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RESEARCH ARTICLE

Investigations on Calving Interval and Dry Period in Anatolian Buffaloes Reared in Kütahya Province

Kürşat ALKOYAK[1]*, Cüneyt KAPTAN[2], Mehmet Akif YÜKSEL[2]

[1]*Republic of Türkiye Ministry of Agriculture and Forestry, General Directorate of Agricultural Research and Policies, Department of Livestock and Aquaculture Research, Ankara, Türkiye,*
[2]*Republic of Türkiye Ministry of Agriculture and Forestry, Sheep Breeding Research Institute, Balıkesir, Türkiye*

ABSTRACT

The study is intended to determine the calving interval (CI) and Dry period (DP), affecting both production and reproduction characteristics of Anatolian buffaloes reared under farm conditions, to investigate the environmental effects on these characteristics, and to use the results in stud selection programs for breeding in buffalo herds. In the study, 1427 calving interval and dry period records of 756 head of Anatolian buffalo reared between 2014-2021 were used. In this study, the overall mean and standard error of CI and DP were determined as 411.37±4.10 days and 191.70±3.13 days, respectively. The effects of county, calving year, season and parity on these features were determined. In the study, the effect of all environmental factors on CI and DP, apart from the county, was found to be significant ($p<0.01$, $p<0.001$). In the study, concluded that considering the factors affecting yield and reproductive performance in selection programs and monitoring of estrus and drying off by breeders will contribute to farm productivity.

Keywords: Buffalo, calving interval, dry period, environmental factors

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Kütahya İlinde Yetiştirilen Anadolu Mandalarında Buzağılama Aralığı ve Kuruda Kalma Süresi Üzerine Araştırmalar

ÖZ

Sunulan çalışmada çiftlik şartlarında yetiştirilen Anadolu mandalarında Buzağılama aralığı (BA) ve üreme ve üretim özelliklerini etkileyen Kuruda kalma süresi (KKS)'ni belirleyerek bu özellikler üzerine etki eden çevresel etkileri araştırmak ve elde edilen sonuçların manda sürülerinde ıslaha yönelik damızlık seçim programlarında kullanma imkanlarının belirlenmesi amaçlanmıştır. Çalışmada 2014-2021 yılları arasında yetiştirilen 756 baş Anadolu mandasına ait 1427 adet Buzağılama aralığı ve Kuruda kalma süresine ait kayıtlar kullanılmıştır. Bu araştırmada, BA ve KKS genel ortalama ve standart hatası sırasıyla 411.37±4.10 gün ve 191.70±3.13 gün olarak belirlenmiştir. İlçe, buzağılama yılı, mevsimi ve laktasyon sırası bu özellikler üzerine etkileri belirlenmiştir. Çalışmada ilçe hariç incelenen tüm çevresel faktörlerin BA ve KKS üzerine etkisi önemli bulunmuştur ($p<0.01$, $p<0.001$). Çalışmada, seleksiyon programlarında verim ve üreme performansına etki eden faktörlerin dikkate alınması ve yetiştiriciler tarafından östrus ve kurutmanın izlenmesinin çiftlik verimliliğine katkı sağlayacağı sonucuna varılmıştır.

Anahtar kelimeler: Buzağılama aralığı, çevresel faktörler, kuruda kalma süresi, manda

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ORCID ID; *KA: 0000-0001-6621-6136, CK: 0000-0001-9867-7025, MAY: 0000-0003-3767-5936*

*Corresponding author e-mail: kursatalkoyak@gmail.com

INTRODUCTION

Buffaloes play a crucial role in ensuring a sustainable food production system in many developing countries (Pasha and Hayat 2012). The buffaloes raised in Türkiye originate from the Mediterranean subgroup of the riverine-type buffaloes, and are called as Anatolian Buffalo (Cicek et al. 2009).

