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The effect of some environmental factors on lactation length, milk yield and calving intervals of Anatolian Buffaloes in Bartın province of Turkey

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Abstract

This study aims to determine the environmental factors effected to lactation length (LL), lactation milk yield (LMY), calving intervals (CI) of Anatolian buffaloes in Bartın. In this study, 1511 milk yield data belonging to 762 Anatolian buffaloes and 957 CI data belonging to 543 Anatolian buffaloes which has been reared in different environmental conditions between 2015-2019 under the scope of the Anatolian Buffalo Breeding Project being conducted in Bartın province. The least squares method was used for determining the effect of environmental factors, and Tukey multiple comparison tests were used for multiple comparison. Mean and standard deviations relevant to the LL, LMY, and CI were detected as 260.26 ± 1.33 days, 1035.5 ± 8.21 kg, and 426.35 ± 2.91 days, respectively. County, calving year, and season, age, and lactation number's effects on those parameters were investigated. The effect of calving year (P<0.001) county and season (P<0.01) on LL; county, calving year (P<0.001) and calving age (P<0.05) on LMY; lactation number (P<0.001) and calving age (P<0.01) and season (P<0.05) on CI were found statistically significant. Meanwhile, a highly significant positive phenotypic correlation was calculated between LMY and LL (r = 0.66, P <0.001). There are no adequate studies related to the environmental factors influencing lactation length, lactation milk yield, calving intervals of Anatolian buffaloes. Significant environmental factors detected in this study should be considered in selection programs.

Introduction

Buffalo (*Bubalus Bubalis*) is an extensively reared as a dairy animal and originated from Asia (Borghese, 2010). While the world's buffalo population was 173 million in 2005, it has reached 206.6 million in 2018. The increasing percentage in the world's buffalo population between 2005-2018 is 19.4 (FAO, 2020). Buffaloes have great importance in regards to the amount of milk produced and milk's nutritional composition. Total buffalo milk production in 2018 was 127.7 million tonnes in the world. This amount constitutes around 15% of total milk production of the world, therefore buffaloes have become the second highest milk producers of the world after dairy cattle (FAO, 2020).

Buffaloes have been reared in Turkey originated from Mediterranean Buffaloes, which are the sub-group of Riverin Buffaloes and named as Anatolian Buffaloes (Cicek et al., 2009). Buffaloes mainly reared at the Northern, Middle, Marmara, Eastern, and South-Eastern Regions of Turkey (Atasever and Erdem, 2008). While Turkey's buffalo population was 105 thousand in 2005, it has reached 184 thousand in 2019 thanks to the National Anatolian Buffalo Breeding Project in Farm Conditions implemented by the Turkish Ministry of Agriculture and Forestry. There are 1.659 buffaloes reared currently in Bartın province located in the Northwest part of Turkey (TUIK, 2020a). Buffaloes being bred in Turkey for milk and meat production. In addition to their resistance against diseases and harsh environmental conditions, not only the higher capability of feed efficiency, converting poor-quality feedstuffs into high-quality milk and meat, but also lower expenses needed for husbandry compared to dairy cattle could be considered as other main reasons for engaging in buffalo husbandry (Atasever and Erdem, 2008). Buffalo milk is used in order to produce yoghurt, cream, cheese, and ice cream, and it contains 7.92% fat and 4.09% protein. Meanwhile, buffalo meat is used for producing salami (Soysal et al., 2015).

According to TUIK (2020b) 79 thousands tonnes of milk and 73 tonnes of meat produced from buffaloes in 2019 in Turkey. To increase the efficiency of dairy buffaloes, factors that influence milk production should be ameliorated. Total milk production of buffaloes; effected by non-genetic parameters such as season, management, and feed quality (Afzal et al., 2007; Pawar et al., 2012) some other parameters like calving interval and age are closely related to efficient milk production (Khosroshahi et al., 2011). LMY and LL are significant parameters for dairy buffaloes (Chaudhry, 1992).

There is not adequate research about the environmental factors which influence LL, LMY, and CI of Anatolian Buffaloes. Hence, more studies required to determine the effects of environmental parameters on production of Anatolian Buffaloes. This study aims to examine siginificant environmental factors influencing LL, LMY, and CI of Anatolian buffaloes.

