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Factors Affecting Days Open in Dairy Buffalo and Evaluation the Impact of Days Open on the Subsequent Reproductive Traits

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ABSTRACT

DAYS OPEN (DO) is considered one of the most important parameters used to determine the reproductive performance of dairy buffalo farms. It is known as the duration between calving and the next pregnancy, minimizing this period helps control the calving interval and thus the reproductive efficiency of the buffalo farms. So, the aim of this study was to apply the Poisson regression model to determine factors influencing days open (DO) in dairy buffalo farms, by evaluating several parameters such as calving seasons, parity, 305- day milk production, lactation length, Age at first calving (AFC), age at first service (AFS), calving interval (CI), and evaluating how days open affect the subsequent reproductive indices. A total of 1388 buffaloes were collected from reliable records of large dairy buffalo farms. These buffaloes calved during the period extending from 2003 to 2015. The results of this study revealed that the important factors for DO were uniparous parity (P=0.03), calving seasons, calving interval, age at first calving, 305-day milk yield and lactation length ($P \leq 0.001$). The reproductive measurements of CI, AFC, and N/C showed significant difference at the level of days open groups ($P \leq 0.001$). Subsequently; they considered good indicators for evaluating fertility in dairy buffalo farms.

Keywords: Days open, Reproductive indices, Egyptian buffaloes, Poisson regression.

Introduction

Worldwide, a herd's capacity for reproduction plays a significant role in determining how profitable buffalo herds are [1]. Furthermore, poor reproductive performance is one of the most popular explanations for culling on dairy buffalo farms [2]. Days open (DO), also known as the time between calving and the subsequent pregnancy, is one of the crucial factors that are thought to be indicators of reproductive efficiency; reducing this time helps regulate the interval between calvings. Days open to buffaloes have varied population estimates, ranging from 100 to 425 days. The open days of Egyptian buffaloes are shorter than those of Asian dairy buffaloes [3]. Many factors affect days open in buffaloes such as, parity and season of calving [4]. Additionally, a number of factors, such as body condition score (BCS), calving to first service interval (DO), heat stress, age, parity, 305-day milk yield, and peripartum disorders (dystocia, metritis, and retained placenta), have been investigated for their impact on the days open [5–7]. Numerous non-genetic factors influence female buffalo fertility, regardless of the breeding strategy used—natural service or artificial insemination. [8], some of these have to do with farm management, which includes reproduction-related concerns like the chosen bulls' libido or the efficacy of artificial insemination and estrus detection. Another important factor influencing DO is the typical environmental impacts of the season and year [9].

The aim of this study was to use of Poisson count regression model as a statistically appropriate procedure to analyze certain data from dairy buffalo farms in order to evaluation the effects of some factors (parity, calving season, calving interval, age at first calving, age at first service, lactation length and 305-day milk production) on DO, and as a result, the effect of DO on the subsequent reproductive indices in dairy buffaloes.

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Material and Methods

Herd management:

Every farm animal was kept in a free-stall that had a water-spraying device to cool the environment when the outside temperature reached above 30°C. According to the recommendation of the Animal Production Research Institute (APRI), animals were fed on a balanced total mixed ration that met all their requirements, including those for maintenance and milk production. Heifers are naturally served for the first time when they are 24 months old or 300–350 kg in body weight. All animals receive regular vaccines against most the frequent diseases [10].

Ethical approval:

All examinations were done after the approval of the Ethics Committee of Benha University with the approval number: BUFVTM06-12-23.

Data collection and evaluation factors that effecting on days open (DO):

The data for 1388 buffaloes were collected from reliable records obtained directly from electronic records documented by the station administration. The nature of the data was recorded in the ethical approval. It is for large herd of purebred Egyptian buffaloes held at the Mahalet-Mousa experimental farms of the Animal Production Research Institute (APRI), the Agricultural Research Centre, and the Ministry of Agriculture. These buffaloes calved during the period extended from 2003 to 2015. The data includes some productive and reproductive traits. DO was determined as the difference between the dates of successful insemination and the preceding calving [11]. It was an important trait with a complicated genetic nature that significantly increases the overall milk yield during lactation and enhances the profitability of the farms [12-14]. In this research, the following parameters were studied (parity, calving season, age at first calving (AFC), age at first service (AFS),calving interval(CI), lactation length (LL) and 305-day milk yield) to determine which of these explanatory variable can influence the response variable (days open).