In Türkiye, the number of Anatolian buffaloes was 185.574 in 2021 and they are mostly grown in North, Central, West, East and Southeast Anatolia (Atasever and Erdem 2008, TUIK-Anonymous 2022). The Ministry of Agriculture and Forestry started to implement the "National Anatolian Buffalo Breeding Project " to improve the buffalo breeding. In Türkiye, buffalo breeding is generally carried out for milk production (cream, yogurt, cheese, ice cream). To increase milk yield in buffaloes, it is necessary to know the factors affecting milk production. Milk yield and reproductive characteristics are affected by the factors such as genotype, age, season, nutrition and management (Kumar et al. 2017). Similarly, the economic return of buffalo milk depends on the milk production and reproductive efficiency of the animals, and the reproductive efficiency in buffaloes is affected by the dry period (DP) and especially the calving interval (CI). Indeed, CI is an important parameter used as a fertility index in farms (Ramos et al. 2006, Yılmaz Adkinson and Konca 2021).

Most breeding experts agree that the 13-14 month calving interval is ideal to maximize profitability in buffalo breeding. Also, to obtain optimal milk, approximately 2 months of DP should be left before the next lactation. Shorter or longer DP negatively affects the subsequent lactation yield (Şekerden 2001). Bachman and Schairer (2003) reported that animals with low milk yield tend to stay in dry period for a longer time, while animals with high milk yield do the opposite. Indeed, a dairy animal must have a shorter DP and a lower CI to be economical. In this respect, DP and CI are important economic features that determine the milk yield of buffaloes (Sanker et al. 2014).

There is not enough research on the calving interval and especially on the dry period in Anatolian buffaloes. Therefore, more studies are needed to determine these characteristics of Anatolian buffaloes. The aim of this study is to contribute to stud selection programs in buffalo herds by investigating the reproductive characteristics CI and DP in Anatolian water buffalo reared under farm conditions and the environmental effects on these characteristics.

MATERIAL AND METHOD

Location of the study, animals and data collection

The material of the research consists of 1427 CI and DP records of 756 heads of Anatolian buffalo reared in Kütahya province (39° 25' 11" N and 29° 59' 8" E) between 2014-2021. The data were obtained from the "Manda Yıldızı" data registration system, which was created within the scope of the "National Anatolian Buffalo Breeding Project" promoted by the General Directorate of Agricultural Research and Policies (Tekerli 2019).

In the region where the research was carried out, buffalo breeding generally consists of family type enterprises and the number of buffaloes per farm is approximately 5 heads. Buffalo farming is generally carried out in pasture conditions and supplementary feeding is done by giving small amounts of forage available only in winter months (silage, straw, alfalfa, legume grass, etc.). Milking is performed in the morning and evening, mostly by hand and sometimes by machine.

Data between CI≥300 and ≤700 days, and DP≥30, and ≤300 days were used in the study (Poudel et al. 2017, Koçak et al. 2019). CI (days) was calculated as the interval between two consecutive calvings, and DP (days) was calculated as the time from the date of dry off to the subsequent calving.

The study was carried out in 3 counties of Kütahya; (1) Altintas, (2) Center, and (3) Tavşanlı. The calving year was divided into four groups: (1) 2014-2015, (2) 2016-2017, (3) 2018-2019, and (4) 2020-2021. The calving seasons were divided into four groups; (1) winter, (2) spring, (3) summer, and (4) autumn. The parity is numerically ranked from 1 to 5.

Statistical analysis

Due to the insufficient data in the subgroups, it was assumed that there was no two- or three-way interaction between the factors examined. The GLM (General Linear Model) method in the "Minitab-Version 18" program package was utilized for the analysis (Minitab 2017). The following model was used to determine the effect of environmental factors on calving interval and dry period.

$Y_{ijklm} = \mu + C_i + Y_j + S_k + P_l + e_{ijklm}$ Where;

Y_{ijklm}: Level of CI and DP features of any buffalo (i. county, j. year, k. season, l. Parity, m. The observation value for an investigated trait)
μ: Overall (expected) average,
C_i: The effect of i^{th} county (i= 1,2,3),
Y_j: The effect of j^{th} calving year (j=1, 2, 3, 4),
S_k: The effect of k^{th} calving season (i= 1,2,3,4),
P_l: The effect of l^{th} parity (l=1, 2, 3, 4, 5),
e_{ijklm}: Random error which is assumed to be normally independently distributed with zero mean and constant variance (NID, 0, σ^2).

