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Influence of Environmental Factors on Performance Traits in Murrah Buffaloes: A Review

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Abstract

Murrah buffaloes are the most important milch buffalo breed in India with superior genetic potential and has been used quite extensively for upgrading local stock to improve performance of nondescript buffaloes throughout the country. The success of Indian dairy industry is much dependent on production, reproduction and functional traits of Murrah buffaloes. Performance of these traits in Murrah buffaloes are generally affected by environmental or non-genetic factors such as season of calving, period of calving and parity of animals. Proper evaluation or unbiased prediction of genetic worth (breeding value) depends upon the adjustment of effect of significant non-genetic factors on the production, reproduction and functional traits. The production traits reviewed were monthly test day milk yield (MTDMY), monthly test day fat yield (MTDFY), first lactation 305-days or less milk yield, first lactation 305-days or less fat yield, first lactation total milk yield, lactation length and dry period. The reproduction traits reviewed were age at first calving, calving interval, service period, conception rate, sire conception rate, number of services per first conception and daughter pregnancy rate. The functional traits reviewed were mastitis, metritis and abnormal calving in Murrah buffaloes. In order to improve productivity, obtain efficient reproduction and health of dairy animals it is necessary to develop an understanding of the factors affecting milk production, reproduction and functional traits.

Keywords: *Murrah, milk production, reproduction, functional traits*

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INTRODUCTION

Buffaloes are considered as the major dairy animal and backbone of Indian dairy industry. India ranks first in milk production accounting for 18.5% of worlds' milk production with an annual output of 146.3 million tons resulting in per capita availability of 322 g/day (NDDB, 2014–15) [1]. Buffaloes with a population of 108.7 million, the largest in the world, contribute 51.06% (74.71 million tons) to the total milk production in the country, which is valued for its quality being twice as rich in fat and other milk constituents as compared to the cow milk. Much higher average production in buffaloes (6.9 kg/day/animal) than that of indigenous cattle (3.9 kg/day/animal) with its unique feed conversion efficiency and adaptation speaks of its significance as dairy animal in the country (BAHS, 2014) [2]. Besides this, buffaloes contribute significantly towards meat production, draft power, dung for manure and fuel. Thus, buffaloes are the most important and indispensable component of livestock sector in the country. The buffalo genetic resources of the country are represented by 13 registered breeds and graded buffalo populations adapted to different ecological niches. Murrah is one of the superior breeds of Indian buffaloes with a population of 20.49 million, which constitutes around 65% of Indian buffaloes of well-defined breeds. Haryana (Jhajjar, Rohtak, Bhiwani, Jind) is the home tract of Murrah buffaloes but the graded Murrah buffaloes are found throughout the country owing to its higher milk production potential coupled with adaptation to wide ecological conditions and feed conversion efficiency. Murrah buffalo's milk contains higher fat percentage as compared to cattle [3–5]. The economics of any dairy enterprise is influenced by the production, reproduction and health status of

livestock. The goal of animal breeder is to evaluate genetically the animals for improving the quality of animals over the generations. The present breeding goals in the country are primarily focused on increasing milk production and not directed towards the cost effective performance of dairy animals. It is therefore imperative that attempt should be made to consider production, reproduction and health traits together in genetic improvement programmes. The non-genetic factors such as management, amount and quality of feed, season, period of calving, parity etc. influences these performance traits. Under this background, this review was aimed to evaluate the effects of various non-genetic factors on production, reproduction and health traits of Murrah buffaloes. This will help to formulate suitable evaluation procedures and selection of superior animals for future generation for improving economic traits of Murrah buffaloes.