Materials and Methods

Animal material of the study comprises of pedigree records of 762 Anatolian buffaloes' milk yield records and 543 calving interval records in Bartın province (410 38' 28'' N and 320 19' 59'' E) between 2015-2019. In this study, 1511 milk yield records and 957 calving interval records were evaluated and obtained from Anatolian buffaloes that were born between these years. LMY and CI records procured from the database named 'Manda Yıldızı'. The data being uploaded by project technical staff hired for The National Anatolian Buffalo Breeding Project which has been coordinated and supported by the General Directorate of Agricultural Research and Policies (Tekerli, 2019).

Buffaloes are milked twice daily, at morning and evening. Milk records are collected each month with a precision scale which is sensitive to 10 g / 50 kg. Anatolian buffaloes with at least the 4 months of lactation data were included in the analysis (Koç and Kızılkaya, 2009). The records between 123≤LL≤404 d for LL and 300≤CI≤700 d for CI (Soysal et al., 2018) were evaluated in this study. The data of animals leaving the herd before the lactation ended due to diseases, sales, and deaths were not evaluated. Abort and stillbirths were excluded in the calculation of the CI.

Buffalo husbandry is carried out under extensive conditions plus similar management and nutritional conditions in the region where the research was conducted. Farmers do not usually apply additional feeding to buffalos particularly in the pasture period, but they do additional feeding according to the current feed (straw, alfalfa, silage, etc.) in winter. On the days when seasonal conditions are suitable for grazing in the region, buffaloes are taken to pasture after morning milking. While most of the farmers are milking by hand, fewer are milking with a machine. This study was conducted in 4 counties; (1) Amasra, (2) Kurucaşile, (3) Center and (4) Ulus. Calving year was grouped between 2015 to 2019. Based on the geo-climatic conditions prevailing in Turkey, calving seasons allocated into four groups; (1) winter (December, January and February), (2) spring (March, April and May), (3) summer (June, July and August) and (4) autumn (September, October and November). Age was divided into five groups: (1) 3-4 yrs, (2) 5-6 yrs, (3) 7-8 yrs, (4) 9-10 yrs, (5) 11 yrs and older. Lactation number was listed numerically one through five.

Among the environmental factors examined in this study, the effect share of the county, calving year, season, age, and lactation number on LL, LMY, CI and were determined using the least squares method. The test of significance in terms of statistics were made by variance analysis and the differences between the averages were evaluated by the Tukey multiple comparison tests. Besides, a phenotypic correlation was calculated from unadjusted data via Pearson Method. The GLM (General Linear Model) procedure in the "Minitab-Version 18" program package was used for statistical analysis of the data (Minitab, 2017).

The effects of various environmental factors on lactation length, lactation milk yield, and calving interval were examined using the model below.

$Y_{ijklmn} = \mu + C_i + Y_j + S_k + A_l + L_m + e_{ijklmn}$ as follows;

Y_{ijklmn}: The yield characteristics of any buffalo (i: county, j: year, k: season, l: age, m: Lactation number)

μ: Overall (expected) average,

C_i: The effect of County (i= 1,2,3,4),

Y_j: The effect of Calving Year (j= 2015, 2016, 2017, 2018, 2019),

S_k: The effect of Calving Season (k= 1,2,3,4),

A_l: The effect of Calving Age (l=1,2,3,4,5)

L_m: The effect of Lactation Number (m= 1, 2, 3, 4, 5),

e_{ijklmn}: Random error which is assumed to be normally independently distributed with zero mean and constant variance (NID, 0, σ2).

Results

In this study, LL, LMY, CI overall mean and standard error were determined as 260.26 ± 1.33 days, 1035.5 ± 8.21 kg, and 426.35 ± 2.91 days, respectively (Table 1). The effects of some environmental factors on LL, LMY, and CI in Anatolian buffaloes are examined and the mean, standard errors, and effective factors of these characteristics are given in Table 2.