RESULTS

In this study, the least squares means and standard errors for some environmental factors on CI and DP characteristics in Anatolian buffaloes are given in Table 1. CI and DP overall mean and standard error were determined as 411.37±4.10 days and 191.70±3.13 days, respectively (Table1). The effects of the county, calving year, season and parity on these characteristics were defined. In the study, the effect of all environmental factors on CI and DP, except the county, was found to be significant ($p<0.01$, $p<0.001$) (Table 1).

Table 1. Least squares means of CI and DP according to county, calving year, season, and parity of Anatolian buffalos

PARAMETER	n	Calving Interval (days)	Dry Period (days)
		Mean±SEM	Mean±SEM
Overall means	1427	411.37±4.10	191.70±3.13
County			
Altıntaş	169	412.97±6.52	192.15±4.98
Merkez	691	414.62±4.08	195.13±3.12
Tavşanlı	567	406.54±4.67	187.81±3.57
p		0.129	0.062
Calving Year			
2014-2015	83	394.61±8.88^{c}	165.39±6.78^{c}
2016-2017	369	411.10±5.22^{bc}	194.14±3.99^{b}
2018-2019	554	415.57±4.19^{ab}	205.52±3.20^{a}
2020-2021	421	424.21±4.42^{a}	201.73±3.38^{ab}
p		0.005	0.000
Calving Season			
Winter	58	452.69±9.85^{a}	221.18±7.52^{a}
Spring	584	387.58±3.88^{c}	163.40±2.96^{c}
Summer	642	383.80±3.80^{c}	173.01±2.90^{b}
Autumn	143	421.43±6.63^{b}	209.20±5.06^{a}
p		0.000	0.000
Parity			
1st	524	427.83±4.24^{a}	206.08±3.24^{a}
2nd	394	425.89±4.90^{a}	205.76±3.74^{a}
3rd	270	401.50±5.51^{bc}	183.25±4.21^{b}
4th	152	412.25±6.76^{b}	193.40±5.16^{b}
5th ≤	87	389.40±8.65^{c}	169.98±6.61^{c}
p		0.000	0.000

a, b, c : Means in a column with different superscripts differ significantly ($p<0.01$; $p<0.001$).

DISCUSSION

The CI value determined in this study (411.37±4.10 days) (Table 1) is higher than the study by Marai et al. (2009) (402.6±2.6) and Ayad et al. (2022) (393.75 days) in Egyptian buffaloes. However, it is similar to the researchers conducted by Malhado et al. (2013) (411 days) on Murrah buffaloes in Brazil and by Soysal et al. (2018) (417 days) on Anatolian buffaloes in Türkiye. On the other hand, this value determined in the study is lower than the CI determined by many other researchers. Kandasamy et al. (1993) reported (547.6±6.0 days) in Murrah buffaloes, Sanker et al. (2014) (450.24±1.53 days) reported in Murrah and Diara buffaloes In India; Charlini and Sinniah (2015) (470±4.87 days) reported Murrah, Surti, Nili-Ravi and their crossbred buffaloes in Siri-lanka; and in Anatolian buffaloes in Türkiye, Koçak et al. (2019) (450.35±2.98 days), Alkoyak and Öz (2020) (426.35±2.91 days) and Kaplan (2021) (470.08±9.32) reported.

These variations in CI may result from the differences in genotypes of buffaloes grown in the research locations, in care and feeding conditions in the enterprises, and differences in administrative practices. The average CI value in this study is very close to the ideal calving interval, which allows approximately one calf per year. This result shows that Anatolian buffaloes respond well to good management practices in the region where the breeding project is carried out.

