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Effect of Mastitis on the Reproductive Performance of Holstein Frisian Cows in Northern Gezira Dairy Project (Al Bagair)

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Abstract

The aim of this study was to investigate the effect of mastitis on reproductive performance of Holstein Frisian cattle reared in the farm of the Arab Company for Agricultural Production and Processing (ACAPP), about 40 km south of Khartoum at Al Bagair area. A total number of 4893 recorded cases of mastitis covering the period from 1990 to 1999 were studied for their effect on reproductive performance under the prevailing management and environmental conditions. The traits examined were calving interval (CI), days open (DO), and numbers of services per conception (NS\C).Data were subjected to statistical analysis of variance. The results obtained showed that the overall mean (CI), (DO), and (NS\C), were 394 ± 45.87 days, 110.21 ± 45.75 days, and 2.81 ± 1.1-63 respectively. The mean (CI) was highly significantly (P≤ 0.01) affected by the level of mastitis (MS). The results revealed were (403.00± 50.65, 399.03± 49.33, 388.40 ± 40.60) at high, medium, and low level of (MS) respectively. The effect of (MS) on (DO) was highly significant (P≤ 0.01) the results obtained for (DO) were (117.27± 50.75, 114.69± 49.25, and 104.70± 40.54). The effect on (NS/C) was also highly significant (P≤ 0.01). The results obtained for (NS/C) were (3.07± 1.89, 2.92± 1.74, 2.63 ± 1.41) at high, medium, and low level of (MS) respectively. It is concluded that mastitis had significantly affected the reproductive performance of Holstein Friesian cows in the farm under study.

Keywords: Reproductive performance, Mastitis, Calving intervals, Days open, and Number of services per conception.

Introduction

Calving interval (time between successive calvings) and "days open" (count of days from calving to conception), and the number of services per conception (is the total number of services given to a group of cows eligible for service, divided by the number of conceiving cows) are used to assess the reproductive performance of dairy cows (Grohn *et al* 1998). Calving interval is probably the best index of a cattle herd's reproductive efficiency (Holness *et al.*, 1980). Yet, higher producing cows are more likely to be inseminated more times and for longer than lower producers (Eicker *et al.*, 1996). Days open is routinely used to

assess reproductive performance and to make economic decision in dairy herds (Farin *et al.*, 1994; Arthur *et al*., 2001). The "days open" period should not exceed 80-85 days if a calving interval of 12 months is to be achieved (Peters, 1984). The duration of this period is influenced by nutrition (Wiltbank *et al.*, 1962) season, milk yield, parity (Buck, *et al*., 1975) suckling and uterine involution. Number of services per conception [NS/C] is influenced by factors related to the cow, the bull, or artificial insemination (AI) and the farming system. It depends largely on the breeding system used. Choudhuri *et al.*, (1984) reported that heritability of NS/C is low and most of the variation in NS/C is attributable to environmental factors.