PRODUCTION TRAITS

Monthly Test Day Milk Yield (MTDMY)

Each test day is the average of two times milk yield (morning and evening), recorded in a particular test date and expressed as in kg/day. Many research workers have done genetic evaluation of cows and bulls using monthly test day milk yield (MTDMY), however the concept is new in buffaloes and the literature are less. Katneni [6] reported minimum MTDMY as 4.17± 0.12 kg on Test day 11 (305th day) in first lactation and 4.19±0.09 kg [7] on Test day 11 (305th day) while maximum least-squares means were obtained as 8.05 ± 0.11 kg [6] and 8.10 ± 0.09 kg [7] on Test day 3 (65th day) in first lactation of Murrah buffaloes. Khosla *et al.* [8] reported that season and period of calving had significant effect on the entire MTDMY in Murrah buffaloes. On the other hand, Singh and Yadav [9] observed non-significant effect of season of calving on test day milk yield in Murrah buffaloes.

Monthly Test Day Fat Yield (MTDFY)

Kumar *et al.* [10] reported highest monthly test day fat yield **(**MTDFY) in MTDFY-3 (0.706 kg) and lowest in MTDFY-11 (0.333 kg). The effect of parity was highly significant up to MTDFY-6 and it was non-significant in rest test days (TD). The effect of season of calving was highly significant up to MTDFY-3 and further from MTDFY-8 to MTDFY-11 whereas non-significant effect of season of calving was observed for MTDFY-4 to MTDFY-7. Significant effect of the period of calving was observed for MTDFY-1, MTDFY-2, MTDFY-3, MTDFY-5, MTDFY-7, MTDFY-9 MTDFY-10 and MTDFY-11. Non-significant effect of period of calving was found on MTDFY-4, MTDFY-6, and MTDFY-8.

305-Days or Less Milk Yield

The FL305MY is the most important economic trait of the dairy animals' productivity, which determines profitability from dairy farming. Majority of animals give their maximum production during this period and it is standardized in such a way as to give around 60 days of dry period for animals, which is necessary for optimum production and reproductive performance in succeeding lactations to meet the goal of one calf per year. Least-squares means for 305 days or less milk yield varied from 1365.40±03 kg to 2078.20±31.21 kg. The effect of parity, period and season of calving on 305-days or less milk yield (kg) in Murrah buffaloes is given in Table 1. The 305-days or less milk yield was found to be significantly influenced by period of calving as studied by Wakchaure [11], Gupta [12], Jamuna *et al.* [13], and Ratwan *et al.* [14, 15].

305-Days or Less Fat Yield

Kumar *et al.* [10] reported least squares mean along with their standard errors for 305-days or less fat yield as 175.74±4.12 kg. Ibrahim *et al.* [26] and Tonhati *et al.* [27] reported overall mean of 305-days fat yield as 147.67 kg and 90.1 kg in Egyptian buffaloes and Murrah buffaloes herd in Sao population. According to Kumar *et al.* [10] effect of parity, season and period of calving were highly significant for 305-days or less fat yield in Murrah buffaloes.

First Lactation Total Milk Yield

Least-squares means varied from 1365.08±2.98 kg to 2182.82±20.19 kg and effect of parity, period and season of calving on first lactation total milk yield (kg) in Murrah buffaloes are presented in Table 2.

Lactation Length

Least-squares means ranged from 303.74±5.92 days to 326.13±6.70 days and effect of period and season of calving on lactation length (days) in Murrah buffaloes are shown in Table 3.

First Dry Period

Least-squares means and effect of period and season of calving on first dry period in Murrah buffaloes are given in Table 4. Average dry period ranged from 164.18±4.70 [11] to 331.30±9.2 [33].

Significant effect of period of calving on dry period was reported by Suresh *et al.* [34]. The effect of season of calving was reported as non-significant by Wakachaure [11] and significant by Suresh *et al.* [34].

