**: 729-732.

Charlini, B.C.and Sinnaih, J. (2015) Performance of Murrah, Surti buffaloes and their crosses in Intermediate zone in Sri Lanka . *Livestock Research for Rural development*, **27**(3).

Dhaka, S.S., Chaudhary, S.R., Pander, B.L., Yadav, A.S. and Singh, S. (2002) Genetic studies on production efficiency traits in Hariana cattle. *Asian-Aust. J. Anim. Sci.,* **15**: 466-469.

FAO (2015) *FAOSTAT database*. FAO, Rome, Italy. http:// www.fao.org/faostat.

Godara, A. (2003) Genetic studies on performance traits in different lactation of Murrah buffaloes. M.Sc. Thesis, CCS Haryana Agricultural University., Hisar, India

Gupta, J.P., Sachdeva, G.K., Gandhi, R.S. and Chakaravarty, A.K. (2012) Non-genetic factors influencing growth and production performance in Murrah buffaloes. *Indian J. Dairy Sci.,* **65**(3): 239-241.

Harvey, W.R. (1990) Mixed model least squares and maximum likehood computer program. January, 1990.

Kapil Dev, Dhaka S.S., Yadav A.S. and Sangwan S.K. (2015) Genetic parameters of early performance traits in Murrah Buffaloes. *Haryana Vet*, **54**(2): 144-146.

Kramer, C.Y. (1957) Extension of multiple range tests to group correlated adjusted means. *Biometrics,* 13: 13-18.

Kumar, D., Verma, S.B., Singh, S.R., Mandal, K.G. and Pandey, R.P. (2005) Effect of genetic and non-genetic factors on dry period and age at first calving in Hariana and its crosses. *Indian J. Anim. Health.,* **44**(2): 99-102.

Kumar, V., Chakravarty, A.K., Patil, C.S., Valsalan, J., Sharma, R.K. and Mahajan, A. (2014) Genetic studies of first lactation production traits of Murrah buffaloes under network project of buffalo improvement. *Indian Vet. J.,* **91** (07): 26-28.

Naqvi, A.N and Shami S.A. (1999) Age at first calving in Nili-Ravi Buffaloes. *Pakistan Journal of Animal Sciences*, **2**(2): 438-441

Nehra, M. (2011) ‘Genetic analysis of performance trends in Karan Fries cattle.’ M.V.Sc. Thesis. NDRI Deemed University, Karnal, India.

Pawar, H.N., Kumar, G.V.P.P.S.R. and Narang, R. (2012) Effect of Year, Season and Parity on Milk production traits in Murrah buffaloes.*J. Buff. Sci*., **1**: 122-125.

Robertson, A. (1959) The sampling variation of genetic correlation coefficient. *Biometrics.,* **15**: 469-485.

Seno, L.O., Cardoso V.L., faro L.El., Sesana R.C., Aspilureta-Borquis R.R., Camago de G.M.F. and Tohanti H. (2010). Genetic parameters of milk yield, age at first calving and interval between First and Second calving in milk Murrah buffaloes. *Livestock Research for Rural development*, **21**(2).

Singh, C.V and Barwal, R.S. (2012) Use of different animal models in prediction of genetic parameters of first lactation and herd life traits of Murrah buffaloes. *Indian J. Dairy Sci.,* **65**(5): 399-404.

Snedecor, G.W. and Cocharan, W.G. (1968) Statistical methods, Oxford & IBH Publ. Co., New Delhi, India.

Suresh, R., Bidarkar D.K., Gupta B.R., Sudhakarrao B. and Sudhakar K. (2004) Production and Reproduction Performances of Murrah buffalo. . *Indian Journal of Animal Sciences,* **74**(8): 854-857.

Swiger, L.A., Harvey, W.R., Everson, D.O. and Gregory, K.E. (1964) The variance of interclass correlation involving groups with one observation. *Biometrics*. **20**: 818-826.

Tanpure, Mahesh U., Suryawanshi, Vaibhav R., Jadhav, Sahadeo S. (2013) Study of productive and reproductive traits of Murrah buffaloes. *Golden Research Thought*., **3** (3): p1

Thiruvenkadan, A.K. (2011) Performance of Murrah buffaloes at coastal region of Tamil Nadu, India. *Indian J. Anim. Sci.,* **81**(10): 1080-1083.

Thiruvenkadan, A.K., Panneerselvam, S., Murali, N., Selvam, S. and Sarvanakumar, V.R. (2014) Milk production and reproduction performance of Murrah buffaloes of Tamil Nadu, India. *Buffalo Bulletin*., 33**(3)**: 291-300.