Mastitis is defined as inflammation of the mammary gland, and can be triggered by many factors such as trauma and/or injury to the udder, infection due to microorganisms, and chemical irritation (Philpot et al, 2000). Barker et al. (1998) showed that the onset of clinical mastitis before first AI increased days to first service and days open (DO), but did not affect services per conception (S/C). The same researchers reported that when clinical mastitis occurred between first AI and conception, both DO and S/C increased significantly compared to uninfected cows. Schrick *et al.*, (2001) concluded that subclinical mastitis reduced reproductive performance of lactating cows similar to clinical mastitis. Subclinical mastitis followed by clinical mastitis resulted in the most severe loss in reproductive performance. They revealed that cows with clinical or subclinical mastitis before first service had increased days open (110.0 ± 6.9 and 107.7 ± 6.9 d), and services per conception (2.1 ± 0.2 and 2.1 ± 0.2) compared with controls (67.8 ± 2.2 d, 85.4 ± 5.8 d, 1.6 ± 0.2; $P < 0.05$). (Barker *et al.*, 1998) demonstrated that onset of clinical mastitis before first service increased the number of days open (136.6 d) compared with cows without clinical mastitis or cows with clinical mastitis after establishment of pregnancy (71.0, 92.1d) respectively. (Moore *et al.*, 1991) reported a negative correlation between clinical mastitis and reproduction due to altered inter estrus intervals and decreased length of the luteal phase in cows with clinical mastitis caused by gram-negative mastitis pathogens. Cullor (1990) suggested that endotoxin might induce luteolysis and influence conception and early embryonic survival by the release of inflammatory mediators. Moor *et al.*, (1993) hypothesized that gram-negative mastitis pathogens may stimulate production of prostaglandin F2α (PGF2α), which subsequently would cause luteal regression. Cows suffering from mastitis are at increased risk for reduced conception rate and increased fetal loss, regardless of the causative agent being Gram-positive or Gram-negative bacteria (Santos *et al*., 2004). The same author reported 134 days open for cows suffered from mastitis and 114 days open for uninfected cows. Huszenicza *et al*., (2005) stated that mastitis could affect the resumption of ovarian activity in post-partum dairy cows e.g., if cows have mastitis soon after calving, luteal activity starts approximately 7 days later than healthy animals. Mastitis may also impair reproduction in cyclic cows in a form of premature luteolysis or prolonged follicular phase. Indeed, there is evidence that the calving-to-pregnancy interval is extended for at least 7, 8, 26, and 31 days in cows treated for mastitis,

retained fetal membranes, hypocalcaemia, or endometritis, respectively, compared with healthy herd-mates (Schrick *et al*., 2001.; Borsberry and Dobson, 1989). Mastitis is still the most costly disease in dairy farms because of reduced milk production, increased involuntary culling rate, and discarded milk (Philpot and Nickerson, 2000) The costs associated with mastitis for the US dairy industry has been estimated over 2 billion US dollars per year DeGraves and Fetrow, 1993).

The aim of this study was to investigate the effect of mastitis on reproductive performance of Holstein Frisian cattle reared in the farm of the Arab Company for Agricultural Production and Processing (ACAPP).

Materials and Methods

Study area: This study was carried out in the farm of the Arab Company for Agricultural Production and Processing (ACAPP) located about 40 km south of Khartoum at Al Bagair area.

Management: The farm under study was well established and strict hygienic measures were adopted. Vaccination against the major prevailing epidemic diseases in Sudan was a regular practice in the farm. The main diseases vaccinated against were Rinderpest, Anthrax, Black Quarter, Hemorrhagic Septicemia, Contagious Bovine Pleuropneumonia, Brucellosis, and Foot and Mouth Disease.

Data collection: The data for this study were compiled from the records of the Holstein- Friesian herd in the farm. A number of 4893 records of mastitis infected cases covering the period 1990 - 1999 were studied for their effect on:

i. Calving interval (period of time between two successive calving's).
ii. Days open. (Count of days from calving to conception).
iii. Number of services per conception. (The total number of services given to a group of cows eligible for service, divided by the number of conceiving cows)

The number of cases of each was divided into three groups; High, Medium, and Low according to the number of cases reported in each year as shown below:

High ≥ 600
Medium 350 - 600
Low ≤ 350

Statistical Analysis: The data were analyzed by analysis of variance (Amir, 2002). They were analyzed using SPSS Version 20 program. The one-way analysis of variance (ANOVA) was applied.

The following fixed model was used:

$$Yijkl = \mu + ai + bj + ck + eijkl$$

Where

Yijkl = calving interval, days open, and services per conception
μ = overall mean,
ai = effect of high incidence of infection
bj = effect of medium incidence of infection
ck = effect of low incidence of infection and
eijkl = random error.

Results and Discussion

Overall means: The statistical analysis of the data showed that the overall means of calving intervals (CI), days open (DO), and number of services per conception (NS/C) throughout the period 1990 to 1999) were 394.51, 110.21, and 2.81 as shown in (Table 1). Means and standard deviation for CI, DO, and NS/C are shown in Tables (2, 3 and 4) respectively. The frequency distributions of CI, DO, and NS/C are presented in Figure (1, 2, and 3) respectively. The histograms illustrate the means of the three traits of reproductive performance;

Calving intervals (CI), Days open (DO), and Number of services per conception (NS/C) through the years of the study.

