Effect of Calving Interval on Milk Yield in Italian Buffalo Population

E. Parlato[1,*] and L. Zicarelli[2]

[1]M'ama Buffalo Welfare Science and Technology, via G. Alviani, 31 Capua, ITA, Italy

[2]Animal Production Department, Faculty of Veterinary, University of Naples Federico II, ITA, Italy

Abstract: The objective of this study was to investigate the effect of the previous calving intervals (CI) on milk yield (MY) in the current lactation for the Italian buffalo breed population.

Data for 86,585 lactation records from the Italian Buffalo Breeders Association database, were analyzed. MY BLUP-estimates were obtained by including in the Animal Model the fixed effects of age-parity, previous CI, and herd-contemporary-group. The MY solutions for the months of CI were analyzed with the linear regression model where CI in months was the explanatory variable. 59.66% of the lactation records had CI between 11 and 14 months. 37.91 % of the lactation records were distributed between 15 and 24 months. The smaller percentage of records showed CI greater than 24 months. This CI distribution may be, in part, the result of herd management strategies. Dairy producers try to shorten the CI of their herd in order to get the most profit from early conceptions of the buffalo. The regression model and its parameters were statistically significant. The coefficient of determination was equal to 0.58. The intercept was equal to 72.42 kg; and the linear coefficient (b) was equal to -3.43. The negative value of b denotes a negative effect of CI on MY. This result indicates that there is a negative linear relationship between previous CI and MY in the current lactation. Therefore, shorten the CI may increase the profits of the farm through higher MY, because it has less of a negative effect on MY than longer CI.

Keywords: Italian Mediterranean Buffalo, milk yield, calving interval.

INTRODUCTION

Calving interval is the fertility index widely used at the small farm level for Italian buffalo. Under herd conditions, a buffalo usually produces two calves in three years. But in well- managed herds of dairy buffalo, calving intervals of 11-12 months have been achieved. In dairy cows, calving interval is highly dependent on year and season of breeding [1, 2] and on farm management and herd size [3]. Increases in the interval from the first to the sixth lactation was observed in the US dairy population [4]. Although, Syed M. *et al*. [5] showed higher calving intervals in primiparous then in pluriparous buffalo. Other factors that may affect the length of calving intervals in buffalo, are conception rate [6], buffalo age [6, 7], and service sire [8]. In dairy cows, high milk production lead to longer calving intervals [9, 10, 11].

Prolonged calving interval in buffalo is primarily related to delayed breeding. Breeding may be delayed by prevalence of silent estrus, summer infertility, low progesterone levels [12], lower LH levels [13] and suckling [14]. Seasonality of breeding and nutritional status are additional contributing factors [15, 16]. Month of calving had significant effects on calving interval in the Italian buffalo population [17]. Females that calved between April and September had shorter intervals than those calving between October and December [17]. Because buffalo are less sensitive to high temperatures than bovine, they tend to reproduce more efficiently during the warmest months of the year [17].

The general practice in both buffalo and bovine dairy herds with intensive milk production, is to breed cows with the aim of establishing a calving interval of 12 months. This traditional breeding system is based on the idea that the production economy benefits from an early conception [18, 19, 20]. In order to shorten the calving interval, the female should be bred as soon as possible after calving. However, the relationship between time intervals from calving to eventual conception and various physiological, environmental, and management features make it difficult to determine how to manage for optimum length of calving interval. High milk yields and 12 month calving intervals cause general concerns about metabolic diseases. It has been shown that increasing milk yield leads to an increase in the frequencies of metabolic diseases, such as ketosis and milk fever [21]. Cows with short calving intervals tend to be discarded after just one or two lactations. The most common reason for culling is fertility problems, which account for as much as 25% of the culled cows [22]. Even though several studies suggest an optimal calving interval of near 12 months, there are studies that have shown an advantage for a longer period of days open and, consequently, an extended calving interval [23]. Gaines W. L. and Palfrey G.R [24] found a negative correlation between

*Address correspondence to this author at the M'ama Buffalo Welfare Science and Technology, via G. Alviani, 31 Capua, ITA, Italy; Tel: 00393898853266; E-mail: manup9@gmail.com

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calving interval and milk yield. Increases in calving intervals over time have been reported in dairy cow populations in many countries, including Spain [25], and the United Kingdom [26]. Although the economic importance of Italian buffalo has always been known, very little work has been done to evaluate the effect of the previous calving interval on milk yield on the current lactation in the buffalo species.

