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EFFECT OF NON-GENETIC FACTORS ON REPRODUCTIVE EFFICIENCY OF MEHSANA BUFFALOES MAINTAINED AT ORGANIZED FARM

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ABSTRACT

The present investigation included the data pertaining to lactation records of 301 Mehsana buffaloes, spread over a period of 30 years (1991 to 2020), collected from the records maintained at Livestock Research Station, SDAU, Sardarkrushinagar, District Banaskantha, Gujarat; to evaluate the reproduction performance of Mehsana buffaloes. The data pertaining to different performance traits was collected from the records of the farm and analysed to know the effects of non-genetic factors like- period of calving, season of calving, parity and age at first calving group on these performance traits. The LSM of AFC have been observed 1295.54±11.80 days (N=301), but it was significantly (P≤0.01) affected by the period of birth. Similarly, LSM for SP was calculated 145.72±4.98 days (N=1038) and it was significantly (P≤0.01) affected by period of calving, season of calving and parity, but AFC group did not have any effect on this trait. The LSM of DP was estimated as 213.69±9.17 days (N=869), while it was significantly (P≤0.05) affected by period of calving, but effect of season of calving and parity on this trait was highly significant (P≤0.01). Similarly, LSM of CI was observed 451.97±4.97 days (N=1054), which was significantly (P≤0.01) affected by the period of calving, season of calving and parity. Therefore, based on these observations it was concluded that significant effect of non-genetic factors play an important role to improve the reproduction performance of the Mehsana buffalo herd, therefore emphasis must be given on nutrition, management and health cover practices to improve the performance of the indigenous breed on the farm.

Keywords: *Bubalus bubalis*, buffaloes, Age calving interval, dry period, Mehsana buffaloes, non-genetic factors, service period

INTRODUCTION

India is the world's top milk-producing nation. There are four well-established buffalo breeds in Gujarat: Mehsana, Surti, Jaffarabadi, and

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Banni. The state is home to a diverse population of buffalo. There are 108.7 million buffalo in the nation overall, according to the 19th Livestock Census. According to the Annual Report for 2016 to 2017, buffalo make up about 21.23% of all livestock in India. Mehsana buffaloes are regarded as regular breeders and are among the greatest dairy breeds. The breed's genetic potential has not been fully utilized, despite the fact that it has made a substantial contribution to milk production and played a larger role in the "Operation Flood" program developed to increase milk output in India. Looking towards the contribution of buffalo, which has occupied an essential role in India's agricultural economy due to their resilience to severe weather, resistance to tropical illnesses, and have the ability to convert the poor quality roughages into the milk, meat and draught power, where important buffalo breeds originated from Gujarat and its total population is 10.5 million while total Mehsana buffalo population is 2.67 million. Among these breeds, Mehsana is well known for its characteristics like: higher milk production and "persistent milking and regular breeding" (AGRI-IS, NBAGR). It is important to remember that income from dairy enterprises largely depending on the dairy herd's ability to reproduce efficiently. At the same time, it is highly desirable to record the major economic attributes such as age at first calving, service period, dry period and calving interval of the animals kept for milk production. Therefore, precise and accurate knowledge of different economic parameters is important to plan appropriate selection, breeding, feeding and marketing strategies for improvement of the herd. Looking above facts, improvement in reproduction characteristics of indigenous breeds has become essential for keeping the dairy enterprises economically viable, while improvement in the performance of indigenous breeds can be achieved by implementing appropriate management and breeding strategies. The non-genetic factors have a great role in determining the production traits. The season or period of calving determines what animal will get to feed when the animal will be lactating like availability of fodder, temperature, humidity etc. The present study had been done to evaluate the effect of non-genetic factors on reproduction performance of Mehsana buffalo.

MATERIALS AND METHODS

The relevant data regarding present investigation was collected from the history cum pedigree sheets maintained at Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat during the period from 1991 to 2020. Geographically, Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar is located in the North Gujarat. The climate of the livestock research station is semi-arid. The animals of all age groups are reared under similar climatic conditions. Management practices followed on the farm were uniform for the herd. All animals were housed under a loose housing system with adequate sheds for shelter against sun, rain and extreme winter. All animals at the farm were stall fed with dry roughages, green fodder and concentrate in proper proportion. The animals having lactation length less than 100 days, incomplete lactation due to sale or death during lactation, abortion and still birth etc. were considered as abnormal lactation and not included in the study. The data pertaining to Mehsana buffaloes was maintained over a period of 30 years from 1991 to 2020. The data was grouped

into 6 periods with duration of 5 years *viz*. P1: 1991 to 1995, P2: 1996 to 2000, P3: 2001 to 2005, P4: 2006 to 2010, P5: 2011 to 2015 and P6: 2016 to 2020. Each year was delineated into 3 seasons each with duration of 4 months *viz*. S1: Nov-Feb (winter), S2: Mar-Jun (summer) and S3: Jul-Oct (Rainy). The records on parity were collected from history sheets of individual animals having 1st to ≥5th parities. The age at first calving group were classified based on age at first calving of Mehsana buffaloes as A1: <1151 days, A2: 1151 to 1541 days and A3: >1541 days. The traits included in the study were age at first calving, service period, dry period and calving interval. The period of calving, season of calving, parity and age at first calving group were considered as fixed effects for all reproduction traits. The least squares analysis of variance for unequal sub-class numbers (Harvey, 1990) considering six periods, three seasons, five parities and three age at first calving groups was used to analyze the data on various reproduction traits using the following statistical model. The least squares of variance analysis were done using LSML software package:

$$Y_{ijklm} = \mu + A_i + B_j + C_k + D_l + e_{ijklm}$$

Where,

Y_{ijklm} = m^{th} record of buffalo calved in i^{th} period, j^{th} season, k^{th} parity and l^{th} age at first calving group

