Optimum Time of Insemination after Onset of Oestrus in Holstein – Friesian Dairy Cows in the Peri-urban Khartoum (Sudan)

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Abstract

The aim of this study was to determine the optimum time of insemination after onset of oestrus in Holstein-Friesian dairy cows. 146 and 92 Cows were randomly assigned to the control and prostaglandin $F_2\alpha$ treated groups respectively. The experimental animals were then visually observed for oestrus for a period of twelve months. 188 and 99 inseminations were given to the control and prostaglandin $F_2\alpha$ treated groups respectively. The inseminations were given at time intervals of 1-6, 7-12, 13-18, and 19-24 hours after onset of oestrus during winter, hot dry summer and hot wet summer. During the three seasons, inseminations were carried out in cows at postpartum interval of 41-60, 61-80, 81-100, 101-120, 121 and over days. The trial was conducted in Cows at parities 1 and 2 as a group, and parities 3 and over as a separate group. The optimum time of insemination to achieve the highest conception rates was at 13-18 hours in the control group of Cows. Winter had the highest conception rates compared to other seasons. Cows at postpartum intervals of 121 and over days had the highest conception rates. Conception rates in cows at parities 1 and 2 had the highest conception rate compared to other parities. The present study revealed that the control group of cows had the highest conception rates when inseminations were at 13 – 18 hours after onset of oestrus compared to prostaglandin $F_2\alpha$ treated cows.

Keywords: cows, Holstein – Friesian, conception, insemination, optimum time, onset of oestrus

1. Introduction

Basic information on the onset of oestrus and the optimum time of artificial insemination is needed in order to achieve maximum conception rates in Holstein-Friesian dairy cows maintained under tropical conditions in the Sudan. Considerable information relative to such needs has been accumulated from the temperate regions of the world (Trimberger and Davis, 1943; Hall *et al*. 1959; Demirci *et al*, 1992; Nebel *et al*, 2000), but information from tropical regions is scarce. Therefore, methods to improve conception rates through improved detection of oestrus and optimum time of insemination could have significant impact on the dairy industry of the Sudan. Most artificial inseminations carried out in the Sudan yield low conception rates (A.I report, 2001) because farmers and farm workers fail to determine the exact time of oestrus onset in their herds. The exact time of oestrus onset could not be determined because farm workers do not spend enough time in the process of oestrus detection, and even no specific workers are assigned for oestrus detection. The problem is further aggravated by the occurrence of oestrus onset at very awkward times during 24 hours of the day (Senger, 1990; Nebel, 1999). Many environmental influences interfere with expression of oestrus in the herds. Environmental influences could be attributed to high ambient temperatures during the hot summer months of March to October. These temperatures inhibit or shorten the expression of oestrus, and cows that are seen in oestrus are haphazardly inseminated without the knowledge of the exact interval from onset of oestrus to the time of insemination. The time of artificial insemination to achieve the highest conception rates depends on the frequency of oestrus detection and the efficiency of the method for detecting oestrus. Visual observation is more reliable than other methods (Nebel, 1998), but observation for oestrus should be continuous throughout the 24 hours of the day. Individual cow variation in the interval from calving to insemination, parity of the cow at insemination and different climate conditions further complicate the interpretations and recommendation for the optimum time of insemination. The main objective of this study was to determine the optimum time of insemination after onset of oestrus in Holstein-Friesian dairy Cows. The specific objectives of the study were:

(i) To determine the relationship between conception rate and time of insemination during oestrus,

(ii) To determine the influence of season and time of insemination during oestrus on the conception rate,

(iii) To determine the influence of days postpartum and time of insemination during oestrus on conception rate,

(iv) To determine the influence of parity and time of insemination during oestrus on the conception rate.