Data statistical analyses:

All statistical procedures were performed using SPSS software statistical package version 25.0 (SPSS, Inc., Chicago, Ill, USA). The generalized linear models (GLMs) are an extension of the linear regression model that is a powerful and flexible tool for modeling relationships between outcome and explanatory variables, Poisson regression model is a type of generalized linear model that is used to model count response variable.

In this research Poisson regression assumes the response variable (Y) of DO has a Poisson distribution, and by using a log-link function we can make relationship between it and the predictors (parity, calving season, AFC, AFS, CI, LL and 305-day milk yield). The descriptive statistics for these variables were illustrated in table (1).

A Poisson regression model was used to analyze factors influencing days open in the present investigation, where a discrete random variable y (DO) is said to have a Poisson distribution, with parameter λ and it has a probability mass function as follows:

$$Pr\{Y = y\} = \frac{e^{-\lambda}\lambda^{y}}{y!})$$

[**15**]

Where:

1. Y is the number of occurrences (Y = 0, 1, 2, 3, 4…)
2. e is Euler's number =2.71828
3. ! Is the factorial function.

The Poisson regression model was assumed as follows:

When the positive real number λ is equal to the expected value of Y and variance, thus the model can be expressed as follows:

$$\mathrm{E(Y)} = \mathrm{Var(Y)} = \lambda$$

$$Y_i = E(Y_i) + \mathcal{E}_i$$

$$Y_i \sim p(\lambda_i)$$

$$E(Y_i) = \lambda_i = x_i{}'\beta = [\beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p]$$

[16]

$$\mathrm{Log}\ (\lambda_i) = x_i\text{`}\beta$$

$$\lambda_i = \exp\{x_i'\beta\} = e^{x_i'\beta}$$

Where: Yi: The response variable; (days open).

$\mathcal{E}_i$: is the random error, which represents the random variation component of Y.

x_i: The value of the predictor for the ***i_{th}*** individual where x_i are parity, AFC, CI, AFS, calving season, 305-day milk production and lactation length.

β_0: The intercept, represents the expected value of the outcome.

β: is the slope of the line, which represents the average change in outcome per one-unit increase in the predictor.

Evaluation of days open (DO) in relation to reproductive traits:

Data on the following variables were recorded in the study at the level of DO groups: CI, AFC, AFS, and N/C. The variance component homogeneity and normality between test groups were then tested, and the data were then analyzed using the Kruskal-Wallis test using the SPSS program. Group 1 (less than 60), Group 2 (60-109), Group 3 (110-160), and Group 4 (greater than 160) are the four DO groups. The statistical significance level of less than 0.05 was selected.

Result

As shown in Table 2, the results of omnibus test showed that the LRχ^2 (likelihood ratio chi-square) value for the model with the log link function is 4209.00 with11 degrees of freedom and a P-value of 0.001. On the other hand, Pearson correlation was used to assess the relationship between DO and the predicted value of it. The results indicated a significant correlation at the 0.001 level, with a Pearson correlation value of 0.57 (Table 3).

Factors affecting the length days open (DO)

Table 4 displays the findings of the Poisson regression model, which suggest that the following significant factors affected DO: age at first calving, lactation length, 305-day milk yield (P-value < 0.001), and uniparous buffaloes (P-value < 0.05). However, the model did not identify age at first service or multiparous buffaloes (P-value > 0.05).