μ = Population mean

A_i = Fixed effect of i^{th} period of calving where i = 1, 2, 3, 4, 5 and 6

B_j = Fixed effect of j^{th} season of calving where j = 1, 2 and 3

C_k = Fixed effect of k^{th} parity where k = 1, 2, 3, 4 and 5 and above

D_l = Fixed effect of l^{th} age at first calving group where l = 1, 2 and 3

e_{ijklm} = Random error assumed to be normally and independently distributed with zero mean and constant variance (NID, 0, σ^2).

The difference of means between any two subclasses of period, season, parity and age at first calving group was tested for significance using Duncan's Multiple Range Test (DMRT) as modified by Kramer (1957). Statistical model for age at first calving:

$$Yijl = \mu + Ai + Bj + eijl$$

Where,

Yijl = lth record of buffalo born in ith period and jth season

μ = Population mean

Ai = Fixed effect of ith period of birth where i = 1, 2, 3, 4, 5 and 6

Bj = Fixed effect of jth season of birth where i = 1, 2 and 3

eijl = Random error assumed to be normally and independently distributed with zero mean and constant variance (NID, 0, σ2).

RESULTS AND DISCUSSIONS

The present investigation was conducted at Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, S.K. Nagar, District-Banaskantha, Gujarat to evaluate the reproduction performance of Mehsana buffaloes maintained from 1991 to 2020. The climate of the area is semi-arid; summers are hot and dry, with highs of 40˚C; winters are mild, with average highs of 10˚C to 30˚C with morning and afternoon relative humidity levels of 69% and 48%, respectively.

To improve the productivity of dairy

animals, one must get knowledge about the variables that impact milk yield. Milk yield in dairy animals depends on various factors like non-genetic factors. The effect of non-genetic factors such as period of calving, season of calving, parity and age at first calving groups on various reproduction traits needs to be corrected for accuracy in estimation of breeding value. The least squares mean along with their standard errors for various reproduction traits in Mehsana buffaloes are presented here under the following sub-headings-

Age at first calving

The age at first calving is a crucial factor that can enhance milk production and reproductive success, as it greatly influences the number of calves a cow gives birth to in her lifetime (Ettema and Santos, 2004). From an economic perspective, it becomes important to reduce AFC in order to reduce the costs associated with raising heifers and producing milk. Therefore, under present investigation LSM of AFC was calculated and results were presented in Table 1.

The overall LSM of AFC was calculated and found 1295.54±11.80 days from 301 Mehsana buffaloes (Table 1). The reduction of AFC (162 days), over the period of 30 years shows that all the animals were kept under ideal management conditions, which will result into more number of calves per animal and reduce the feed cost. The present estimates of AFC in Mehsana buffaloes were in close agreement with Chaudhari (2003); Chaudhari (2016); Prajapati *et al.* (2017); Parmar *et al.* (2019); Gangurde *et al.* (2020) in Mehsana buffaloes; Gupta *et al.* (2012); Jamuna *et al.* (2015); Jamal *et al.* (2018) in Murrah buffaloes; Chaudhary (2015) in *Nili-Ravi* buffaloes; Pawar *et al.* (2018); Rathod *et al.* (2018) as in Surti buffaloes. On the other hand, the LSM for AFC in the present study was lower than those reported by Hussain *et al.* (2006); Bashir *et al.* (2015) in *Nili-Ravi* buffaloes; Thiruvenkadan *et al.* (2010); Chaudhary (2015) in Murrah buffaloes; Charlini and Sinniah (2015) in Murrah, Surti, *Nili-Ravi* buffaloes and their crosses; Galsar *et al.* (2016a) in Mehsana buffaloes.

The LSM of AFC of Mehsana buffaloes during different periods of calving *viz.* P1, P2, P3, P4, P5 and P6 were 1348.90±23.66 days, 1338.70±21.35 days, 1324.39±22.18 days, 1372.11±22.45 days, 1202.78±23.28 days and 1186.36±35.65 days, respectively (Table 1). In the present investigation, the period of birth had a highly significant ($P \leq 0.01$) effect on AFC. However, a mean comparison of AFC revealed that it was highest in P4 (1372.11±22.45 days) and lowest in P6 (1186.36±35.65 days), but there were no significant differences among P1, P2, P3 and P4 and P5 and P6. The present findings of highly significant ($P \leq 0.01$) effect of period of birth on AFC is in the line of findings of Thiruvenkadan *et al.* (2010) in Murrah buffaloes; Galsar *et al.* (2016a); Prajapati *et al.* (2017); Parmar *et al.* (2019) in Mehsana buffaloes. However, significant ($P \leq 0.05$) effect of period of birth on AFC was reported by Chaudhary (2015); Jamal *et al.* (2018) in Murrah buffaloes; Chaudhari (2003); Gangurde *et al.* (2020) in Mehsana buffaloes. Conversely, Jamuna *et al.* (2015); Chaudhary (2015) in *Nili-Ravi* buffaloes further observed non-significant effect of period of birth on AFC.