In this study, CI was not significantly ($p>0.05$) (Table 1) affected by the county. Similar to this research, Sanker et al. (2014) reported that the region did not have a significant effect on CI in the study conducted in Murrah and Diara buffaloes in India; and, in the research on Anatolian buffaloes in Istanbul, Soysal et al. (2018) also reported that the county did not have a significant effect on CI. In this study, although the highest CI value was found in the central county, and the lowest CI value was found in the Tavşanlı county, no statistically significant difference was found between the counties. We can attribute this result to the fact that buffalo breeding in the counties where the study was conducted was carried out with similar methods.

In this research, the effect of calving year on CI was determined to be significant ($p<0.01$) (Table 1). Similar to this research, the effect of calving year on CI was reported to be significant in Anatolian buffaloes (Soysal et al. 2018, Koçak et al. 2019, Alkoyak and Öz 2020, Kaplan 2021); and in Egyptian buffaloes (Ayad et al. 2022). On the other hand, unlike this study, the effect of calving year on CI was not significant in the studies conducted by Kandasamy et al. (1993) in Murrah buffaloes in India; and in the studies by Marai et al. (2009) on Egypt buffaloes in India. The significant effect of calving year on CI can be attributed to fluctuations in environmental conditions that have changed over the years in buffalo farms, and particularly to enterprise management procedures, weather, nutritional level and feeding practices (Ahmad and Shafiq 2002). In this study, while the lowest CI values (394.61±8.88 days) were found in 2014-2015, the highest CI values (424.21±4.42 days) were obtained in 2020-2021. The current study, there is a general increase in CI values over the years. This may be due to the fact that the breeders have not paid enough attention to the heat period of the buffaloes in recent years, and preferred to obtain more milk than to make the buffaloes get pregnant.

In this study, the effect of calving season on CI was found to be significant ($p<0.001$) (Table 1). Similar to this research, the effect of calving season on CI was reported to be significant in Anatolian buffaloes (Tekerli et al. 2001, Koçak et al. 2019, Alkoyak and Öz 2020, Kaplan 2021) in Türkiye and in Egyptian buffaloes (Marai et al. 2009, Ayad et al. 2022). Unlike this study, on the other hand, in the studies by Kandasamy et al. (1993) in Murrah buffaloes in India, and by Soysal et al. (2018) in Anatolian buffaloes in Istanbul, the effect of the calving season on CI was not significant. In our research, the shortest CI period was found in buffaloes calving in summer (383.80±3.80 days), and the longest CI period was found in buffaloes calving in winter (452.69±9.85 days). Studies conducted by some researchers in Anatolian buffaloes in Türkiye have also supported this study by finding the CI period in buffaloes calving in the shortest summer and longest winter seasons (Koçak et al. 2019, Alkoyak and Öz 2020). CI which exists in buffaloes calving in the shortest spring and summer months can be explained by the fact that calving buffaloes show estrus and become pregnant in autumn and winter. In autumn and winter, the decrease in day length and air temperature may cause an increase in reproductive activity in buffaloes. As a matter of fact, it was reported in studies that oestrus is delayed in buffaloes that give birth in spring due to high temperatures, then ovarian activity resumes in the rainy season and winter months, and their pregnancies mostly coincide with the period when the day length is shortened in the autumn and winter months of the year (Sule et al. 2001, Zicarelli 2007).

In this study, the effect of parity on CI was determined to be significant ($p<0.001$) (Table 1). Similar to this research, the effect of parity on CI was reported to be significant in Anatolian buffaloes (Soysal et al. 2018, Alkoyak and Öz 2020) in Türkiye, in Murrah buffaloes (Kandasamy et al. 1993) in India, in Egyptian buffaloes (Marai et al. 2009, Ayad et al. 2022) in Egypt, in Bangladesh buffaloes (Fakruzzaman et al. 2020), in Murrah and Diara buffaloes (Sanker et al. 2014) in India, and in Venezuela (Nava-Trujillo et al. 2018). On the other hand, unlike this research, Tekerli et al. (2001)

reported that parity did not have a significant effect on CI in the study conducted in Anatolian buffaloes in Türkiye. In our study, the shortest CI period was found as (389.40±8.65 days) at 5th ≤ parity, and the longest CI period was found as (427.83±4.24 days) at 1st parity. In the study, a regular decrease was observed in CI period with increasing parity in general. This result is consistent with the reports of studies conducted by some researchers (Marai et al. 2009, Charlini and Sinniah 2015, Nava-Trujillo et al. 2018). This may be attributed to the lower reproductive performance of buffaloes in the early parity and the increase in reproductive performance due to the advancing age. As a matter of fact, Kandasamy et al. (1993) reported that the reason for the decrease in CI in later parities may result from physiological stability of buffaloes.