Table 1: *Least-Squares Means and Effect of Period, Season of Calving and Parity on 305-Days or Less Milk Yield (kg) in Murrah Buffaloes.*

Mean ± SE (kg)	N	Non-genetic factors			References
		Period	Season	Parity	
1648.00 ± 22.00	1176	S	S	-	Dass and Sharma (1994) [16]
1784.90 ± 16.70	566	S	S	-	Nath (1998) [17]
1760.69 ± 42.25	655	S	NS	-	Gupta (2009) [12]
1818.06 ± 22.46	326	NS	NS	-	Chakraborty *et al.* (2010) [18]
1636.4 ± 23.9	1479	NS	NS	-	Singh *et al.* (2011) [19]
1706.52± 17.85	395	S	NS	-	Thiruvenkadan (2011) [20]
1853.49 ±15.88	961	S	S	-	Sahoo *et al.* (2014) [21]
1365 ± 03	113	S	S	-	Pandey *et al*. (2015) [22]
2065.76 ± 41.29	162	S	NS	-	Kumar *et al*. (2015b) [4]
2060.93 ± 20.22	1637	S	NS	-	Jakhar *et al.* (2016) [23]
2078.20 ± 31.21	154	S	NS	-	Jamuna *et al.* (2016) [24]
1977.9 ± 36.2	315	S	S	-	Chitra *et al.* (2016) [25]

S–Significant; NS–Non-significant

Table 2: *Least-Squares Means and Effect of Period, Season of Calving and Parity on First Lactation Total Milk Yield (kg) in Murrah Buffaloes.*

Mean ± SE (kg)	N	Non-genetic factors			References
		Period	Season	Parity	
1844.99 ± 21.31	628	S	NS	-	Nath (1998) [17]
1997.9 ± 66.2	1479	NS	NS	-	Singh *et al.* (2011) [19]
1942.75 ± 53.79	330	NS	NS	-	Gupta *et al.* (2012) [28]
1365.08 ± 2.98	116	S	S	-	Pandey *et al.* (2015) [22]
2182.82 ± 20.19	1637	S	NS	-	Jakhar *et al.* (2016) [23]

S–Significant; NS–Non-significant

Table 3: *Least-Squares Means and Effect of Season and Period of Calving on Lactation Length (Days) in Murrah Buffaloes.*

Mean ± S.E. (days)	N	Non-genetic factors		References
		Season	Period	
306.00 ± 4.00	404	S	NS	Dass & Sharma (1994) [16]
317.64 ± 2.58	465	S	S	Nath (1998) [17]
303.74 ± 5.92	1003	-	-	Yadav *et al.* (2002) [32]
323.62 ± 3.73	441	-	-	Katneni (2007) [6]
321.21 ± 2.25	1200	S	NS	Wakchaure (2008) [11]
326.13 ± 6.70	628	S	NS	Gupta (2009) [12]
313.16 ± 0.43	113	S	S	Pandey *et al.* (2015) [22]
311.68 ± 3.35	2107	S	NS	Jakhar *et al.* (2016) [23]

S–Significant; NS–Non-significant

Table 4: *Least-Squares Means and Effect of Period, Season of Calving and Parity on First Dry Period (Days) in Murrah Buffaloes.*

Mean ± SE (days)	N	Non-genetic factors			References
		Period	Season	Parity	
205.4 ± 8.7	236	S	NS	-	Tailor *et al.* (1992) [35]
187 ± 2.2	2107	-	-	-	Kuralkar & Raheja (1997) [31]
164.18 ± 4.70	1200	S	S	-	Wakachaure *et al.* (2008) [11]
250.5 ± 15.9	698	S	S	-	Thiruvenkadan *et al.* (2010) [36]
331.30 ± 9.2	917	-	-	-	Sharma *et al.* (2010) [33]
173.34 ± 5.59	1637	NS	S	-	Jakhar *et al.* (2016) [23]

S–Significant; NS–Non-significant

Table 5: *Least-Squares Means and Effect of Period and Season of Birth on Age at First Calving in Murrah Buffaloes.*