The objective of this study was to evaluate the effect of the previous calving interval on milk yield in the current lactation for the Italian buffalo breed population.

MATERIALS AND METHODS

Data

Data for 86,585 lactation records from the Italian Buffalo Breeders Association (ANASB) database, were used to determine the effect of previous calving intervals (CI) on milk yield (MY) for the Mediterranean Italian buffalo breed. Only records from buffalo with a calving date after December 31, 1980, were included in the analyses. All records were extended to 270 days for lactations less than 270 days. Editing consisted of accepting only lactation records of buffalo having more than 150 or less than 570 days of lactation and having, in the current lactation, calving to conception intervals (days open) between 20 and 730 days. Parities were grouped into three different classes: parities 1, 2 and ≥ 3. Days open (DO) in the current lactation was approximated by taking the difference between two consecutive calving intervals and subtracting the length of the average buffalo gestation period (310 days). For first lactations an average DO of 170 days was assigned. Lactation records were grouped into seven DO classes: DO were rounded to the nearest month to form classes corresponding to months 1 to 6. Months ≥ 7 constituted the last class. Contemporary groups were formed by grouping records of buffalo calving in the same herd in the same year and season of calving within the year. Three seasons of calving were defined: January to April; May to August; and September to December. This dataset was reduced by removing records in contemporary groups in herds with number of observations less than five for the variance components estimation and less than two for the genetic evaluation. CI were calculated as the number of months between two calving dates. Records for a cow were excluded if the calving interval was less than 11 months or greater than 30 months. Each month of CI (from 11 to 30 months) represented a single class. After preliminary analyses, parities were grouped into three different classes: parities 1, 2 and equal to or greater than 3. Ninety-three age classes were formed. Twenty-one classes were assigned to parity 1, twenty-nine classes were assigned to parity 2, and forty-three classes were assigned to parities equal to or greater than 3. All age classes contained a single age in months, with the exception that the last class in parities equal to or greater than 3 included all ages greater than 90 months. This data set was reduced by removing contemporary groups with a number of observations less than five.

Statistical Models

Two statistical analyses were used sequentially in evaluating the effect of the previous CI on MY in the current lactation. Estimates of MY (expressed as deviations from the mean) from the first analysis were used in the second analysis. The first analysis included the fixed effects of age-parity, previous calving interval, and herd contemporary group. The MTDFREML programs [27] were used for this analysis.

The second analysis fit the solutions of MY for the effect of months of CI from the first analysis using linear regression, where CI class in months from 11 to 30 was the explanatory variable. PROC REG, the linear regression procedure of SAS [28] was used for this analysis.

RESULTS AND DISCUSSION

Summaries of number and frequencies of records, and unadjusted means for MY by class of CI are shown in Table **1**. Most of the records are distributed between CI of 11 and 14 months (59.66%). This distribution of CI may be, in part, the result of herd management strategies. Dairy producers try to shorten the CI of their herd in order to get the most profit from early conceptions of the cows [18, 19, 20]. Average MY slightly varied among CI classes. In general, lactation records with longer CI showed greater MY than lactation records whose previous CI were shorter. These results agree with previous experimental studies [9, 10, 11] that found longer CI in high milk production cows.

The regression model was statistically significant (Table **2**). The coefficient of determination (R^2) was equal to 0.58. The intercept (a) was equal to 72.42 kg; and the linear coefficient (b) was equal to -3.43. Both coefficients estimated were also statistically significant.

Table 1: Number of Records (N), Frequencies of Records (%) with Average Means for Milk Yield (kg) by Classes of CI in Months

CI	N	Frequency	Average milk yield
11	12,096	13.74	2,356
12	18,724	21.26	2,361
13	12,910	14.66	2,374
14	8,806	10.00	2,372
15	6,800	7.72	2,394
16	5,707	6.48	2,386
17	5,388	6.12	2,406
18	4,421	5.02	2,402
19	3,323	3.77	2,411
20	2,369	2.69	2,428
21	1,688	1.92	2,411
22	1.446	1.64	2,441
23	1,259	1.43	2,427
24	984	1.12	2,422
25	673	0.76	2,437
26	434	0.49	2,362
27	340	0.39	2,404
28	280	0.32	2,369
29	211	0.24	2,254
30	195	0.22	2,348

Table 2: Parameters of the Equation[1] $y_{ij} = a + bx_j$ to Predict Milk Yield (kg) at Various Interval of CI in Months

Parameter	Estimate	Std. Error	t- value	Pr > t
a	72.42	14.45	5.01	< 0.0001
b	-3.43	0.68	-5.06	< 0.0001

[1]y= milk yield at various interval from parturition; x= CI.

