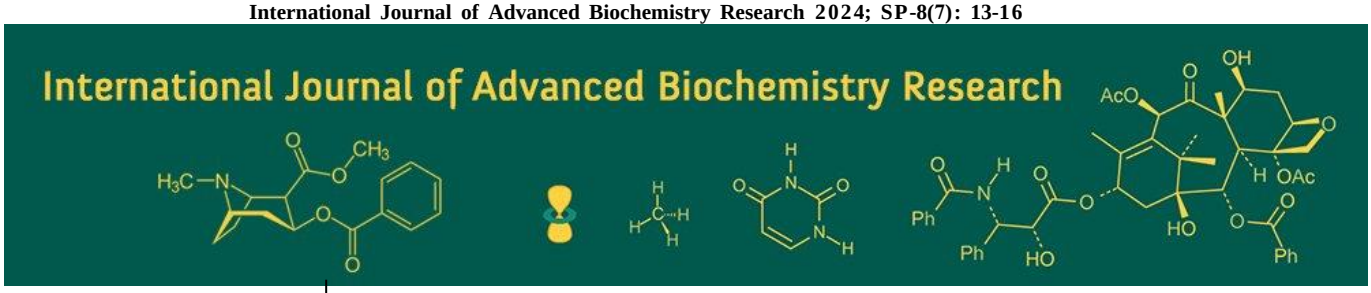

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Effect of non-genetic factors on lifetime milk production and productive life of Murrah buffaloes

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Abstract
The success of a dairy industry in India is much dependent on buffaloes and the level of lifetime performance traits. These performance traits depend on several genetic and non-genetic factors which introduce biasness in the estimation of genetic value of performance traits. In the absence of accurate phenotypic value of milk production traits, it becomes difficult to estimate genetic parameters of the traits which determine the optimum selection criterion for planned improvement programme of the animals. Also, genetic evaluation of animals requires the assumption that phenotypic measurements are adjusted for non-genetic factors that can affect production efficiency and reproduction traits (ex. Year/period of calving, season of calving, calving order, age at calving, length of lactation) to obtain accurate estimates of the genetic parameters and the breeding value of animals. This research paper aimed to analyse the effect of various non-genetic factors on Lifetime Milk Production (LTMP) and Productive life (PL). The data on performance records of 2959 Murrah buffaloes, progeny of 220 sires were collected from the pedigree, breeding and performance records from 1992-2015 maintained at Buffalo Research Center (BRC), LUVAS, Hisar and Central Institute for Research on Buffaloes, Hisar. The overall least-squares means for PL and LTMP, were 1275.24±31.82, 5586.42±17.96 respectively. Among the different non-genetic factors studied, the farm had significant effect on LTMP. The period of calving had highly significant effect on PL and LTMP both. The PL and LTMP showed an decreasing trend across the periods. Effect of season of calving was non-significant on both longevity traits. Regression of age at first calving (linear) had non-significant effect on both traits. Effect of various non-genetic factors help us to provide a deep role of management strategies in improvement of lifetime performance traits in dairy animals and it may also lead to a better progressive strategy for increasing most probable producing ability also of the Murrah buffaloes.

Keywords: Productive life, lifetime milk production, farm, season of calving, period of calving, murrah buffaloes

Introduction
The dairy industry in India is heavily reliant on buffaloes, particularly the Murrah breed, due to their significant contribution to milk production. Murrah breed of buffalo is considered to be the best milk-cum-meat breed. The home tract of breed is around the Southern part of Haryana comprising the districts of Rohtak, Jind, Hisar, Gurgaon and Delhi. Home tract has relatively hot and dry climate. In any breeding programme it is important to bring about the improvement in production performance traits so as to select the best performing individuals. These production performance traits were influenced by several non-genetic factors like parity, period of calving, season of calving which have significant effect on full expression of these production traits. Difference in season weather summer or winter, availability of fodder in different climatic areas and also different manage mental activities of farm manager largely affect the production traits. Therefore, the present investigation was conducted to study the effect various non-genetic factors on production performance traits in Murrah buffaloes. The success of this industry is largely determined by the lifetime performance traits of these animals. Accurate phenotypic values of milk production traits are essential for estimating genetic parameters, which are crucial for developing optimal selection criteria in planned improvement programs. Additionally, the genetic evaluation of animals necessitates adjusting phenotypic measurements for non-genetic factors to ensure precise estimates of genetic parameters and breeding values.

This study aims to analyze the effect of various non-genetic factors on Lifetime Milk Production (LTMP) and Productive Life (PL) in Murrah buffaloes.

Materials and Methods

Classification of data: The data on longevity traits was classified according to parity, period of calving and season of calving.