Mean ± S.E. (days)	N	Non-genetic factors		References
		Period	Season	
1380.92 ± 15.82	190	S	NS	Vij & Tiwana (1987) [29]
1511.42 ± 9.17	45	-	-	Dehuri & Nayak (1987) [37]
1330.79 ± 7.42	832	S	NS	Nath (1998) [17]
1400 ± 40.00	115	-	-	Suresh *et al.* (2004) [34]
1349.39 ± 6.33	1200	S	S	Wakchaure (2008) [11]
1307.18 ± 12.39	1700	S	S	Gupta (2009) [12]
1309.97 ± 25.92	560	S	NS	Nawale (2012) [38]
1364.18 ± 3.95	707	S	NS	Patil *et al.* (2012) [39]
1307.18 ± 12.39	330	S	S	Gupta *et al*. (2012) [28]
1578.7 ± 20.3	698	S	S	Thiruvenkadan *et al.*(2015) [40]

S–Significant; NS–Non-significant

REPRODUCTION TRAITS

Age at First Calving

Age at first calving (AFC) suggest an indication about the ability of a heifer to conceive and give birth to a calf. Lower AFC is necessary for early returns as it increases the lifetime production and decrease the generation interval and increase the genetic gain. This lowered generation interval helps in earlier evaluation of sires and results in faster genetic gain. If the age at first calving is below optimum level, it will lead to weak calves, difficulty in calving and less milk production in first lactation.

Least-squares means varied from 1307.18±12.39 to 1578.7±20.3 days and effect of period and season of calving on age at first calving in Murrah buffaloes are shown in Table 5.

Calving Interval

Calving interval is the time period between two successive calving. It should be optimum for obtaining high lifetime milk production. The total number of calvings and lifetime milk production will decrease if the calving interval is more. Least-squares means and effect of period and season of calving on calving interval (days) in Murrah buffaloes are given in Table 6. Average first calving interval ranged from 478±5.1 [41] to 532±5 days [40].

Service Period

The service period has a direct effect on length of calving interval and thereby influence the production efficiency of animal. Any variability in service period is directly reflected into variation in calving interval. Longer service period also influences lactation length and dry period. The literature revealed that least-squares means of average service period in Murrah buffaloes (Table 7) ranged from 143.41±3.97 [17] to 208.23±9.78 days [12].

Conception Rate

Sarkar *et al*. [44] reported least-squares means of conception rate in Murrah buffaloes as 33.19% and period of calving had significant effect on conception rate in Murrah buffaloes. Pasha *et al*. [45] reported conception rate as 47.07%, 41.51%, 39.81%, and 51.96% in winter, spring, summer and autumn, respectively in Nili-Ravi buffaloes with significant effect of season on conception rate.

Sire Conception Rate

A national evaluation for service sire conception rate (SCR) was executed in August 2008 by the USDA Animal Improvement Programs Laboratory [46]. The SCR rankings are based on a large, nation-wide database [47], and allow up to seven confirmed services per cow (≤ 22 month of age) per lactation. SCR of Holstein and Jersey bulls ranges from +5% to -6% [48] and +7% to -4%, respectively [49].

Number of Services per First Conception

Reports available in the literature (Table 8) indicated that least-squares means for number of services per conception (NS) in Murrah buffaloes ranged from 1.73±0.00 [37] to 3.74±0.26 [42].

Table 6: *Least-Squares Means and Effect of Period, Season of Calving and Parity on Calving Interval (Days) in Murrah Buffaloes.*

Mean ± SE (days)	N	Non-genetic factors			References
		Period	Season	Parity	
528 ± 2.9	2107	-	-	-	Kuralkar & Raheja (1997) [31]
478 ± 5.1	1164	S	S	-	Triveni *et al.* (2001) [41]
488.19 ± 5.44	1200	S	S	-	Wakachaure *et al.* (2008) [11]
532 ± 5	698	-	S	-	Thiruvenkadan *et al.* (2015) [40]
479.47 ± 4.88	1637	NS	S	S	Jakhar *et al.* (2016) [23]

S–Significant; NS–Non-significant

Table 7: *Least-Squares Means and Effect of Period of Calving, Season of Calving and Parity on Service Period (SP) in Murrah Buffaloes.*