The least squares analysis of variance conveyed that season of birth had non-significant effect on AFC in the present investigation on Mehsana buffaloes (Table 1). The buffaloes born during winter and rainy season have longer AFC (1316.72±17.47 and 1317.97±12.74 days, respectively) than born during summer (1251.94±26.93 days) season. The present findings of non-significant

effect of season of birth were in accordance with Hussain *et al.* (2006) in *Nili-Ravi* buffaloes and Chaudhary (2015) in Murrah buffaloes. Contrary to the present findings, significant effect of season of birth on AFC was reported by Jamuna *et al.* (2015); Jamal *et al.* (2018) in Murrah buffaloes; Chaudhary (2015) in *Nili-Ravi* buffaloes; Chaudhari (2003); Galsar *et al.* (2016a); Prajapati *et al.* (2017); Parmar *et al.* (2019) in Mehsana buffaloes.

Service period

This is the time interval from the date of the calving to the next successful conception. Generally, a service period of 60 days is highly desirable. It is generally regarded as the function of induction and regularity of estrus, excluding managemental and environmental factors.

The overall LSM of SP was estimated as 145.72±4.98 days (n=1038), which was decreased from 182.36±8.30 to 123.40±7.36 days (Table 1). The buffaloes calving for the first time had longest SP, then decreased thereafter. The present findings of SP were close to the findings of Chaudhary (2015) in *Nili-Ravi* buffaloes; Chaudhary (2015); Jamuna *et al.* (2015); Jakhar *et al.* (2016); Jamal *et al.* (2018) in Murrah buffaloes; Galsar *et al.* (2016a); Chaudhari (2016); Bhatt (2019) in Mehsana buffaloes. Comparatively, higher estimates of SP than the present findings were obtained by Thrivenkadan *et al.* (2010); Gupta *et al.* (2012); Thrivenkadan *et al.* (2014) in Murrah buffaloes; Hussain *et al.* (2006) as and Bashir *et al.* (2015) in *Nili-Ravi* buffaloes; Prajapati (2017) l; Parmar *et al.* (2017); Sathwara (2018) in Mehsana buffaloes.

The LSM of SP of Mehsana buffaloes during different periods of calving *viz.* P1, P2, P3, P4, P5 and P6 were 164.98±7.84 days, 114.98±9.49 days, 131.59±9.05 days, 144.00±8.95 days, 148.81±9.76 days and 169.95±10.77 days, respectively (Table 1). The present estimates of highly significant (P≤0.01) effect of period of calving on SP is on the line of those reported by Thrivenkadan *et al.* (2010); Thrivenkadan *et al.* (2014) Murrah buffaloes; Galsar *et al.* (2016a) in Mehsana buffaloes. Similar significant (P≤0.05) effects of period of calving reported by Jamuna *et al.* (2015) in Murrah buffaloes; Chaudhary (2015); Bashir *et al.* (2015) in *Nili-Ravi* buffaloes; Chaudhari (2016); Prajapati (2017); Sathwara (2018); Bhatt (2019) in Mehsana buffaloes. Conversely, Chaudhary (2015); Jakhar *et al.* (2016); Jamal *et al.* (2018) in Murrah buffaloes observed as non-significant effect of period of calving on SP. The mean comparison of SP by DMRT showed that there was no significant difference in SP between P1 and P6, P2 and P3 and P4 and P5.

The effects of season of calving had highly significant effect on SP of Mehsana buffaloes. However, mean comparison of SP by DMRT revealed that buffaloes calving during summer (S2) season have highest SP as 182.02±11.27 days and lowest SP as 114.94±5.00 days reported during rainy (S3) season (Table 2). The present findings of highly significant (P≤0.01) effect of season of calving on SP was in accordance with those reported by Thrivenkadan *et al.* (2010); Thrivenkadan *et al.* (2014); Jamuna *et al.* (2015; Chaudhary (2015); Jamal *et al.* (2018) in Murrah buffaloes; Chaudhari (2016); Prajapati (2017) Mehsana buffaloes. A similar significant (P≤0.05) effect of season of calving was reported by Chaudhary (2015); Bashir *et al.* (2015) in *Nili-Ravi* buffaloes, Jakhar *et al.* (2016); Gunwant *et al.* (2019) in Murrah buffaloes. On the other hand, the non-significant effect of season of calving on SP was estimated by Hussain *et al.* (2006) in *Nili-Ravi* and Galsar *et al.* (2016a) in Mehsana buffaloes.