Impacts of days open on the subsequent reproductive traits:

The findings of the Kruskal Wallis test indicated a statistically significant variation in (N/C), (AFC), and (CI) among days open groups (P-value < 0.001).The corresponding Chi-square values are 64.43, 10.45, and 41.45. Otherwise, there was no significant difference in (AFS) as P-value > 0.05 (Table 5, Figures 1 and 2).

Disscussion

Reproductive indices are thought to be a good way to gauge a buffalo herd's reproductive status [17]. The postpartum anestrus phase, which buffalo experienced after calving, is an extended period of varied length sexual rest. If this period is prolonged, it could negatively impact the reproductive indices.

The purpose of this study was to identify the factors that contribute to a buffalo's increased number of days open. The results of this report revealed that Poisson regression model can do well in determining the association between DO and important significant explanatory variables. According to the result of the omnibus test, which was used to evaluate whether the model significantly explains the variability in the response variable, it was indicated that the model with the log link function significantly explained the variability in the DO (Table 2).

Poisson regression analysis results showed that several factors significantly affected DO. Table 4 illustrates that uniparous buffalo had a significant effect on DO with P-value < 0.05, compared to multiparous one. The estimated EXP (B) for uniparous buffalo equal 1.23 (more than one), which indicated that uniparous buffalo had 23% increase in the DO than multiparous one. This result was agreed with Peeva et al. [9] and Ayad et al. [18] who claimed that one of the elements influencing DO is parity. However, Hussain et al. [19] noted that multiparous parity had no appreciable impact on DO. In this context, the result was disagreed with Mahdy et al. [20], Marai et al. [21]; and Nan et al. [11] who noted that multiparous parity had highly significant effect on CI and DO, with increasing parity number, CI and DO decreased. In addition, According to Bashir [22] the first parity buffaloes had the highest DO, which progressively decreased as the parity increased.

Consistent with previous reports of Peeva et al. [9], Fathy et al. [23] and Marai et al. [24], the DO was found to be significantly associated with season of calving with P-value < 0.001. The estimated EXP (B) for autumn calving season equal 0.87 (less than one) which means that there was 5% decrease in the number of DO in buffaloes calved in autumn season than those calved in winter season. The EXP (B) for spring season equal 1.06 (more than 1), which indicated that buffaloes calved in spring season had 6% increase in the number of DO than those calved in winter season. Meanwhile, the EXP (B) for summer season equal 0.95 (less than 1), which indicated that buffaloes calved in summer season had 5% decrease in the number of DO than those calved in winter season. Those result were in the same line with Khan et al. [25], and Peeva et al. [9] who noted that calving season had significant effect for DO. On the contrary, buffaloes that calved in the winter had the longest DO; while those calved in the summer had the lowest days open [26].

According to our findings, lactation length and 305-day milk production were important predictors (P-value ≤ 0.001) for DO. For every one point increase in 305-day milk output and lactation time, there was a 1% increasing in number of DO, as indicated by the fact that the Exp (B) for these variables equals 1. These results disagree with those of Ayesh, [27] , Ali et al. [28]., Atashi et al. [29].and Němečková et al. [30].who showed that low-producing cows had higher calving intervals, days open, and number of services per conception than did higher-producing animals.

AFC is one of the economically significant reproductive traits; the decrease in AFC will lower the cost of maintaining the animal till it reaches its reproductive age, increasing the yearly genetic gain [31].The current research found that (AFC) and (CI) had significant effect on DO ($P \leq 0.001$). The Exp (B) for AFC and CI equal 1.2 and 1.1 respectively, which means that there was 1% increase in DO for every one point increase in AFC and CI. This results was in the same line with Verma et al. [32], who claimed that in Murrah buffaloes DO had a substantial association between AFC and CI, Additionally, he noted that buffaloes with shorter AFC and CI were reported by the lower (DO). However, AFS had no effect on the duration of DO in buffalo herds (P-value > 0.05).