Table 1. Descriptive statistics for LL, LMY, and CI in Anatolian buffaloes

Number of Animals	Number of Records	Mean	Standard Error (S)	Minimum	Maximum
Lactation Length (days)					
762	1511	260.26	1.33	123	404
Lactation Milk Yield (kg)					
762	1511	1035.5	8.21	294.9	1986.6
Calving Interval (days)					
543	957	426.35	2.91	300	700

Table 2. Least squares means (± SE) of lactation number, LMY, and CI according to the county, calving year, season, and age, lactation number of Anatolian buffaloes

Factors		Lactation Length (days)		Lactation Milk Yield (kg)		Calving Interval (days)	
		n	(Mean±SE)	n	(Mean±SE)	n	(Mean±SE)
County	P		**		***		NS
	Amasra	73	278.34±6.05^{a}	73	1145.0±32.0^{a}	55	399.0±12.5
	Kurucaşile	65	246.97±6.52^{b}	65	1045.4±34.5^{ab}	33	397.9±15.9
	Center	1201	257.66±2.11^{b}	1201	1026.4±11.2^{b}	767	402.45±5.34
	Ulus	172	255.72±4.16^{b}	172	1100.3±22.0^{a}	102	395.39±9.46
Calving Year	P		***		***		***
	2015	236	263.66±4.59^{ab}	236	870.6±24.3^{d}	98	363.10±12.2^{d}
	2016	309	258.40±4.04^{b}	309	973.4±21.4^{c}	195	383.45±9.41^{cd}
	2017	425	268.26±3.61^{ab}	425	1182.8±19.1^{b}	263	397.30±8.25^{bc}
	2018	431	272.21±3.23^{a}	431	1251.2±17.1^{a}	326	425.91±6.95^{a}
	2019	110	235.82±5.23^{c}	110	1118.4±27.7^{b}	75	423.50±11.1^{ab}
Calving Season	P		**		NS		*
	Winter	221	265.35±4.09^{a}	221	1113.4±21.6	137	418.04±9.34^{a}
	Spring	398	261.61±3.59^{a}	398	1072.7±19.0	230	390.28±8.57^{b}
	Summer	523	251.68±3.29^{b}	523	1058.7±17.4	333	390.62±7.50^{b}
	Autumn	369	260.05±3.69^{ab}	369	1072.4±19.6	257	395.71±8.32^{ab}
Calving Age (year)	P		NS		*		**
	3-4	348	259.88±5.19	348	1020.3±27.5^{b}	51	357.0±15.1^{c}
	5-6	531	256.13±3.90	531	1054.8±20.6^{b}	333	388.36±8.71^{bc}
	7-8	338	258.47±3.79	338	1072.6±20.0^{ab}	298	405.52±7.69^{ab}
	9-10	200	268.09±4.47	200	1140.9±23.6^{a}	183	408.72±8.35^{ab}
	11≤	94	255.79±6.46	94	1107.8±34.2^{ab}	92	433.70±11.5^{a}
Lactation Number	P		NS		NS		***
	1st	470	258.21±4.54	470	1022.1±24.0	374	452.97±7.84^{a}
	2nd	420	259.93±3.94	420	1068.2±20.9	322	422.79±7.91^{b}
	3rd	352	258.73±3.93	352	1092.3±20.8	204	381.97±9.39^{c}
	4th	211	260.76±4.76	211	1103.4±25.2	57	336.90±13.9^{d}
	5th	58	260.72±7.54	58	1110.5±39.9	-	-

* : P<0.05 ** : P<0.01 *** : P<0.001 NS : Non-Significant (P>0.05)
a, b, c, d : Means in a column with different superscripts differ significantly (P<0.05).

The effects of the county, calving year, season, calving age, and lactation number on these characteristics were determined. The effect of calving year (P <0.001) county and season (P <0.01) on LL; the effect of calving age (P <0.05) on LMY was found important, and the effect of calving year and the county on calving age was considered significantly important (P <0.001). While the effects of calving season on CI (P <0.05) and calving age (P <0.01) were found statistically significant, the effects of calving year and lactation number on CI were found to be significant (P <0.001). The high positive phenotypic correlation was calculated between LMY and LL (r = 0.66, P <0.001). In addition, low positive phenotypic correlations were calculated between CI and LL (r = 0.15, P <0.001) and between CI and LMY (r = 0.13, P <0.001) (Table 3).