Mean ± S.E. (days)	N	Non-genetic factors			References
		Period of calving	Season of calving	Parity	
148.40 ± 8.90	170	-	-	S	Swain & Bhatnagar (1983) [43]
143.41 ± 3.97	465	S	NS	-	Nath (1998) [17]
161.10 ± 13.51	497	S	S	-	Suresh *et al*. (2004) [34]
151.46 ± 3.87	1200	S	NS	-	Wakchaure (2008) [11]
208.23 ± 9.78	655	NS	NS	-	Gupta (2009) [12]
161.04 ± 6.03	554	S	S	NS	Patil (2011) [7]
187.10 ± 5.91	1637	S	S	-	Jakhar *et al*. (2016) [23]

S–Significant; NS–Non-significant

Table 8: *Least-Squares Means and Effect of Period and Season of Calving on Number of Services per First Conceptions (NS) in Murrah Buffaloes.*

Mean ± S.E.	Non-genetic factors		References
	Period of calving	Season of calving	
2.02 ± 0.11 (732)	NS	NS	Basu *et al.* (1977) [50]
3.74 ± 0.26 (392)	NS	S	Yadav and Rathi (1983) [42]
1.73 ± 0.00 (80)	-	-	Dehuri & Nayak (1987) [37]

2.2 ± 0.05 (935)	S	NS	Vij & Tiwana (1987) [29]

Daughter Pregnancy Rate

United States Department of Agriculture (USDA) in February 2003, introduced national genetic evaluations for fertility of cattle. Pregnancy rate is defined as the ability of a cow to return to normal reproductive status after successful calving and to show clear visible signs of estrus, to conceive when inseminated and to maintain the pregnancy. The assumption for calculations of pregnancy rate is that the voluntary waiting period is fixed and known. Patil [7] observed in Murrah buffaloes that voluntary waiting period of 63 days was ideal for obtaining best daughters pregnancy rate (DPR) and reported 36% pregnancy rate in Murrah buffaloes.

Functional Traits

The term functional trait is used to summarize those characters of an animal, which increases efficiency, not by higher output of product but by reduced cost of input [51]. A general characteristic of functional traits is that these are genetically unfavorably correlated to milk production and have low heritability with considerable genetic variability [52]. Udder and reproductive disorders are in general the two most common reasons for involuntary culling of dairy cows. Genetic evaluation for health traits is practiced in Nordic countries to minimize health problems. These traits are defined as binary traits (i.e., either the presence or absence of disease during specific time intervals).

Mastitis

Least-squares means and effect of period of calving, season of calving and parity on incidence of clinical mastitis in Murrah buffaloes are given in Table 9. Various workers [53, 54] observed significant effect of season of calving on the incidence of clinical mastitis in buffaloes. Taraphder *et al.* [54] reported that the incidence of clinical mastitis ranged from 8.75% in winter to 16.28% in rainy season. Chand *et al.* [55] reported significant effect of period of calving on the incidence of clinical mastitis in buffaloes. Significant effect of parity on the incidence of clinical mastitis in bovines was observed by Chand *et al.* [55], Joshi and Shrestha [53], Taraphder *et al.* [54] and Sharma *et al.* [56]. Taraphder *et al.* [54] reported a significant and consistent increasing trend in the incidence of mastitis with increase in parity.

Table 9: *Least-Squares Means and Effect of Period of Calving, Season of Calving and Parity on Mastitis in Murrah Buffaloes.*

Average incidence (%)	N	Non-genetic factors			References
		Period	Season	Parity	
4.22	994	S	NS	S	Chand *et al.* (1995) [55]
8.80	493	NS	S	S	Joshi and Shrestha (1995) [53]
4.01	998	-	NS	-	Chand *et al.* (1995) [55]
7.44	1115	NS	NS	NS	Pal (2003) [57]
5.56	612	-	-	-	Mandali *et al.* (2004) [58]
12.53	2306	NS	S	S	Taraphder *et al.* (2006) [54]
21.08	370	-	-	S	Chishty *et al.* (2007) [59]
13.05	1625	-	-	-	Rani *et al.* (2008) [60]

S–Significant; NS–Non-significant

Table 10: *Least-Squares Means and Effect of Period of Calving, Season of Calving and Parity on Metritis in Murrah Buffaloes.*