Table 1: The overall means and standard deviations for Calving intervals, Days open, and Number of services per conception

Dependent variable	Mean	St. deviation
CI	394.51	45.87
DO	110.21	45.75
NS/C	2.81	1.63

Table 2: Means and standard deviation for Calving intervals through years

Dependent Variable	YEAR	Mean	std.dev.
Calving interval	90	390.50	56.86
	91	402.51	46.78
	92	392.88	42.40
	93	388.57	42.57
	94	391.58	45.27
	95	413.12	56.05
	96	388.10	36.13
	97	404.08	42.38
	98	390.98	39.00
	99	382.76	39.30
	Total	394.51	45.87

Table 3: Means and standard deviation for Days open through years

Dependent Variable	YEAR	Mean	std.dev.
Days open	90	105.87	56.91
	91	117.37	46.64
	92	107.78	42.31
	93	103.38	42.37
	94	106.62	45.19
	95	126.76	56.52
	96	104.30	36.16
	97	120.82	42.06
	98	105.42	39.71
	99	103.76	39.08
	Total	110.21	45.75

Table 4: Means and standard deviation for Number of services per conception (NS/C) through years (1990-1999)

Dependent Variable	YEAR	Mean	SD
Number of services / conception	90	2.63	1.92
	91	3.01	1.69
	92	2.68	1.48
	93	2.64	1.46
	94	2.67	1.58
	95	3.46	2.16
	96	2.54	1.27
	97	3.14	1.56
	98	2.69	1.36
	99	2.60	1.39
	Total	2.81	1.63

Effect of mastitis on calving interval, days open, and number of services per conception:

Results obtained indicates that the effect of incidence of occurrences of mastitis on CI, DO, and NS/C were highly significant (P≤ 0.01), Table (5).The incidence of mastitis was high on years (1990 and1991), medium on years (1992, 1995, and 1997), and low on years (1993, 1994, 1996, 1998, and 1999). The analysis of data showed that means and standard deviations of calving intervals, days open, and number of services per conception were higher during years of high incidence of mastitis Table (6).

Table 5: Analysis of variance for the effect of mastitis on calving interval (CI), days opens (DO), and number of services per conception (NS/C):

Dependent variable	Source of Variation	Sum of Squares	Df	Mean Square	F	Sig.
CI	Between Groups	69467.130	2	34733.565	16.801	0.01
	Within Groups	3652989.243	1767	2067.340		
	Total	3722456.373	1769			
DO	Between Groups	55202.765	2	27601.383	13.369	0.01
	Within Groups	3648003.308	1767	2064.518		
	Total	3703206.073	1769			
NS/C	Between Groups	60.228	2	30.114	11.491	0.01
	Within Groups	4630.915	1767	2.621		
	Total	4691.144	1769			

Table 6: Means and St. Deviations of the three traits of reproductive performance at three levels of mastitis:

Mastitis	Incidence of infection	Mean	Standard deviation
CI	High	403.00	50.65
	Medium	399.03	49.33
	Low	388.40	40.60
DO	High	117.27	50.75
	Medium	114.69	49.25
	Low	104.70	40.54
NS/C	High	3.07	1.89
	Medium	2.92	1.74
	Low	2.63	1.41