In the results obtained in this study, the average DP value (191.70±3.13 days) was consistent with the studies by Charlini and Sinniah (2015) in Siri-lanka in Surti (185 days) and Surti crosses (199 days) buffaloes, and by Hussain et al. (2006) (194.4±12.37 days) in Nili Ravi buffaloes in Pakistan. However, the results of the present study are lower than the values reported in the study conducted in Murrah buffaloes by Kandasamy et al. (1993) (219.3±4.7 days) in India. On the other hand, the DP value of our study was higher than the values reported by Marai et al. (2009) (148.7±2.0 days) in Egyptian buffaloes, Poudel et al. (2017) (110.9±61.4 days) in Murrah crossbred buffaloes in Nepal, Sanker et al. (2014) (144.34±0.77 days) in Murrah and Diara buffaloes in India, and by Ayad et al. (2022) in Egyptian buffaloes (98.46 days). However, if a dairy animal is to be economical, it must have a shorter DP (Poudel et al. 2017). A long DP means that the animals have reproductive problems, while a short one means that the calf to be born does not develop sufficiently and the milk yield of the animal decreases after birth. In this respect, the dry period, which affects both milk and fertility, is a feature that should be carefully considered (Karaağaç 2019).

In this study, the effect of counties where Anatolian buffaloes are raised on DP was not found significant ($p>0.05$) (Table 1). Similar to this research, Sanker et al. (2014) reported that the region did not have a significant effect on DP in a study conducted in Murrah and Diara buffaloes in India. In this study, the longest DP value was obtained in the Central county (195.13±3.12 days), while the shortest DP value was obtained in Tavşanlı (187.81±3.57 days). However, there is no statistically significant difference between the counties and this can be attributed to the similar methods of buffalo breeding and application practices in the counties. In this study, DP was significantly ($p<0.001$) (Table 1) affected by calving year. Similar to this study, Ayad et al. (2022) founded a significant effect of calving year on DP in Egyptian buffaloes. On the other hand, unlike this research, the effect of calving year on DP was not significant in the studies by Kandasamy et al. (1993) on Murrah buffaloes in India and Marai et al. (2009) on Egyptian buffaloes. In the study, the shortest DP values (165.39±6.78 days) were found in buffaloes calving in 2014-2015, and the longest DP values (205.52±3.20 days) were found in buffaloes calving in 2018-2019. In this study, a general increase was observed in DP values as the years passed, and this may be due to the habit of the breeders to dry their buffaloes off earlier than they should in recent years.

In this study, it was revealed that the effect of the season on DP was significant ($p<0.001$) (Table 1). Consistent with this study, effect of calving season on DP was reported to be significant in the studies by Kandasamy et al. (1993) on Murrah buffaloes in India, and by Ayad et al. (2022) on Egyptian buffaloes. On the other hand, unlike this research, the studies conducted by Thevamanoharan (2002) on Nili-Ravi buffaloes in Pakistan and by Marai et al. (2009) on Egyptian buffaloes showed that the effect of calving season on DP was not significant. In the current research, while the shortest DP values were obtained in buffaloes calving in spring (163.40±2.96 days) and summer (173.01±2.90 days) months, the longest DP values were obtained in buffaloes calving in autumn (209.20±5.06 days) and winter (221.18±7.52 days).