Table 3. Phenotypic correlation (rP) for some traits of Anatolian buffaloes

Traits	Lactation Length	Lactation Milk Yield	Calving Interval
Lactation Length	-		
Lactation Milk Yield	0,66***	-	
Calving Interval	0,15***	0,13***	-

*** : P<0.001

Discussion

The LL obtained (260.26 ± 1.33 days) (Table 1) in this study is longer than the lengths found in Şahin and Ulutaş (2014) (146.6 days), Tekerli *et al.* (2016) (229.4 days), Uğurlu *et al.* (2016) (231.9 days), and Koçak *et al.* (2019) (245.4 days) studies on Anatolian buffaloes. The reason for this case could be taken into account under the following conditions, farmers would like to obtain maximum milk from buffaloes as long as possible, ignoring the economy of lifelong milk production (Hussain *et al.*, 2006). The LL found in the study was relatively short but similar to Rosati and Van Vleck (2002) (270 days) findings in Italian buffaloes, Afzal *et al.* (2007) (273.3 days) in Nili Ravi buffaloes in Pakistan. However, the LL obtained at the end of this study is shorter than the values reported by Cady *et al.* (1983) (282 days) and Chaudhry (1992) (302 days) as a result of some researches on Nili Ravi buffaloes. The differences in LL values might be due to various management and feeding programs implemented in the farms.

The effect of county on LL was found significant (P <0.01) in this study in accordance with Soysal *et al.* (2018) findings carried out a study on Anatolian buffaloes reared in İstanbul. The highest LL was calculated in Amasra, the lowest was in Kurucaşile. The effect of calving year on LL was determined significant (P <0.001) in this study (Table 2) compatible with the studies carried out by Charlini and Sinniah (2015) from Sri Lanka and Koçak *et al.*(2019) on Anatolian buffaloes. In this study, the longest LL was obtained in 2018, while the shortest LL was achieved in 2019. Alterations in LL during various calving years may be due to climate factors and/or differences in management practices at the farm. The effect of calving season on LL was found significant (P <0.01) in this study (Table 2) similar to the studies conducted by Hussain *et al.* (2006) on Nili Ravi buffaloes, Şahin and Ulutaş (2014), and Koçak *et al.* (2019) on Anatolian buffaloes. Besides, Bashir *et al.* (2015) also reported that the LL was affected by the calving season. Nevertheless, the abovementioned effect was found non-significant in some studies (Ghaffar et al., 1991; Chaudhry , 1992; Khan and Chaudhry, 2000; Afzal et al., 2007) conducted on buffaloes, in contrast with the findings obtained in this study.

It was observed that Anatolian buffaloes calved in winter have longer LL than calved in summer and autumn as compared with spring (Table 2). Furthermore, the longest LL was achieved in buffaloes calved in winter, while the shortest LL was achieved in buffaloes calved in summer. Similar results were reported by Şahin and Ulutaş (2014) in a study conducted on Anatolian buffaloes in Tokat province of Turkey, contrary to the Khalil *et al.* (1992) 's findings are relevant to the longest LL in buffaloes calved in spring as a result of a study on Egyptian buffaloes. While some researchers reported that the effect of year, season, and age on LL is significant (Hussain et al., 2006; Marai et al., 2009; Koçak et al., 2019), in this study only the effect of age was found non-significant (P>0.05) apart from other factors. Moreover, Soysal *et al.* (2018) reported similar results that the effect of age on LL was not considerable as a result of various studies on Anatolian buffaloes, unlike Khan and Chaudhry (2000)'s reports with respect to the significant effect of calving age on LL.

As a result of this study, no differences were observed (P>0.05) in Anatolian buffaloes in terms of the effect of lactation number on LL. Similar results were obtained by Afzal *et al.* (2007) in consequence of a study carried out Nili-Ravi buffaloes in Pakistan. However, the effect of lactation number on LL was found significant in most studies conducted on buffaloes. These differences might be shown up due to various farm management conditions and various locations of farms. As can be understood from this research (Table 2), as lactation number increases, LL values increase properly even though they are not very dissimilar. Nevertheless, Cady *et al.* (1983) reported that as lactation number increases, LL values reduce.