Period of calving: Due to the changes in feeding and management practices over the particular time interval, there might be variation in the expression of different traits of animals in different periods of calving in the farm(s). Assuming that there is not much variation in adjacent years, entire period of twenty-four years will be divided into 6 periods, each consisting of 4 consecutive years:

Period	Duration (year)
Period (P_1)	1992-95
Period (P_2)	1996-99
Period (P_3)	2000-03
Period (P_4)	2004-07
Period (P_5)	2008-11
Period (P_6)	2012-15

Season of calving: Season is an environmental factor that may influence the expression of performance traits in buffaloes because of wide variation of climatic condition throughout the year. Each year will be divided into four seasons according to the ambient temperature and relative humidity:

Seasons	Months
Summer	S_1 (April to June)
Rainy	S_2 (July to September)
Autumn	S_3 (October to November)
Winter	S_4 (December to March)

Statistical analysis

In order to overcome non-orthogonality of the data due to unequal subclass frequencies, least squares and maximum likelihood computer program of Harvey (1990) using Henderson method 111 (Handerson, 1973) will be utilized to estimate the effect of various tangible factors on various traits under study. The following mathematical model will be used to explain the underlying biology of the traits included in the study.

$$Y_{ijklmn} = \mu + s_i + h_j + c_k + rl + b_l (X_{ijklmn} - \bar{X}) + b_2 (X_{ijklmn} - \bar{X})^2 + e_{ijklmn}$$

Where

Y_{ijklmn}	Is the n^{th} record of individual of the i^{th} sire calved at j^{th} farm, k^{th} period, l^{th} season and m^{th} parity
μ	Is the overall population mean
s_i	Is the random effect of i^{th} sire
h_j	Is the fixed effect of j^{th} farm
p_k c_l r_m	Is the fixed effect of k^{th} period of calving Is the fixed effect of l^{th} season of calving Is fixed effect of m^{th} parity
b_1 and b_2	Are linear and quadratic partial regression coefficients of age at first calving on the traits, respectively?
X_{ijklmn}	Is the age at first calving?
$\bar{X}$	Is the mean of age at first calving?
e_{ijklmn}	Is the random error associated with each observation and assumed to be normally and independently distributed with mean zero and variance σ^2_e.

Result & Discussion

Least squares means and factors affecting different longevity traits

The analysis of variance and least-squares means for longevity traits are presented in the Tables 1 and 2, respectively

1. Productive life (PL)

The overall least-squares mean for PL was estimated as 1275.24± 31.82 days. The overall least-squares mean for PL was estimated as 1275.24±31.82 days. Comparable results were reported by Dev (2015) [4] and Chaudhari, M. (2015) [3] in Murrah buffaloes. A higher estimate of PL was reported by Chander (2002) [2] and Thiruvenkadan *et al.* (2015) [14] in Murrah buffalo. Gowane and Tomar (2007) [8] reported lower values than the present estimates. This type of differences might be partly attributed to the varying herdlife span, no of observations and type of data recorded.

(a) Farm: The analysis of variance revealed non-significant effect of farm on PL. The productive life was highest on farm 1 (1290.71±48.65 days) as compared to farm 1 (21259.78±43.59 days). The productive life was highest on farm 1 as compared to farm 2. Significant effect of farm was reported by Bashir *et al.* (2007) [1].

(b) Effect of period of calving: The analysis of variance revealed highly significant (p<0.01) effect of period of calving on PL. The PL was highest (1688.02±16.12 days) in period 1992-95 and lowest (846.83±11.13 days) in period 2012-15. The PL showed a decreasing trend across the periods. The PL showed a decreasing trend across the periods. Dutt and Taneja (1994) [6] and Chaudhari, M. (2015) [3] reported that the effect of period of calving was significant on PL in Murrah buffaloes. However, Dev *et al.* (2016) [5] reported non-significant effect of period of calving on PL.

(c) Effect of season of calving: The effect of season of calving on PL was non-significant. The Productive life was highest (1292.58±55.73 days) in autumn calvers and lowest (1255.88±46.98 days) in rainy calvers. The Productive life was highest in autumn calvers and lowest in rainy calvers. Chaudhari, M. (2015) [3] and Dev *et al.* (2016) [5] reported non-significant effect of season of calving on PL in Murrah buffaloes. However, Bashir *et al.* (2007) [1] reported that the effect of season of calving was highly significant on PL in Nili-Ravi buffaloes.

(d) Regression effect of age at first calving: Effect of age at first calving (linear as well as quadratic) was found to be non-significant on PL. However, Thiruvenkandan *et al.*

(2015) reported highly significant effect of age at first calving on PL in Murrah buffaloes. The regression coefficient (-0.038±0.12) of AFC on PL indicated that with one day increase in AFC there will be corresponding decrease in productive life by 0.038 days.