The current study, the effect of parity on DP was determined to be significant ($p<0.001$) (Table 1). Consistent with this study, many researchers supported this study by finding that the effect of parity on DP was significant (Kandasamy et al. 1993, Hussain et al. 2006, Marai et al. 2009, Sanker et al. 2014, Ayad et al. 2022). On the other hand, contrary to this research, some researchers reported that parity did not have a significant effect of parity on DP (Poudel et al. 2017, Fakruzzaman et al. 2020). In this study, the longest DP was found in the first parity (206.08±3.24 days), and the shortest DP was reached at 5th ≤ parity (169.98±6.61 days). In general, it is seen that there is a steady decrease in DP value in advancing parities (Table 1). Similar to this study, some researchers reported that there was the longest dry period in buffaloes in the first parity, and a significant shortening was observed in later parities (Kandasamy et al. 1993, Marai et al. 2009, Poudel et al. 2017, Fakruzzaman et al. 2020). These results can be attributed to the fact that the reproductive performance of buffaloes in the early parity is lower than those in the later parity and that the reproductive performance increases due to the progress of the parity. As a matter of fact, Kandasamy et al. (1993) reported that the reason for the decrease in DP in later parities may result from physiological stability of buffaloes.

CONCLUSION

In this study, the best CI and DP values were obtained at $5^{th} \leq$ parity with spring and summer seasons. In addition, according to the results of the research, it can be said that the breeders in Tavşanlı county do better practices related to care, feeding and herd management for their buffaloes. It was concluded that the significant factors that affect the reproductive performances will contribute to the increase in the productivity of the farm if they are formulated in stud selection program and if the breeders are more careful in the heat period and dry period of Anatolian buffaloes.

Conflict of Interest: The authors declare no conflict of interest.

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Ethics Committee Information: This study is not subject to HADYEK's permission in accordance with Article 8 (k) of the "Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees".

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REFERENCES

Ahmad M, Shafiq M. Effect of season on fertility rate and milk production in Nili-Ravi buffaloes. 23rd Annual Report, Livestock Prod. Res. Inst., 2002, Bahadurnagar, Okara, Pakistan.

Alkoyak K, Öz S. The effect of some environmental factors on lactation length, milk yield and calving intervals of Anatolian Buffaloes in Bartın province of Turkey. Livestock Studies, 2020; 60(2), 54-61.

Anonymous. Turkish Statistical Institute Statistics. http://www.turkstat.gov.tr/Start.do; Accession date: 08.03.2022.

Atasever S, Erdem H. Water buffalo raising and its future in Turkey, Anadolu J Agric Sci, 2008; 23(1), 59-64.

Ayad A, Abd-Allah M, Kamal M. Non-genetic factors affecting phenotypic parameters of milk production and reproductive performance in lactating Egyptian buffaloes. AASJ, 2022; 5(1), 10-24.

Bachman KC, Schairer ML. Invited review: bovine studies on optimal lengths of dry periods. J Dairy Sci, 2003; 86(10), 3027-3037.

Charlini BC, Sinniah J. Performance of Murrah, Surti,Nili-Ravi buffaloes and their crosses in the intermediate zone of Sri Lanka. LRRD, 2015; 27(3), 47.

Cicek H, Gunlu A, Tandogan M. Production function analysis of buffalo fattening enterprises in Afyonkarahisar region of Turkey. J Anim Vet Adv, 2009; 8(11), 2158-2163.

Fakruzzaman M, Sufian MKNB, Akter QS, Paul RC, et al. Effect of parity on productive and reproductive performance of buffaloes reared under farmers' management at coastal districts in Bangladesh. IOSR-JAVS, 2020; 13(4), 21-23.

Hussain Z, Javed K, Hussain SMI, Kiyani GS. Some environmental effects on productive performance of Nili-Ravi buffaloes in Azad Kashmir. J. Anim. Plant Sci. 2006; 16(3-4), 66- 69.

Kandasamy N, Lagaiathan VU, Krishnan AR. Nongenetic factors affecting calving interval and dry period of Murrah buffaloes. Buffalo Bull, 1993; 12(3), 63-65.

Kaplan Y. Yozgat İli Anadolu Mandalarında Bazı Büyüme, Üreme Ve Üretim Özelliklerini Etkileyen Genetik Ve Çevresel Faktörlerin Tahmini. Doktora Tezi, Afyon Kocatepe Üniversitesi Sağlık Bilimleri Enstitüsü, Afyonkarahisar, 2021.