The LMY (1035.5±8.21 kg) (Table 1) obtained in this study is higher than Tekerli *et al.* (2001) (894.3 kg), Şahin and Ulutaş (2014) (657.7-761.4 kg) and Uğurlu *et al.* (2016) (925.4 kg) reported. On the other hand, it is similar to the value reported as 1000.7 kg in the study conducted by Tekerli *et al.* (2016) on different originated Anatolian buffaloes. However, this value found in the study is less than the LMY reported by many other researchers. According to some researches carried out on various buffalo breeds from various countries, LMY reported as; Cady *et al.* (1983) (1883 kg), Khan and Chaudhry (2000) (1984 kg) at Nili Ravi buffaloes reared in Pakistan and Rosati and Van Vleck (2002) reported 2286 kg at Mediterranean buffaloes reared in Italy. These production levels are considerably higher than the milk yield of Anatolian Buffaloes reared in Turkey. Likewise, the milk yield value found in this study is lower than the value obtained by Şekerden (2011) (1300 L) as a result of the study carried out on Anatolian buffaloes in Turkey. These differences in milk yield may result from differences in nutritional and management practices (Charlini and Sinniah, 2015).

The effect of county on LMY was found significant (P <0.001) in this study. Soysal *et al.* (2018) was found the effect of region significant in their study on Anatolian buffaloes in İstanbul, which is consistent with this study. The highest LMY was calculated in Amasra, while the lowest in Central County. These results suggest that Amasra is a suitable region for buffalo breeding. The effect of the calving season on LMY found non-significant (P>0.05) in this study. It was observed that buffaloes that calved during winter and autumn seasons possess more milk production than calved at the other seasons (Table 2). Soysal *et al.* (2018) found the effect of season on LMY was important contrary to these findings. However, they reported the highest milk yield from buffaloes calved during the autumn and winter seasons as well. Similarly, Catillo *et al.* (2002) have determined the highest LMY at buffaloes calved in winter and lowest in summer. Şahin and Ulutaş (2014) stated that the main reasons for lower milk yields in summer are temperature stress, the vegetation of pastures, and difficulties at feed supply. On the other hand, the low LL of buffaloes that calved in summer in this study may have caused LMY to be lower than other seasons.

Buffaloes are influenced by different air temperatures in different seasons. They stay longer in barn in the winter, therefore milking for a longer time by feeding inside could provide an opportunity to obtain higher milk yield from buffaloes calved during winter. The region where the research is conducted comprises generally family-type traditional farms. Produced buffalo milk is sold in local markets either as raw milk or by converting it into various dairy products (usually buffalo yoghourt) can thus contribute substantially to the family economy. Considering all these factors, a high level of LMY of buffaloes that are reared in intensive conditions during the winter is an indication of given importance to buffaloes in this period in terms of care and nutrition. Similarly to these findings, Kul *et al.* (2016) in Anatolian buffaloes and Ghaffar *et al.* (1991) in Nili-Ravi buffaloes reported that calving season had no significant effect on milk production. Afzal *et al.* (2007) stated that climate stress factors can be minimized and overcome through better nutrition and management.

The effect of calving year (P <0.001) and age (P <0.05) on LMY were found significant in the study. The highest milk yield was reached in 2018, while the lowest milk yield was achieved in 2015 (Table 2). The alteration in milk yield observed in different years reflected the level of management and environmental impacts at the farm. The level of management varies according to the skills of farmers, cultivating and rearing system, selection method, and density (Khan, 1986). Catillo *et al.* (2002), Şahin and Ulutaş (2014) findings confirmed the noticeable effect of calving age on LMY. In this study, the highest LMY determined from buffaloes calved at 9-10 years of age and lowest LMY at 3-4 years of age. It was observed that LMY gradually increased after the age of calved at the age of 9-10 and decreased after the age of 11≤. Similar results obtained by Koçak *et al.* (2019) the highest milk yield at the age of 9, and the lowest reported at ≤4. Bashir *et al.* (2015) emphasized that age may be a more precise factor to be included in models to be utilized in lactation milk yield. Since the culling of buffaloes with lower milk yield from the herd and the expansion of this process contribute to obtaining better LMY than the herd in subsequent lactations (Khan et al., 1997).

The effect of lactation number on LMY was found statistically non-significant (P>0.05), similar to Pawar *et al.* (2012)'s findings. On the contrary, Afzal *et al.* (2007) reported that the effect of lactation number on LMY was found statistically significant. Lowest LMY was obtained at 1^{th}, while the highest was achieved at 4^{th} and 5^{th}. lactations confirming Marai *et al.* (2009)'s findings related to reaching highest LMY at 4^{th} and 5^{th} lactation number. Furthermore, Afzal *et al.* (2007) and Khosroshahi *et al.* (2011)'s findings have promoted these results by their reports for obtaining the lowest LMY at 1. lactation. It was observed that in this study, as lactation number increased, LMY increased regularly (Table 2). This increased milk production in subsequent lactations can be explained by the continuation and maturation of the mammary gland.