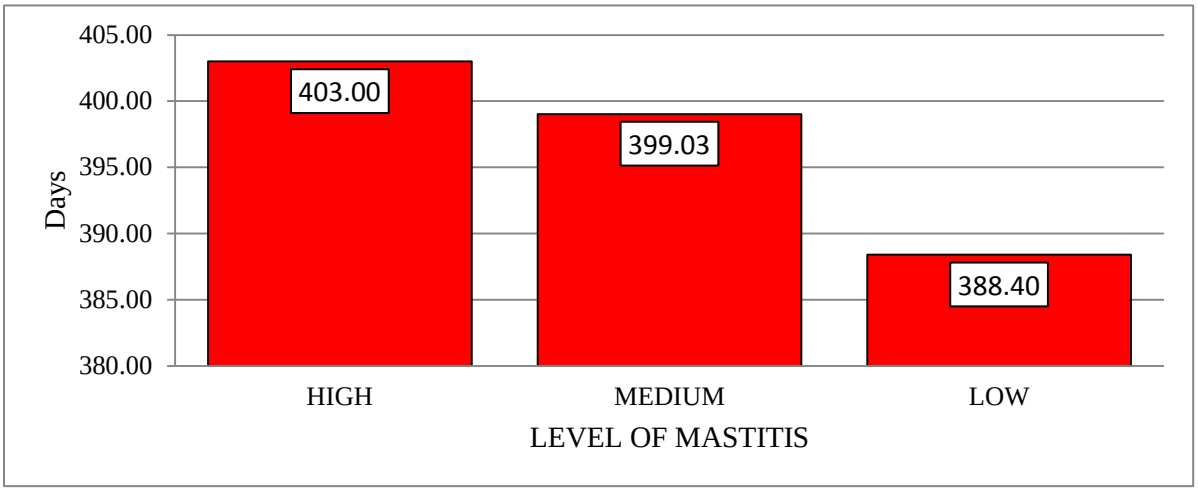

Figure 1: Effect of level of mastitis on Calving interval (CI)

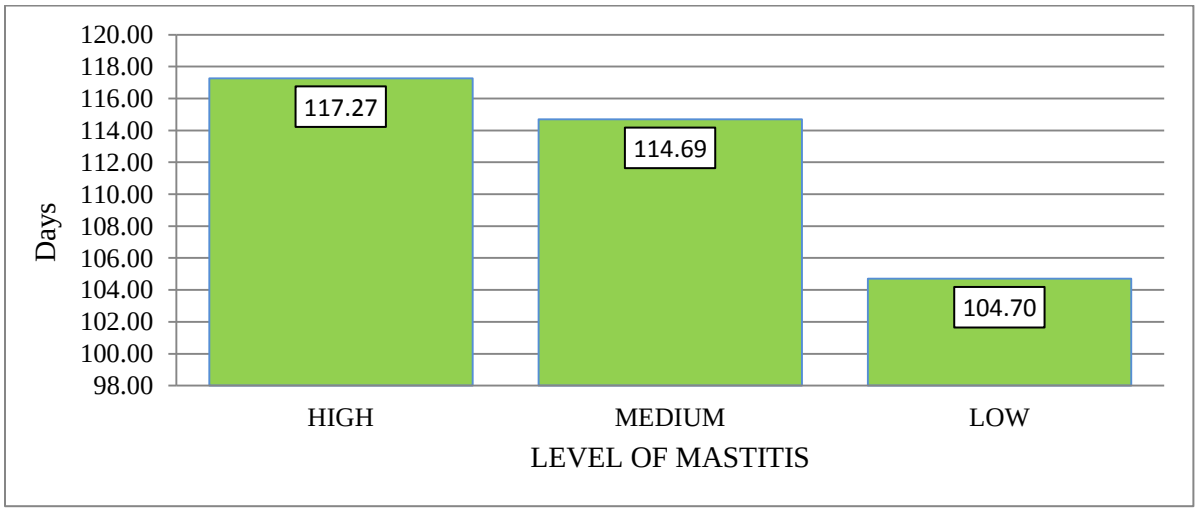

Figure 2: Effect of level of mastitis on Days Open (DO)