The current study found that although AFS showed no significant difference across days open groups, the reproductive indices (CI, AFC, and N/C) in the buffalo herd showed substantial differences at the level of days open groups. These findings indicated that the reproductive performance of buffalo herds might be evaluated using the fertility indicators of DO, CI, and number of services per conception. These outcomes corroborated with Devkota et al. [33] who explained that the best reproductive indicators for assessing buffalo fertility were the age at first conception, the calving to first estrus interval, and calving interval.

Conclusion

In this study, we concluded that there are significant relationships between days open (DO) and calving season, parity (uniparous buffalo), milk production, lactation length, and reproductive parameters such as AFC, AFS, CI, and N/C. So, we can depend on these explanatory variables as significant factors for evaluating days open in dairy buffalo farms. The reproductive indices such as CI, AFC, and N/C have significant difference at the level of days open groups, and may be considered as good indicators to evaluate fertility problems in dairy buffalo.

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Conflicts of interest

This article does not include any declared conflicts of interest.

TABLE 1. Descriptive statistics of days open and continuous predictors used in Poisson regression analysis.

Variables	Mean	Std. Deviation	Minimum	Maximum
DO (days)	97.2	66.76	9.00	517.00
CI (days)	435.7	100.00	213.00	959.00
AFC (month)	36.75	5.00	21.00	69.00
AFS (month)	23.02	3.5	16.00	35.00
305-day milk yield(kg)	2408.00	546.00	216.00	5427.00
LL (days)	196.00	39.83	34.00	380.00

DO = days open, CI = calving interval, AFC = age at first calving, AFS = age at first service, LL= lactation length.

TABLE 2. Omnibus test of model coefficient of Poisson regression analysis.

Chi-square	d.f	*P*-value
4209.00	11	**0.001*** **

***P< 0.001, chi-square value was highly significant.

TABLE 3. Pearson correlation between days open and the predicted value of it.

Variables	Number	Pearson correlation value	*P*-value
Days open (days)	1385	0.57**	0.001
Predicted value of mean of days open	1385		

** Correlation is significant at the 0.01 level (2-tailed).

TABLE 4. Factors affecting days open that analyzed by a Poisson regression analysis.

Variables	Estimate	SEM	*P*-value	EXP(B)	95% Confidence interval
Intercept	4.08	0.107	0.00	59.24	[3.83 , 4.25]
Parity (Uniparous	0.21	0.103	0.03*	1.23	[0.01, 0.41]
Multiparous)	-0.004	0.103	0.95 NS	0.99	[-0.20 , 0.20]
Season of calving					
Autumn *vs* Winter	-0.14	0.01	0.00**	0.87	[-0.15, -0.13]
Spring *vs* Winter	0.06	0.01	0.00**	1.06	[0.05, 0.08]
Summer *vs* Winter	-0.05	0.02	0.00**	0.95	[-0.07, -0.04]
AFC (M)	0.002	0.006	0.002**	1.2	[0.001 , 0.003]
AFS (M)	0.001	0.001	0.44 NS	1.1	[-0.001 , 0.002]
CI (days)	0.001	2.6E-5	0.00**	1.1	[0.001 , 0.006]
305-day milk yield	-3.7E-5	5.6E-6	0.00**	1.0	[-4.7E-5, -2.7E-5]
LL	0.001	6.78E-5	0.00**	1.0	[0.001, 0.002]

*Significant at level ($p \leq 0.05$). ** Highly significant at level ($p \leq 0.001$). NS= Non-significant ($p \geq 0.05$).