The least squares means of SP observed

under different parities *viz*. L1, L2, L3, L4 and ≥L5 were 182.36±8.30, 152.44±8.00, 144.66±8.94, 125.73±9.86 and 123.40±7.36 days, respectively (Table 3). The effects of parity on SP were highly significant (P≤0.01) in the present study on Mehsana buffaloes. The mean comparison of SP by DMRT showed that there were significant differences in SP between L1 and ≥L5 parities, whereas non-significant differences among L2, L3 and L4 and L4 and ≥L5 parities. The effects of parity on SP were highly significant (P≤0.01) in the present study on Mehsana buffaloes. The present findings of highly significant (P≤0.01) effect of parity on SP was in close agreement with that of Thrivenkadan *et al*. (2014); Jamuna *et al.* (2015); Chaudhary (2015); Jakhar *et al*. (2016); Jamal *et al.* (2018) in Murrah buffaloes; Bashir *et al.* (2015); Chaudhary (2015) in *Nili-Ravi* buffaloes; Galsar *et al.* (2016a) in Mehsana buffaloes. Conversely, Hussain *et al.* (2006) reported non-significant effect of parity on SP of *Nili-Ravi* buffaloes, which is opposite to the present findings.

The analysis of variance revealed that AFC group had non-significant effect on SP of Mehsana buffaloes. However, SP was lowest (142.84±5.59 days) in A-2 group and highest in A1 (152.09±9.40 days) group (Table 4). The present findings of non-significant effect of age at first calving group on SP are in accordance with the reports of Thrivenkadan *et al*. (2010); Chaudhary (2015) in Murrah buffaloes; Chaudhary (2015) in *Nili-Ravi* buffaloes. Contrary to the present findings, Jamuna *et al.* (2015) in Murrah buffaloes; Sathwara (2018); Bhatt (2019) in Mehsana buffaloes reported significant effect of AFC group on SP.

Dry period

It is the time between the date of drying and the subsequent calving when the cow is not producing milk. It is an important reproductive trait of lactating animals and the most important phase of any dairy animal's lactation cycle. If the DP is more, then it will reduce the economic returns from the dairy farming enterprises. During this phase, the animal and its udder prepared for the next lactation, therefore if there is any change in the dry period will have a negative effect on the animal's health and milk yield in subsequent calving.

The overall LSM of DP was observed 213.69±9.17 days (n=869), which was decreasing from 357.08±35.18 to 159.77±7.91 days (Table 3). The decline in DP about 197.31 days over a period of 30 years might be due to better management, ideal health and breeding services and used of improved germplasm on the farm. The present findings of Mehsana buffaloes are in accordance with the findings of Bharat *et al.* (2004); Chaudhari (2016) in Mehsana buffaloes; Bharat *et al.* (2004); Rathod *et al.* (2018) in Surti buffaloes. However, higher estimates of DP were reported by Thrivenkadan *et al*. (2010); Thrivenkadan *et al*. (2014) in Murrah buffaloes. Comparatively lower estimates of DP were reported by Charlini and Sinniah (2015) in Murrah, Surti and *Nili-Ravi* buffaloes; Chaudhary (2015) in *Nili-Ravi* buffaloes; Chaudhari (2003); Galsar *et al.* (2016a) in Mehsana buffaloes; Jakhar *et al.* (2016); Jamal *et al.* (2018) in Murrah buffaloes.

The LSM of DP of Mehsana buffaloes during different periods of calving *viz*. P1, P2, P3, P4, P5 and P6 were 220.26±11.68, 196.02±12.71, 196.19±12.58, 206.23±12.10, 239.82±13.15 and 223.64±17.56 days, respectively (Table 1). The effects of period of calving had significant (P≤0.05) effect on DP of Mehsana buffaloes. The ANOVA revealed that the highest DP was in P5 (239.82±13.15 days) and lowest DP in P3 (196.19±12.58 days). The mean comparison of DP

by DMRT showed that there were no significant differences among P1, P5 and P6 and P2, P3 and P4. Similarly, a significant (P≤0.05) effect of period of calving was reported by Thrivenkadan *et al.* (2010) in Murrah buffaloes. However, Chaudhari (2003); Bharat *et al.* (2004); Chaudhari (2016) in Mehsana buffaloes; Thrivenkadan *et al.* (2014); Jamal *et al.* (2018) in Murrah buffaloes reported highly significant (P≤0.01) effect of period of calving on DP. Contradictory to present findings, non-significant effect of period of calving on DP has been reported by Chaudhary (2015) in *Nili-Ravi* buffaloes and Galsar *et al.* (2016a) in Mehsana buffaloes. The differences in the values of DP among the different periods may be due to the variations in the management practices and environmental conditions from period to period.

The effects of season of calving had highly significant (P≤0.01) effect on DP of Mehsana buffaloes (Table 2). The dry period of Mehsana buffaloes in present study was significantly highest (252.94±15.05 days) during summer (S2) season calvers and lowest (190.91±9.30 days) during rainy (S3) season calvers. The present estimates were in proximity with the reports of Chaudhari (2003); Bharat *et al.* (2004); Galsar *et al.* (2016a); Chaudhari (2016) in Mehsana buffaloes; Bharat *et al.* (2004) in Surti buffaloes; Chaudhary (2015) in *Nili-Ravi* buffaloes; Thrivenkadan *et al.* (2014); Jamal *et al.* (2018) in Murrah buffaloes.