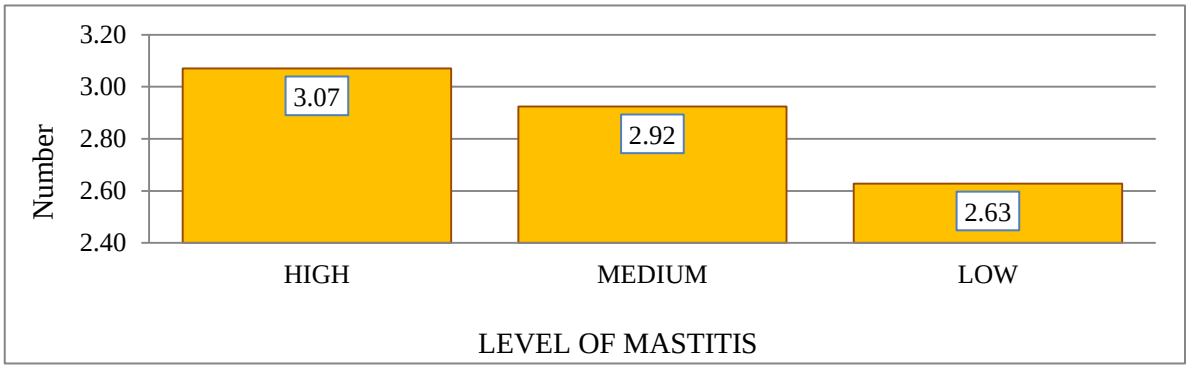

Figure 3: Effect of level of mastitis on Number of Services per Conception (NS/C) from 1990 to 1999

The results of this study revealed that mastitis had statistically significant effect on CI, DO, and NS/C ($p \leq 001$) for all traits. The average mean of CI was higher in years of high level of occurrences of mastitis (1992, 1995) than in years of low level of occurrence (1993, 1994, 1996, 1998, 1999), (403.00 ± 50.65, versus 388.40 ± 40.60) respectively. The average mean of DO was higher in years of high incidence of mastitis than those in years of low incidence (117.27 ± 50.75, versus 104.70 ± 40.54) respectively. This result agrees with the results revealed by Schrick *et al,* 2001) for DO for cows with clinical and subclinical mastitis. The days open reported in the present study was less than results demonstrated by Barker *et al.* (1998), who reported 136.6 days, and also less than those reported by Santos *et al*. (2004) who reported 134 days, and this could be attributed to management practices and / or breeding system followed. The average mean of NS/C was higher in years of high incidence of mastitis than those in years of low incidence (3.07 ± 1.89, versus 2.63 ± 1.41) respectively. The number of services per conception reported by this study was more than those revealed by Barker *et al.* (1998), and this could be attributed to management practices and/or breeding system followed. As it has been shown previously at the literature review chapter mastitis negatively affects the reproductive performance of dairy cows regardless of the causative agent being Gram positive or Gram-negative bacteria (Santos *et al*. 2004). Mastitis altered inter-estrous intervals and decreased the length of the luteal phase in cows with clinical form of mastitis (Moor *et al*, 1991). In addition Moor and O'Connor (1993) hypothesized that Gram-negative mastitis pathogens may stimulate production of prostaglandin F2α which subsequently would cause luteal regression. Mastitis could affect the ovarian rebound in post-partum cows. Increased PGF2α in infected cows may cause premature luteal regression and (or) may have detrimental effects on embryonic development and quality, causing increased embryonic loss, and consequently, increased number of services per conception and days open. Interestingly, PGF2α can affect a cow's fertility by negatively affecting bovine oocytes and (or) the bovine developing embryo (Hansen *et al*, 2004). Therefore,

mastitis impairs reproduction in cyclic cows in a form of short luteal phase and prolonged follicular phase.

Intramammary infection (IMI) triggers a complex acute-phase response that includes increased secretion of inflammatory proteins, cytokines, prostaglandins and more, which can be detected in milk and plasma (Shuster *et al*. 1991; Eckersall *et al*. 2001).