TABLE 5. Test statistics of Kruskal Wallis test for assessing the effect of days open on the subsequent reproductive parameters:

Parameters	Chi-square	*P*-value
Calving intervals (day)	64.43	< 0.001**
Age at first calving(month)	10.45	< 0.001*
Age at first service (month)	1.72	0.63 NS
Number of services per conception	41.45	< 0.001**

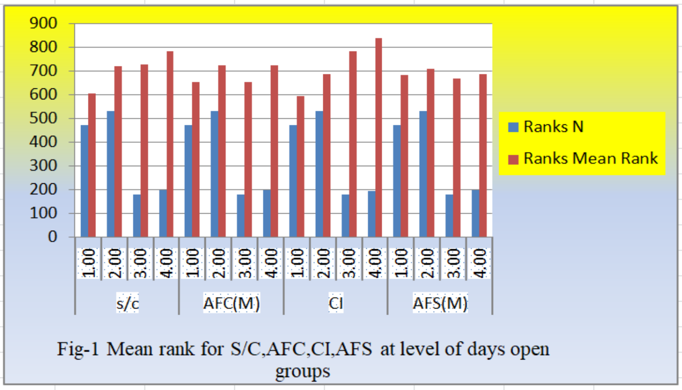

Fig. 1. Shown the mean ranks for service per conception, age at first calving, calving interval and age at first service within the level of days open groups.

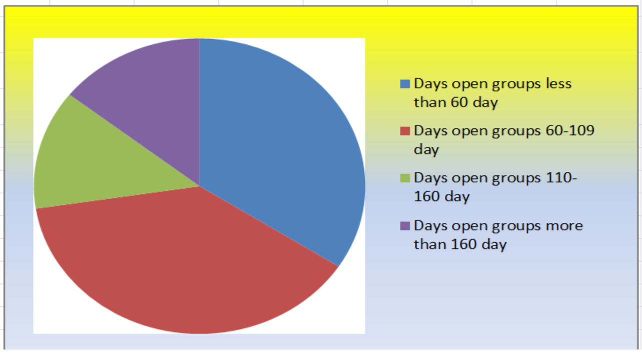

Fig.2. Shown the numbers of days open within each group.

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العوامل المؤثرة على الفتره المفتوحه في جاموس الألبان وتقييم تأثيرهذه الفتره المفتوحه على الصفات التناسليه اللاحقة

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الملخص

تعتبرالفتره المفتوحه (DO) أحد أهم العوامل المستخدمة لتحديد الأداء التناسلي لمزارع جاموس الألبان. وهي تعرف بالمدة بين الولادة والحمل التالي، وتقليل هذه الفترة يساعد في التحكم في الفتره بين الولادات وبالتالي الكفاءة الإنجابية لمزارع الجاموس. لذلك، كان الهدف من هذه الدراسة هو تطبيق نموذج انحدار بواسون لتحديد العوامل المؤثرة على الفتره المفتوحه (DO) في مزارع جاموس الالبان، من خلال تقييم عدة عوامل متضمنه مواسم الولادة، عدد الولادات، إجمالي إنتاج اللبن لفترة 305 يوم ، طول فترة الرضاعة، عمر الحيوان عند أول ولاده (AFC)، عمرالحيوان عند أول تلقيحه (AFS)، والفتره بين الولادات (CI)، وتقييم كيفية تأثير هذه الفتره المفتوحه على مؤشرات الإنجاب اللاحقة. تم جمع بيانات ل 1388 جاموسًا من السجلات الموثوقة لمزارع جاموس الألبان الكبيرة. ولدت هذه الجاموس خلال الفترة الممتدة من 2003 إلى 2015. وكشفت نتائج هذه الدراسة أن العوامل المهمة لـ DO هي الجاموس وحيدة الولاده (P = 0.03)، مواسم الولادة، الفتره بين الولادات ، العمر عند أول ولاده، إجمالي إنتاج اللبن لفترة 305 يوم ، و طول فترة الرضاعة ($P \geq 0.001$).وبالتبعيه أوضحت النتائج أن القياسات التناسليه مثل CI وAFC وN/C توضح اختلافاً معنوياً في مجوعات الفتره المفتوحه ($P \geq 0.001$) ؛ ومن ثم تعتبر مؤشرات جيدة لتقييم معدل الخصوبة في مزارع جاموس الألبان.

الكلمات الدالة: الفترة المفتوحة، المؤشرات التناسليه، الجاموس المصري، نموذج انحدار بواسون.