The negative value of b denotes a negative effect of months of CI on MY.

Solutions by month of CI on MY from the management adjusted model and the predictions from the linear model expressed as deviation from the mean of MY (2,356 kg) are shown in Table **3**. Solutions ranged between – 80.60 kg and 32.69 kg, respectively for 29 and 15 months of CI. Whereas, the liner predictions ranged between -29.58 kg and 35.02 kg, respectively for 30 and 11 months of CI.

The solutions and the predictions by CI on MY are presented in Figure **1**. The linear model was a good fit of the management adjusted MY solutions for CI between 11 and 24 months. Whereas, the solutions for the other CI classes exhibited greater deviations from their linear prediction. The small number of records in those classes, or some kind of error in reporting calving dates, could be an explanation of those outliers. As shown from the graph, there was a negative relationship between MY and CI length. For each month increase in CI, there was an approximate drop of 3.5 kg in MY, which leads to a decrease of close to 60 kg from 11 to 24 month CI. This result agrees with the finding of Gaines W. L. and Palfrey G.R [24] that demonstrated a negative correlation between CI and MY. There may be a physiological reason for the negative correlation between CI length and milk production. In fact, for longer CI, the mammary gland may become quiescent. And, it may regress to a

Table 3: Management Adjusted Solutions[a] and Linear Predictions[b] of Milk Yield by CI (Months) Expressed as Deviation from the Mean Milk Yield (2,356 kg)

CI	Milk yield solutions	
	Management adjusted	Linear prediction
11	27.11	35.02
12	21.99	31.62
13	20.49	28.22
14	19.36	24.82
15	32.69	21.42
16	22.30	18.02
17	20.07	14.62
18	1.49	11.22
19	9.96	7.82
20	9.63	4.42
21	-10.33	1.02
22	10.03	-2.38
23	3.55	-5.78
24	0.00	-9.18
25	11.42	-12.58
26	-30.90	-15.98
27	5.19	-19.38
28	-31.58	-22.78
29	-80.60	-26.18
30	-20.73	-29.58

[a]Effects included in management adjusted model were: age-parity class, CI class, and contemporary group in herd as fixed effects; and residual error as random effect.
[b]Effects included in the linear prediction model were: intercept and linear coefficient of regression of CI on milk yield solutions from the management adjusted model.

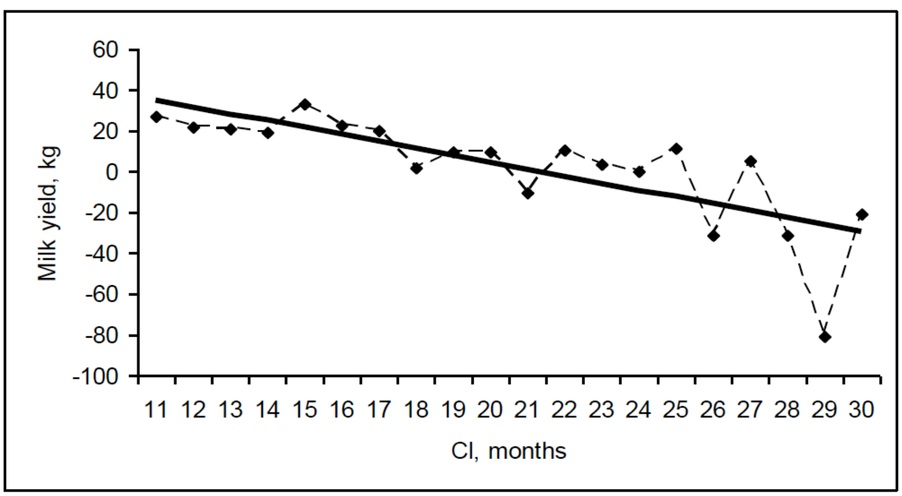

Figure 1: Plots of average solutions for CI classes from management adjusted model (- ♦ -) and predictions from linear prediction model (▬) for milk yield expressed as deviation from the mean milk yield (2,356 kg).

primitive status, similar to that of a primiparous. Thus, longer CI will lead to lower milk production.

CONCLUSION

The present study indicates that there is a negative linear relationship between previous CI length and MY in the current lactation in the Italian buffalo population. This means that shorter previous CI have less of a negative effect on milk production of Italian Mediterranean buffalo than longer previous CI. Therefore, a short CI may increase the profits of the farm through higher milk production.

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