David *et al.* (2015) reported that mastitis causes deterioration of ovarian follicular responses in cows resulting in low fertility. The short-term acute clinical form of mastitis has a time-dependent disruptive effect on conception rate. It effectively lowers conception rate if events occur mainly 10 days before to 30 days after artificial insemination. Long-term subclinical mastitis causes a more pronounced decrease in conception rate. The same authors David *et al.* (2015) added that even mild elevation of somatic cell count in subclinical cows significantly lowers conception rate. Disruptive follicular responses include depression of steroid production in the pre ovulatory follicle associated with low and delayed preovulatory luteinizing hormone surge, resulting in delayed ovulation in one-third of subclinical cows. Both clinical and subclinical mastitis also impair oocyte competence, reflected in low production of blastocysts. They also reported that clinical mastitis was associated with activation of the glucocerticoid system, resulting in a sharp rise of systemic cortisol, known to be involved in depression of gonadotrophic-releasing hormone (Gn RH) and LH secretion, Roth *et al.* (2013) also provided evidence for impairment of oocyte competence in mastitic cows. Santos *et al.* (2004) reported that conception rate at first postpartum A.I. and pregnancy rate were both decreased by mastitis prior to or after first artificial insemination. Cows with mastitis prior to first postpartum A.I., and cows with mastitis between first postpartum A.I. and pregnancy diagnosis had both extended days open.

Conclusion and Recommendations

The performance of animals depends not only on their genetic merits, but also on other factors. It is accepted that reproduction is important for the profitability of dairy farms, and health of dairy cows during their reproductive period is one of the many determinants of reproductive success. Appropriate herd health policies can directly influence the reproductive performance of a dairy herd. The effects of mastitis on reproductive performance of Holstein Frisian cows in the farm under study were well-documented. Proper management at all its components (proper buildings, adequate supply of nutrients both quantities and qualities, well-trained personnel is highly needed to sustain successful dairy farming particularly with exotic breeds such as H/F cows. Conduction of analysis of disease incidence records and an efficient control and preventive measures are very vital.

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تأثير التهاب الضرع على الأداء التناسلي لأبقار الهولستاين فرزيان بمشروع البان شمال الجزيرة (الباقير)

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المستخلص:

أجريت هذه الدراسة للتقصي عن تأثير التهابات الضرع على الأداء التناسلي لابقار الحليب من سلالة الهولستاين فرزيان المرباة بمزرعة الشركة العربية للانتاج و التصنيع الزراعي (ACAPP) بمنطقة الباقير حوالي 40 كلم جنوب الخرطوم . تمت دراسة عدد 4893 حالة التهاب ضرع مسجلة تغطي الفترة من عام 1990 الى 1999م لمعرفة تأثيرها على الاداء التناسلي تحت الظروف البيئية و الادارية السائدة خلال الفترة المعنية. الصفات التناسلية التي تمت دراستها هي طول الفترة بين ولادتين و الأيام المفتوحة (الفترة من الولادة و حتى الإخصاب بعد الولادة) و عدد التلقيحات اللآزمة لحدوث الإخصاب. تم اجراء تحليل احصائي للنتائج المتحصل عليها (تحليل التباين) اوضحت النتائج المتحصل عليها أن المتوسط العام لطول الفترة بين ولادتين, و الايام المفتوحة, و عدد التلقيحات اللازمة لحدوث الإخصاب كانت كما يلي: 45.87 ± 394 يوم , 45.75 ± 110.21 يوم , و 1.63 ± 2.81 تلقيحة على التوالي.كان تاثير معدل الاصابة بالتهابات الضرع على متوسطات الفترة بين ولادتين و الفترة من الولادة حتى الاخصاب و عدد التلقيحات اللازمة للاخصاب معنوياً ($P \leq 0.01$). خلصت الدراسة الى ان متوسط طول الفترة بين ولادتين تأثر معنوياً بمعدل الاصابة بالتهابات الضرع خلال فترة الدراسة ± 399.03 ,40.60 ± 388.40) (50.65 ± 403.00 ,49.33 وكذلك طول الفترة من الولادة وحتى الاخصاب ± 114.69 ,40.54 ± 104.70) (50.75 ± 117.27 ,49.25 وعدد التلقيحات اللازمة لحدوث الاخصاب ± 3.07 ,1.74 ± 2.92 ,1.41± 2.63) (1.89 عندما كان معدل الاصابة عاليا او متوسطا او منخفضا على التوالي. خلصت الدراسة الى ان الاصابة بالتهابات الضرع لها تأثير معنوي على الأداء التناسلي لأبقار الهولستاين فرزيان بالمزرعة موضع الدراسة.