The least squares means of DP were observed under different parities *viz.* L1, L2, L3, L4 and ≥L5 and corresponding values were 357.08±35.18, 201.51±9.26, 182.67±10.39, 167.44±11.13 and 159.77±7.91 days, respectively (Table 3). The effects of parity on DP were observed highly significant (P≤0.01) on Mehsana buffaloes. The highest DP was observed in 1st parity though the lowest DP in ≥5th parities. However, there is decreasing trend in DP was observed among different parities. The present estimates of highly significant (P≤0.01) effect of parity on DP is in close agreement with those reported by Chaudhari (2003); Bharat *et al.* (2004) in Mehsana buffaloes; Bharat *et al.* (2004) in Surti buffaloes; Chaudhary (2015) in *Nili-Ravi* buffaloes; Thrivenkadan *et al.* (2014); Jakhar *et al.* (2016) in Murrah buffaloes. Alternatively, Galsar *et al.* (2016a) in Mehsana and Jamal *et al.* (2018) in Murrah observed parity had non-significant effect on DP.

The ANOVA revealed that AFC group did not have any effect on DP of Mehsana buffaloes. However, it was the lowest as 203.09±13.84 days in A3 and highest as 227.53±12.23 days in A1 group (Table 4). The present findings of non-significant effect of AFC group on DP was in accordance with the reports of Thrivenkadan *et al.* (2010) in Murrah buffaloes and Chaudhary (2015) in *Nili-Ravi* buffaloes. The better reproductive management and nutrition of the herd will help in decreasing the duration of DP. This may also get affected with the lactation length and calving interval.

Calving interval

The overall LSM of CI was found 451.97±4.97 days (n=1054), which was decreased from 489.94±8.28 to 428.09±7.29 days (Table 4). Therefore, to manage the reproductive efficiency of the dairy animals properly, animals should be fed sufficiently according to their nutrient requirement, then the CI can be reduced considerably by adopting suitable management practices.

The present findings of Mehsana buffaloes were in close proximity with those reported by Chaudhari (2003) in Mehsana buffaloes; Hussain *et al.* (2006) in *Nili-Ravi* buffaloes; Chaudhary (2015) in *Nili-Ravi* buffaloes; Charlini and Sinniah (2015) in Murrah, Surti, *Nili-Ravi* buffaloes; Chaudhary

(2015); Jakhar *et al.* (2016); Jamal *et al.* (2018) in Murrah buffaloes; Rathod *et al.* (2018) in Surti buffaloes.

Comparatively, higher estimates of CI than the present findings have been reported by Bharat *et al.* (2004) in Surti buffaloes; Thiruvenkadan *et al.* (2010); Gupta *et al.* (2012); Thrivenkadan *et al.* (2014) in Murrah buffaloes; Bharat *et al.* (2004); Chaudhari (2016); Parmar *et al.* (2017) in Mehsana buffaloes.

The LSM of CI of Mehsana buffaloes were calculated during different periods of calving and found that during the period *viz.* P1, P2, P3, P4, P5 and P6 correspondence values were 471.58±7.86, 421.33±9.57, 438.37±8.90, 452.57±8.89, 454.23±9.71 and 473.75±10.86 days, respectively (Table 1). It can be seen from the ANOVA that the period of calving had a highly significant (P≤0.01) effect on CI of Mehsana buffaloes. However, there was an increasing trend in calving interval after the completion of 1st period. In the present study, the highest CI was observed during P6 and lowest CI was recorded during P2. The mean comparison of CI by DMRT revealed that there were no significant differences among P1 and P6, P2 and P3 and P4 and P5. The present findings are in close agreement with the reports of Chaudhari (2003); Bharat *et al.* (2004); Chaudhari (2016) in Mehsana buffaloes; Thiruvenkadan *et al.* (2010); Thrivenkadan *et al.* (2014) in Murrah buffaloes.

However, contrary to the present findings, Chaudhary (2015) in *Nili-Ravi* buffaloes; Galsar *et al.* (2016a) in Mehsana buffaloes; Chaudhary (2015); Jamal *et al.* (2018) in Murrah buffaloes reported non-significant effect of period of calving on CI.

In the present investigation it was observed that effects of season of calving had highly significant (P≤0.01) effect on CI of Mehsana buffaloes (Table 2). However, it was highest (487.14±11.30 days) in summer (S2) season calvers and lowest (421.64±4.95 days) in rainy (S3) season calvers.

The present findings are in accordance with the reports of Chaudhari (2003); Chaudhari (2016); Galsar *et al.* (2016a) in Mehsana buffaloes; Chaudhary (2015) in *Nili-Ravi* buffaloes; Chaudhary (2015); Thrivenkadan *et al.* (2014); Jamal *et al.* (2018) in Murrah buffaloes. Conversely, Hussain *et al.* (2006) reported non-significant effect of season of calving-on-calving interval of *Nili-Ravi* buffaloes.

The least squares mean of CI were observed under different parities *viz.* L1, L2, L3, L4 and ≥L5 were 489.94±8.28, 459.92±8.02, 448.31±8.99, 433.60±9.82 and 428.09±7.29 days, respectively (Table 3). The effects of parity on CI were highly significant (P≤0.01) of Mehsana buffaloes. However, it was highest in the 1st parity and lowest in the 5th and above parities. As the parity increases, CI decreases gradually, it means that we can get more number of progenies in her lifetime considering better management practices at the farm, which realized from the observations that there were significant differences among L1, L2 and ≥L5 parities.