2. Life time milk production (LTMP)

The overall least-squares mean for LTMP was estimated as 5586.42± 17.96 kg. Kuralkar and Raheja (2000) [11], Singh and Barwal (2012) [12], Kumar *et al.* (2015) [10] and Thiruvenkadan *et al.* (2015) [14] reported comparable least-squares means for LTMP in Murrah buffaloes. Dutt *et al.* (2001) [7], Chaudhari, M. (2015) [3] and Dev *et al.* (2016) [5] reported higher least-squares mean for LTMP in Murrah buffaloes. The differences in means of lifetime traits may be due to the differences in defining and editing data on trait, variation in parities included, herd health and reproductive status

(a) Farm: The analysis of variance revealed highly significant (<0.01) effect of farm on LTMP. The lifetime milk production was highest on farm 1 (6106.69±26.49 kg) as compared to farm 2 (5066.15±23.81 kg). The lifetime milk production was highest on farm 1 as compared to farm 2. Similar results were reported Bashir *et al.* (2007) [1].

(b) Effect of period of calving: The analysis of variance revealed significant ($p<0.05$) effect of period of calving on LTMP. The LTMP was highest (7098.53±86.56 kg) in period 1992-95 and lowest (3895.63±61.16 kg) in period 2012-15. The LTMP showed a decreasing trend across the periods. The LTMP showed a decreasing trend across the periods. Tiwana *et al.* (1994) [15] and Kamaldeep (2014) [9] in Murrah reported that the effect of period of calving was highly significant on LTMP. However, Chaudhari, M. (2015) [3] and Dev *et al.* (2016) [5] in Murrah reported non-significant effect of period of calving on LTMP. This differential productivity of LTMY over periods could be attributed to availability of green fodder, climatic condition and managemental conditions.

(c) Effect of season of calving: The effect of season of calving on LTMP was non- significant. The LTMP was highest (5681.84±31.11 kg) in winter calvers and lowest (5436.07±29.12 kg) in summer calvers. The LTMP was highest in winter calvers and lowest in summer calvers. Dutt *et al.* (2001) [7], Chaudhari, M. (2015) [3] and Dev *et al.* (2016) [5] in Murrah buffaloes reported non-significant effect of season on LTMP. However, Singh *et al.* (2011) [13] reported significant effect of season of calving on LTMP in Nili-Ravi buffaloes

(d) Regression effect of age at first calving: Effect of age at first calving (linear as well as quadratic) was found to be non-significant on LTMP, decrease in CI from 1st to 5th parity. However, highly significant effect of AFC on LTMP was reported by Thiruvenkadan *et al.* (2015) [14]. The regression coefficient (0.44±0.65) of AFC on LTMP indicated that with one day increase in AFC there would be corresponding increase of LTMP by 0.44±0.65kg.

Table 1: Least squares analysis of variance for different longevity traits

Source of variation	D.F.	Mean squares	Mean squares
		PL	LTMP
Sire	149	505879.06	15028405.20
Farm	1	98059.27	110992923.20**
Period	5	3014735.46**	35894154.85*
Season	3	73712.55	2066676.21
Regression linear	1	42724.03	5693523.32
Regression quadratic	1	297745.16	25485831.07
Remainder	807	459829.48	12519933.99

*$p<0.05$ and **$p<0.01$

Table 2: Least- squares means and their standard errors for different longevity traits

Source of variation	Obs.	PL (Days)	LTMP (Kg)
Overall mean	968	1275.24± 31.82	5586.42± 17.96
Farm F1	400	1290.71^{a}±48.65	6106.69^{a}±26.49
F2	568	1259.78^{a}±43.59	5066.15^{b}±23.81
Periods: P_1(1992-95)	67	1688.02^{a}±16.12	7098.53^{ab}±86.56
P_2(1996-99)	176	1537.68^{b}±94.36	6730.27^{a}±49.83
P_3(2000-03)	229	1472.59^{b}±76.88	5910.58^{abc}±40.39
P_4(2004-07)	222	1098.93^{c}±78.49	5341.63^{bc}±41.70
P_5(2008-11)	202	1007.41^{c}±84.46	4541.90^{cd}±44.57
P_6(2012-15)	72	846.83^{d}±11.13	3895.63^{d}±61.16
Seasons: Summer	193	1260.89^{a}±58.96	5436.07^{a}±29.12
Rainy	350	1255.88^{a}±46.98	5570.73^{a}±25.96
Autumn	209	1292.58^{a}±55.73	5657.03^{a}±29.57
Winter	216	1291.63^{a}±55.05	5681.84^{a}±31.11
Regressions AFC(Lin)		-0.038±0.12	0.444±0.65
AFC (Quad.)		-0.0002±0.003	-0.002±0.001

Means superscripted by different letters differ significantly among themselves

Conclusion

This research demonstrates that non-genetic factors, especially the farm and period of calving, significantly influence the lifetime performance traits of Murrah buffaloes. Understanding these effects can help in devising better management strategies to improve the productivity

and longevity of dairy animals. Future research should focus on integrating genetic and non-genetic factors to develop comprehensive breeding programs that enhance the overall performance of Murrah buffaloes in the dairy industry.

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