The average CI value for Anatolian buffaloes (426.35 ± 2.91 days) (Table 1) was determined higher than the values found in the studies by Marai *et al.* (2009) (402.6 day) on Egyptian buffaloes and Soysal *et al.* (2018) (417 days) on Anatolian buffaloes. Although CI was relatively high in the study conducted by Tekerli *et al.* (2001) they found as 441.9 days similar to this study. On the other hand, from India conducted by Hussain *et al.* (2006) (473.7 days) on Nili-Ravi buffaloes, Charlini and Sinniah (2015) (470 days) from Sri Lanka, and Koçak *et al.* (2019) (450.3 days) on Anatolian Buffaloes obtained higher CI values than this study.

The effect of county on CI was found non-significant ($P > 0.05$) in this study similar to Soysal *et al.* (2018)'s findings. The highest CI was observed in Central County, while the lowest in Ulus county. This result shows that the buffalo breeders in Ulus county are more meticulous in reproductive traits and estrus monitoring. CI value was linearly decreased, as lactation number increased, coherently with Cady *et al.* (1983) and Charlini and Sinniah (2015)'s findings. The effect of calving season on CI was found statistically significant ($P<0.05$), similar to the Tekerli *et al.* (2001) and Koçak *et al.* (2019)'s findings at Anatolian buffaloes and Marai *et al.* (2009)'s findings at Egyptian buffaloes. On the other hand, Soysal *et al.* (2018) found the effect of calving season on CI was non-significant. In the study, the longest CI value was observed in Anatolian buffaloes calved in winter, while the shortest value was observed in buffaloes calved in winter. Bashir *et al.* (2015) and Koçak *et al.* (2019) support that results by finding the longest CI value in buffaloes that calved in winter, the shortest CI in buffaloes that calved in summer. The shortest CI obtained from the buffalo calved in summer can be explained by the occurrence of postpartum estrus and conception period in the winter. The reduction at daylight and air temperature in winter and autumn seasons may increase the reproductive activity in the buffaloes. As a matter of fact, Hafez (1955) reported that sexual activity was observed in some buffaloes at the onset of autumn. Likewise, Soysal *et al.* (2018) detected that the effect of calving year, calving age, and lactation number on CI was significant in a study conducted in Anatolian buffaloes. Similar results were reported by some researchers (Hussain et al., 2006; Marai et al., 2009; Charlini and Sinniah, 2015) as the effect of lactation number on CI was significant. On the contrary, Tekerli *et al.* (2001) reported that the effect of lactation number and age on CI was not significant in Anatolian buffaloes. In this study, it was observed that with the increase of calving age, the duration of CI increased. From this, it can be concluded that CI is prolonged as a result of the fact that buffaloes cannot conceive regularly due to reasons such as farm management and abduction of the oestrus cycle.

It was determined that the positive phenotype correlation between LMY and LL is high and siginificant (Table 3). Similar to this study, many researchers reported that the correlations between LMY and LL are high and significant in buffaloes (Khan et al.1997; Afzal et al. 2007; Galsar et al. 2016; Rathod et al. 2018). Phenotypic correlation between CI and LL and between CI and LMY was found significant, positive and very low (Table 3). Rathod *et al.* (2018) and Jakhar *et al.* (2016) reported that the phenotypic correlation between CI and LL is significant and positive, similar to this study. However, unlike this study, the correlation coefficient was found to be high in the same study. Similar to this study, *Rathod et al.* (2018) found a positive and low relationship between CI and LMY. On the other hand, *Jakhar et al.* (2016) reported that there is a significant, low and negative relationship between CI and LMY.

Conclusion

Taking measures to ameliorate maintenance, feeding, and herd management will improve the current situation of the farms and contribute to productivity, in the buffalo farms in Bartın. Among the environmental factors examined in the research; the effects of the county, calving year and age on milk yields, and calving year, season, age, and parity on CI were found to be significant. Stud selection and breeding studies can be done considering these important environmental factors in order to improve milk yield and other performances of buffaloes. Also, calving can be planned according to the winter since milk yield found highest in the buffaloes that calved in the winter.

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