2. Material and Methods

2.1 The Study Area

This study was conducted at the Dairy unit of the Arab Company for Agricultural Production and Processing (Sudan) Limited. The unit is located in the area of Bagier on the western bank of Blue Nile River, about 30 Km South of Khartoum. Its location is at approximately latitude 15º 33´ N and altitude 380 metres above Sea level. The area has three marked Seasons, namely winter (November to February), hot dry summer (March to June) and hot wet summer (July to October). The annual rainfall in the period 1971 to 2000 was 121.4 mm. Average minimum and maximum temperatures of 17.0º and 34.9º C were respectively recorded. On average the soil of the area is sandy clay. Its structure is poorly developed due to the dominance of the clay mineral, montmorillonite, and the presence of exchangeable sodium in critical amounts. Soil reaction is moderately to highly alkaline. The pH value is 1.5, and Suspension is in the range of 9.5 – 10. Soil salinity in general is low to medium in the top soil, but increases with depth.

2.2 The Study Herd

The herd which was studied, consisted of only Holstein – Friesian stock. The herd numbered 559 head at the time of this study and no bulls ran with the Cows. From the reproductive records kept on the farm, the herd was segregated into reproductive management groups as outlined by Britts (1977) as Follows:

Group	Animals in Group
(1)	(i) Early postpartum Cows; Prebreeding (ii) Breeding group (iii) Problems Cows; open more than 120 days.
(2)	Pregnant Cows; Lactating.
(3)	Pregnant Cows; non Lactating.

After the classification scheme, reproductive records for each of the Cows in group one (1) were checked and evaluated, and Cows with reproductive health problems were removed from the population. Samples for this study were randomly selected from the group of Cows without reproductive problems. The selected Cows were then identified with clearly numbered plastic ear tags that enabled identification of each cow from a distance of about 10 metres. After identification and evaluation of records, routine spraying of the whole herd with antiparasitic drugs was started in order to keep the herd free from external parasites; mainly ticks.

2.3 The Experimental Cows

The experimental cows were randomly assigned to control and prostaglandin $F_{2}\alpha$ treated groups. 146 Cows were assigned to the control group and 92 Cows to prostaglandin $F_{2}\alpha$ treated group. From those cows 188 and 99 inseminations were given to the control and prostaglandin $F_{2}\alpha$, treated groups respectively. Those inseminations were given at time intervals of 1-6 7-12, 13-18, and 19-24 hours after onset of oestrus. From 188 inseminations, 62 were given in winter, 79 during the hot dry summer and 47 during the hot wet summer. From 99 inseminations, 44 were given during winter, 20 during hot dry summer and 35 during hot wet summer. During the three seasons, inseminations were given at postpartum interval of 41-60, 61-80, 81-100, 101-120, 121 and over days. The inseminations were also carried out in cows at parities 1 and 2 as a group and parities 3 and over as a separate group.

2.4 Oestrus Detection

Oestrus was detected visually in the experimental cows by a team of two trained heat detectors, one A.I technician and senior author. The control group of cows were selected randomly for each of the 12 months of the year, and observed visually for oestrus continuously throughout the day and night for a period of 30 days. The prostaglandin $F_2\alpha$ treated group of cows were also selected randomly from the experimental cows for each of the 12 months of the year, and observed visually for oestrus throughout the day and night for 168 hours following the first prostaglandin $F_2\alpha$ treatment (dose). The time of the day that cows were initially observed in oestrus and hours of A.I were recorded for each cow.