The present findings of highly significant (P≤0.01) effects of parity on CI is in equivalence with those reported by Hussain *et al.* (2006); Chaudhary (2015) in *Nili-Ravi*; Charlini and Sinniah (2015) in Murrah, Surti, *Nili-Ravi* buffaloes; Chaudhary (2015); Thrivenkadan *et al.* (2014); Jamal *et al.* (2018) in Murrah buffaloes; Chaudhari (2003); Galsar *et al.* (2016a) in Mehsana buffaloes.

The analysis of variance revealed that AFC group did not have any effect on CI of Mehsana buffaloes (Table 4). However, the gradually slight decline of CI from A-1 group (460.24±9.25 days)

Table 1. Effect of Period on Reproduction Traits of Mehsana buffaloes.

S.N.	Factors	Age at first calving (days)	Service period (days)	Dry period (days)	Calving interval (days)
1	Population Mean (μ±S.E.)	1295.54±11.80 (301)	145.72±4.98 (1038)	213.69±9.17 (869)	451.97±4.97 (1054)
2	Period of calving	**	**	*	**
	P1	1348.90±23.66 (51)^{a}	164.98±7.84 (222)^{a}	220.26±11.68 (188)^{ab}	471.58±7.86 (225)^{a}
	P2	1338.70±21.35 (63)^{a}	114.98±9.49 (172)^{c}	196.02±12.71 (159)^{c}	421.33±9.57 (171)^{c}
	P3	1324.39±22.18 (60)^{a}	131.59±9.05 (196)^{bc}	196.19±12.58 (169)^{bc}	438.37±8.90 (203)^{bc}
	P4	1372.11±22.45 (53)^{a}	144.00±8.95 (189)^{b}	206.23±12.10 (192)^{b}	452.57±8.89 (193)^{ab}
	P5	1202.78±23.28 (53)^{b}	148.81±9.76 (135)^{ab}	239.82±13.15 (109)^{a}	454.23±9.71 (139)^{ab}
	P6	1186.36±35.65 (21)^{b}	169.95±10.77 (124)^{a}	223.64±17.56 (52)^{ab}	473.75±10.86 (123)^{a}

Note: Figures in parenthesis indicates number of observation/records, **P<0.01 highly significant; *P<0.05 significant; NS = Non significant; S.E = Standard Error; Subclass means with different superscripts are significantly different from each.

Table 2. Effect of season on reproduction traits of Mehsana buffaloes.

S.N.	Factors	Age at first calving (days)	Service period (days)	Dry period (days)	Calving interval (days)
1	Population Mean (μ ± S.E.)	1295.54±11.80 (301)	145.72±4.98 (1038)	213.69±9.17 (869)	451.97±4.97 (1054)
2	Season of calving	NS	**	**	**
	S1	1316.72±17.47 (90)	140.19±6.43 (321)^{b}	197.23±9.91 (286)^{b}	447.13±6.41 (325)^{b}
	S2	1251.94±26.93 (37)	182.02±11.27 (96)^{a}	252.94±15.05 (82)^{a}	487.14±11.30 (97)^{a}
	S3	1317.97±12.74 (174)	114.94±5.00 (621)^{c}	190.91±9.30 (501)^{c}	421.64±4.95 (632)^{c}

Note: Figures in parenthesis indicates number of observation/records, **P<0.01 highly significant; *P<0.05 significant; NS= Non significant; S.E= Standard Error; Subclass means with different superscripts are significantly different from each.

Table 3. Effect of parity on reproduction traits of Mehsana buffaloes.

S.N.	Factors	Age at first calving (days)	Service period (days)	Dry period (days)	Calving interval (days)
1	Population mean (μ ± S.E.)	1295.54±11.80 (301)	145.72±4.98 (1038)	213.69±9.17 (869)	451.97±4.97 (1054)
2	Parity		**	**	**
	L1	-	182.36±8.30 (229)^{a}	357.08±35.18 (11)^{a}	489.94±8.28 (233)^{a}
	L2	-	152.44±8.00 (225)^{b}	201.51±9.26 (231)^{ab}	459.92±8.02 (225)^{b}
	L3	-	144.66±8.94 (173)^{bc}	182.67±10.39 (164)^{b}	448.31±8.99 (173)^{bc}
	L4	-	125.73±9.86 (139)^{cd}	167.44±11.13 (139)^{bc}	433.60±9.82 (143)^{cd}
	≥L-5	-	123.40±7.36 (272)^{d}	159.77±7.91 (324)^{c}	428.09±7.29 (280)^{d}

Note: Figures in parenthesis indicates number of observation/records,**P<0.01 highly significant; *P<0.05 significant; NS = Non significant; S.E. = Standard Error; Subclass means with different superscripts are significantly different from each.