Karaağaç M. Kırşehirde yetiştirilen siyah alaca sığırlarda genetik parametre tahminleri. Master's thesis, Kırşehir Ahi Evran Üniversitesi Fen Bilimleri Enstitüsü, Kırşehir, 2019.

Koçak S, Tekerli M, Çelikeloğlu K, Erdoğan M, et al. An investigation on yield and composition of milk, calving interval and repeatabilities in riverine buffaloes of Anatolia. J. Anim. Plant Sci, 2019; 29(3), 650-656.

Kumar M, Ratwan P, Patil CS, Vohra V. Influence of environmental factors on performance traits in Murrah buffaloes: A review. J. Vet. Science and Technology 2017; 6(1), 6–16.

Malhado CHM, Malhado ACM, Ramos ADA, Carneiro PLS, et al. Genetic parameters for milk yield, lactation length and calving intervals of Murrah buffaloes from Brazil. R. Bras. Zootec, 2013; 42(8), 565-569.

Marai IFM, Daader AH, Soliman AM, El-Menshawy SMS. Non-genetic factors affecting growth and reproduction traits of buffaloes under dry management housing (in sub-tropical environment) in Egypt. LRRD, 2009; 21 (3).

Minitab. Minitab statistical software version 18.1, 2017.

Nava-Trujillo H, Escalona-Muñoz J, Carrillo-Fernández F, Parra-Olivero A. Effect of parity on productive performance and calving interval in water buffaloes. J. Buffalo Sci, 2018; 7(1), 13-6.

Pasha TN, Hayat Z. Present situation and future perspective of buffaloes production in Asia. J plant Anim Science, 2012; 22, 250-256.

Poudel D, Bhattarai N, Kaphle K, Sapkota S, et al. Effect of parity on lactational efficiency of Murrah crossbred buffaloes (Bubalus bubalis) in central Nepal. Int. J. Agr. Forest, 2017; 7(6), 140-144.

Ramos AA, Malhado CHM, Carneiro PLS, Gonçalves HC, et al. Phenotypic and genetic characterization of the milk yield and calving interval in buffalo of the Murrah breed. Pesq Agropec Bras, 2006; 41(8), 1261-1267.

Sanker S, Kumar D, Mandal KG, Taggar RK, et al. Factors influencing the dry period and calving interval indifferent grades of buffaloes. Buffalo Bull, 2014; 33(1), 120-126.

Soysal Mİ, Genç S, Aksel M, Özkan Ünal E, et al. Effect of environmental factors on lactation milk yield, lactation length and calving ınterval of Anatolian buffalo in Istanbul. JASP, 2018; 1(1), 93-97.

Sule SR, Taparia AL, Tailor SS. Reproductive status of Surti buffaloes maintained under sub-humid conditions of Rajasthan. Indian Vet J, 2001; 78, 1049-1051.

Şekerden Ö. Büyükbaş Hayvan Yetiştirme (Manda Yetiştiriciliği). Temizyürek Ofset Matbaacılık, Hatay, Türkiye, 2001; pp. 1- 12.

Thevamanoharan K. Genetic analysis of performance traits of swamp and Riverine buffalo. Ph. D Thesis, Katholieke University Leuven, Belgium, 2002.

Tekerli M, Küçükkebabçı M, Akalın NH, Koçak S. Effects of environmental factors on some milk production traits, persistency and calving interval of Anatolian buffaloes. Livest Prod Sci, 2001; 68, 275–281.

Tekerli M. Manda Yıldızı data records, account and project tracking program, v5.04, 2019.

Yılmaz Adkinson A, Konca Y. *Sütçü Manda Irklarının Performans, Süt Verimini ve Kalitesini Etkileyen Faktörler ve Türkiye'deki Geleceği. EJOSAT, 2021; 25, 498-508.*

Zicarelli L. Can we consider buffalo a non-precocious and hypofertile species? Ital J Anim Sci, 2007; 6, 143–54.