Average incidence (%)	No. of observations	Non-genetic Factors			References
		Period	Season	Parity	
3.70	688	-	-	-	Tomar & Tripathi (1991) [61]
6.20	452	NS	S	-	Tomar & Tripathi (1992) [62]
3.60	2373	S	-	S	Tomar & Tripathi (1994) [63]
9.81	292	-	S	S	Murugeppa & Dubey (1997) [64]
9.63	2306	NS	S	S	Taraphder (2002) [65]
11.57	1115	S	S	NS	Pal (2003) [57]

7.84	612	-	-	-	Mandali *et al.* (2004) [58]
6.33	-	-	-	-	Selvaraju *et al.* (2005) [66]
34.79	2344	-	-	-	Srinivas *et al.* (2007) [67]

S–Significant; NS–Non-significant

Table 11: *Least-Squares Means and Effect of Period of Calving, Season of Calving and Parity on Abnormal Calving in Murrah Buffaloes.*

Average incidence (%)	No. of observations	Non-genetic factors			References
		Period	Season	Parity	
Overall abnormal calving					
5.60	2985	S	S	NS	Tomar & Ram (1993) [68]
8.00	3184	S	S	NS	Tomar & Tripathi (1995) [69]
15.92	292	NS	-	S	Murugeppa & Dubey (1997) [64]
12.66	2306	NS	S	S	Taraphder (2002) [65]
8.25	1115	-	-	-	Pal (2003) [57]
1.62	677	-	-	-	Kaushish & Mathur (2005) [70]
10.28	4182	-	S	-	Nagda *et al.* (2006) [71]
Abortion					
3.77	2253	S	S	NS	Tomar & Verma (1987) [72]
6.55	2306	NS	S	S	Taraphder (2002) [65]
4.57	1115	NS	S	S	Pal (2003) [57]
1.18	677	-	-	-	Kaushish & Mathur (2005) [70]
4.66	4182	-	S	-	Nagda *et al.* (2006) [71]
Premature birth					
2.13	2306	NS	NS	NS	Taraphder (2002) [65]
0.54	1115	NS	NS	NS	Pal (2003) [57]
Still birth					
1.11	2253	S	S	NS	Tomar & Verma (1987) [72]
2.30	2306	NS	NS	NS	Taraphder (2002) [65]
1.97	1115	NS	NS	NS	Pal (2003) [57]
0.44	677	-	-	-	Kaushish & Mathur (2005) [70]
1.90	4182	S	-	-	Nagda *et al.* (2006) [71]
Dystocia					
1.78	2306	NS	NS	NS	Taraphder (2002) [65]
1.17	1115	NS	NS	NS	Pal (2003) [57]
2.12	612	-	-	-	Mandali *et al.* (2004) [58]
0.44	677	-	-	-	Kaushish & Mathur (2005) [70]

S–Significant; NS–Non-significant

Metritis

Least-squares means of average incidence of metritis varied from 3.60% to 34.79% and effect of period of calving, season of calving and parity on metritis in Murrah buffaloes are presented in Table 10.

Abnormal Calving

Least-squares means of average incidence of abnormal calving varied 0.54% to 15.92% and effect of period of calving, season of calving and parity on abnormal calving in Murrah buffaloes are given in Table 11.

CONCLUSIONS

The primary goal of animal breeder is to maximize the rate of genetic improvement through selection and improvement of several traits simultaneously. We want to select animals that have not only good production performance, but also have good health and reproduction. Genetic improvement through selection in a breeding program depends on the accuracy of identifying genetically superior animals. Selection of dairy animals is generally based on the records of performance traits. The variations in performance traits may be more of environmental nature as opposed to

genetics and sampling of population. As per the literature, all important non-genetic factors such as season of calving, period of calving and parity of animals had significant influence on the performance traits in Murrah buffaloes. Therefore, adjustment of effect of non-genetic factors is important for accurate and unbiased estimates of genetic parameters.

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