Table 4. Effect of AFC group on Reproduction Traits of Mehsana buffaloes

S.N.	Factors	Age at first calving (days)	Service period (days)	Dry period (days)	Calving interval (days)
1	Population mean (μ ± S.E.)	1295.54±11.80 (301)	145.72±4.98 (1038)	213.69±9.17 (869)	451.97±4.97 (1054)
2	AFC group		NS	NS	NS
	A1	-	152.09±9.40 (147)	227.53±12.23 (151)	460.24±9.25 (155)
	A2	-	142.84±5.59 (623)	210.46±9.03 (621)	449.15±5.61 (626)
	A3	-	142.22±7.74 (268)	203.09±13.84 (97)	446.53±7.72 (273)

Note: Figures in parenthesis indicate number of observation/records,**P<0.01 highly significant; *P<0.05 significant; NS = Non significant; S.E= Standard Error; Subclass means with different superscripts are significantly different from each.

to A-3 group (446.53±7.72 days) shows that there is scope of improvement in future, if improved management practices are to be adopted on the farm. As age at first calving increases, gradually decreases the CI. But, AFC have more impact on profitability on the dairy farm and it is also considered as an essential factor to ascertain the overall production performance of the animal. It can be used as an indicator of fertility and productivity. The present estimates similar to the reports of Thiruvenkadan *et al.* (2010) in Murrah and Chaudhary (2015) in *Nili-Ravi* buffaloes. Conversely, significant effect of AFC group on CI of Murrah buffaloes reported by Chaudhary (2015).

CONCLUSION

On the basis of results obtained in the study, we can conclude that steady improvement in reproduction traits viz: AFC, DP and CI of Mehsana buffaloes maintained under organized herd during the period of assessment, shows that improvement of these traits might be due to better, feeding, breeding, health care and proper culling strategies followed on the farm. However, season of calving, period of calving and parity have significant impact on the performance of the herd, hence such non genetic factors must be taken into consideration in future, for further improvement of the herd.

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REFERENCES

Animal Genetic Resources of India (AGRI-IS). *Mehsana buffalo*. Developed at ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India. Available on: http://14.139.252.116/agris/breed.aspx

Bashir, M.K., M.I. Mustafa, M. Lateef, M.F. Khalid, S. Rehman and U. Farooq. 2015. Reproductive performance of *Nili-Ravi* buffaloes kept under farm conditions in Pakistan. *Pakistan Journal of Life and Social Sciences*, **13**(2): 104-109.

Bharat, N.K., P.C. Thapan and G.C. Gahlot. 2004. Production and reproduction performance of light breed of buffaloes. *Indian J. Anim. Sci*., **74**(5): 527-529.

Bhatt, T.M. 2019. *Genetic evaluation of Mehsana buffaloes based on various lactation curve models*. M.V.Sc. Thesis, Sardarkrushinagar Dantiwada Agricultural University, Gujarat, India.

Charlini, B.C. and J. Sinniah. 2015. Performance of Murrah, Surti, *Nili-Ravi* buffaloes and their crosses in the intermediate zone of Sri Lanka. *Livestock Research for Rural Development*, **27**(3).

Chaudhari, J.D. 2016. *Genetic evaluation of Mehsana buffaloes under field progeny testing programme in Mehsana district*. M.V.Sc. Thesis, Sardarkrushinagar Dantiwada Agricultural University, Gujarat, India.

Chaudhari, R.U. 2003. *Persistency of Milk*

Production in Mehsana Buffaloes. M.V.Sc. Thesis, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India.

Chaudhary, M. 2015. *Genetic studies on production, fertility and longevity traits in Murrah and Nili-Ravi buffaloes*. Ph.D. Thesis, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, India.

Ettema, J.F. and J.E.P. Santos. 2004. Impact of age at calving on lactation, reproduction, health, and income in first-parity Holsteins on commercial farms. *J. Dairy Sci*., **87**(8): 2730-2742. DOI: 10.3168/jds.S0022-0302(04)73400-1

Galsar, N.S., R.R. Shah, J.P. Gupta, D.P. Pandey, K.B. Prajapati and J.B. Patel. 2016a. Analysis of first production and reproduction traits of Mehsana buffaloes maintained at tropical and semi-arid region of Gujarat, India. *Life Sciences Leaflet*, **77**: 65-75.

Gangurde, N., N. Shinkar, V. Potdar, P. Solanki, J. Mori and A. Juneja. 2020. Study of age at first calving in Mehsana buffalo. *In National Symposium on Enhancement of Farmer's Income Through Management of Animal Genetic Resources*. Madhya Pradesh, India.

Gunwant, P., A.K. Pandey, R. Kumar and P. Kumar. 2019. Effect of season of calving on reproductive characteristics of Murrah buffalo at organized dairy farm. *Pharma Innovation Journal*, **8**(2): 435-436. Available on: https://www.thepharmajournal.com/archives/2019/vol8issue2/PartG/8-2-41-854.pdf

Gupta, J.P., G.K. Sachdeva, R.S. Gandhi and A.K. Chakarvarty. 2012. Non-genetic factors influencing growth and production performance in Murrah buffaloes. *Indian J. Dairy Sci*., **65**(3): 239-241. DOI: 10.5146/IJDS.V65I3.26094.G11979

Harvey, W.R. 1990. *User's Guide for LSMLWM and MIXMDL PC-2 Version*, Mixed Model Least-Squares and Maximum Likelihood Computer Programme, Ohio, USA.

Hussain, Z., K. Javed, S.M.I. Hussainn and G.S. Kiyani. 2006. Reproductive performance of *Nili-Ravi* buffaloes in Azad Kashmir, Pakistan. *Journal of Animal Plant Science*, **16**(1-2). Available on: https://thejaps.org.pk/docs/16_1-2_2006/Hussain.pdf

Jakhar, V., A.K. Vinayak and K.P. Singh. 2016. Genetic evaluation of performance attributes in Murrah buffaloes. *Haryana Veterinarian*, **55**(1): 66-69.

Jamal, I., R.K. Mehla, S. Yousuf, A. Naik and K.P. Japeth. 2018. Effect of non-genetic factors on various reproduction traits in Murrah buffaloes. *Indian J. Dairy Sci*., **71**(2): 193-197.

Jamuna, V., C.S. Patil and A.K. Chakravarty. 2015. Influence of Non-genetic factors on performance traits in Murrah buffaloes. *Indian J. Anim. Res*., **49**(3): 279-283. DOI: 10.5958/0976-0555.2015.00089.8

Kramer, C.Y. 1957. Extension of multiple range tests to group correlated adjusted means. *Biometrics*, **13**(1): 13-18. DOI: 10.2307/3001898

Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries. 2017. Annual Report. 2016-2017. *Basic Animal Husbandry and Fisheries Statistics*, Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, Krishi Bhawan, New Delhi, India.

Parmar, G.A., J.P. Gupta, D.P. Pandey, J.D. Chaudhari, B.M. Prajapati, R.N. Sathwara

and P.A. Patel. 2017. Genetic and non-genetic factors affecting reproduction traits in Mehsana buffaloes. *Life Sciences Leaflets*, **92**: 61-69.

Parmar, G.A., J.P. Gupta, J.D. Chaudhari, D.P. Pandey, B.M. Prajapati, R.N. Sathwara and P.A. Patel. 2019. Study of genetic and non genetic factors affecting age at first calving and wet average in Mehsana buffaloes. *Buffalo Bull*., **38**(1): 11-17. Available on: https://kukrdb.lib.ku.ac.th/journal/BuffaloBulletin/search_detail/result/387357

Pawar, V.D., N.S. Dangar, U.V. Ramani, G.M. Pandya, V.B. Kharadi and B.P. Brahmkshtri. 2018. Non genetic factors affecting age at first calving in Surti buffaloes. *International Journal of Livestock Research*, **8**(1): 43-48. DOI: 10.5455/ijlr.20170808085353

Prajapati, B.M. 2017. *Genetic evaluation of Mehsana buffalo bulls for first lactation fat energy corrected milk production*. M.V.Sc. Thesis, Sardarkrushinagar Dantiwada Agricultural Univeresity, Gujarat, India

Prajapati, B.M., J.P. Gupta, D.P. Pandey, J.D. Chaudhari, G.A. Parmar, P.A. Patel, M.N. Prajapati and R.N. Sathwara. 2017. Non genetic factors affecting age at first calving in Mehsana buffaloes. *Life Sciences Leaflets*, **87**: 8-15.

Prajapati, B.M., J.P. Gupta, J.D. Chaudhari, G.A. Parmar, H.H. Panchasara, H.D. Chauhan, K.J. Ankuya and M.N. Prajapati. 2018. First lactation production performance of Mehsana buffaloes under field progeny testing programme in semi-arid region of Gujarat. *Indian J. Dairy Sci*., **71**(4): 404-408.

Rathod, A.S., M.S. Vaidya and S.S. Ali. 2018. Genetic studies of productive and reproductive attributes of Surti buffalo in Maharashtra. *International Journal of Livestock Research*, **8**(08): 309-314.

Sathwara, R.N. 2018. *Univariate versus bivariate models for genetic evaluation of Mehsana buffaloes using first lactation production and fertility traits.* M.V.Sc. Thesis, Sardarkrushinagar Dantiwada Agricultural University, Gujarat, India.

Sathwara, R.N., J.P. Gupta, J.D. Chaudhari, G.A. Parmar, B.M. Prajapati, A.K. Srivastava, H.D. Chauhan, P.A. Patel and M.N. Prajapati. 2020. Analysis of association between various fertility indicators and production traits in Mehsana buffaloes. *Trop. Anim. Health Pro*., **52**: 2585-2592. DOI: 10.1007/s11250-020-02288-5

Thiruvenkadan, A.K., S. Panneerselvam, N. Murali, S. Selvam and V.R. Saravanakumar. 2014. Milk production and reproduction performance of Murrah buffaloes of Tamil nadu, India. *Buffalo Bull*., **33**: (3): 291-300. Available on: https://kukrdb.lib.ku.ac.th/journal/BuffaloBulletin/search_detail/result/286493

Thiruvenkadan, A.K., S. Panneerselvam, R. Rajendran and N. Murali. 2010. Analysis on the productive and reproductive traits of Murrah buffalo cows maintained in the coastal region of India. *Applied Animal Husbandry and Rural Development*, **3**(1): 1-5.