2.5 Insemination of the Experimental Cows

Two inseminators carried out all inseminations using the recto-cervical method. Deep frozen semen from 4 bulls packed in 0.25 ml plastic straws and stored in liquid nitrogen at –196° C was used for A.I. during the 12 months; Semen was thawed in warm water at 35° C for 30 seconds. Cows identified in standing oestrus and confirmed fit for insemination were removed to the insemination stalls. A small farm Semen tank, thermos Flask with hot water, 1-pint wide mouth thermos with cool water, and a box of insemination equipment were transferred from their location of storage to the insemination area. The 1-pint wide mouth thermos was opened and the temperature of the cool water in it was raised to 35° C. With a pair of forceps, a straw was removed from the Semen tank and immediately immersed in warm water at 35° C in the 1-pint wide mouth thermos flask for 30 seconds. After the Semen straw was thawed for 30 seconds, it was removed from the thermos with a pair of forceps and dried thoroughly with a paper towel to protect it from rapid cooling. The straw was then transferred to the insemination gun, and the tip of the crimp-sealed end of the straw was clipped squarely through the air space with a pair of scissors. The insemination gun was then sealed tightly with a plastic sheath. The assembled insemination gun was then wrapped in a clean, dry paper towel, and tucked within the clothing of the inseminator. The inseminator moved to the cow to be inseminated. He first inserted his gloved left hand into the rectum of the cow to locate and grasp the cervix through the rectal wall. The lips of the vulva of the cow were cleaned with a sterile paper towel to avoid contamination of the insemination gun. The insemination gun was then inserted at 30° through the vulva into the vagina and cervix, and the gloved left hand was used to thread the end of the insemination gun through the irregular cervical canal. Semen was then deposited into the cervix at the posterior end, and the insemination gun was removed slowly. Time between removal of Semen straw from frozen storage and insemination was less than 15 minutes.

2.6 Pregnancy Diagnosis

Pregnancy diagnosis was determined by rectal palpation at 60 to 90 days after insemination. One veterinarian, the senior author, and two inseminators carried out the pregnancy diagnosis. A gloved hand was gently inserted through the anus into the rectum, and faeces evacuated by gentle stimulation of the normal defecation reflex. Location and identification of the uterus was by palpating the cervix and bifurcation of the uterine horns. At 60 days there was enlargement of one horn with detectable dorsal bulging. There was thinning of the uterine wall with fluid filled feeling. The pregnant horn was dropping, slightly over the brim of the pelvis, and was feeling like a balloon filled with water. The foetus could be thumped by pressing against the outer curvature of the uterine horn and then moving the hand slightly but quickly posteriorly. The corpus luteum of pregnancy was on the ovary adjacent to the pregnant uterine horn. In the pregnant cow the middle uterine artery was enlarged, and pulsation from it was much more forceful, indicating a greater volume of blood flow.

2.7 Statistical Analysis

Data were analysed using MINITAB ® for windows Inc. personal computer release 11.12 32 Bit (1996).

1. Data on the relationship between conception rate and time of insemination during oestrus were analysed using Chi-Squared test for trend which has 1 degree of freedom; this was described by Kirkwood (1988). The first step was to assign scores, 1, 2, 3 and 4 to the columns to describe the shape of the trend. The next step was to calculate three quantities for each column of the table and to sum the results of each. These were:

(i) rx, the product of the entry, r, in the top row of the column and the score, x,

(ii) nx, the product of the total, n, of the column and the score, x and

(iii) nx^2, the product of the total, n, of the column and the square of the score, x^2. Using N to denote the overall total and R the total of the top row, the formula for the chi-squared test for trend is:

$$X^2 \text{ trend} = \frac{(|A|-0.5)^2}{B}, \text{d.f.} = 1$$

$$\text{Where } A = \frac{\sum(rx) - R\sum(nx)}{N} \text{ and,}$$

$$B = \frac{R\,(N-R)}{N^2\,(N-1)}\ \{\,N\sum nx^2) - (\sum nx)^2\}$$

2. Data on the influence of season, days postpartum, and parity on the time of insemination during oestrus were analysed by first carrying out the chi-squared trend test on each subset. A summary test was then used to combine the evidence from separate trends taking into account the confounding as described by Kirkwood (1988). This is a chi-squared test, which has 1 degree of freedom, irrespective of the number of sunsets. The X^2 value is:

Summary X^2 trend = $\frac{(|\sum A|-0.5)^2}{\sum B}$, d.f. = 1

3. Results

3.1 Relationship Between Conception Rate and Time of Insemination During Oestrus

Conception rates at different time intervals from onset of oestrus to insemination are shown in figure 1. Conception rate was highest in the control group of cows inseminated at 13-18 hours after onset of oestrus. Both control and prostaglandin $F_2\alpha$ treated cows gave an equal conception rate at 7-12 hours after onset of oestrus, but there was a sharp drop in the conception rate when prostaglandin $F_2\alpha$ treated cows were inseminated at 13-24 hours after onset of oestrus.

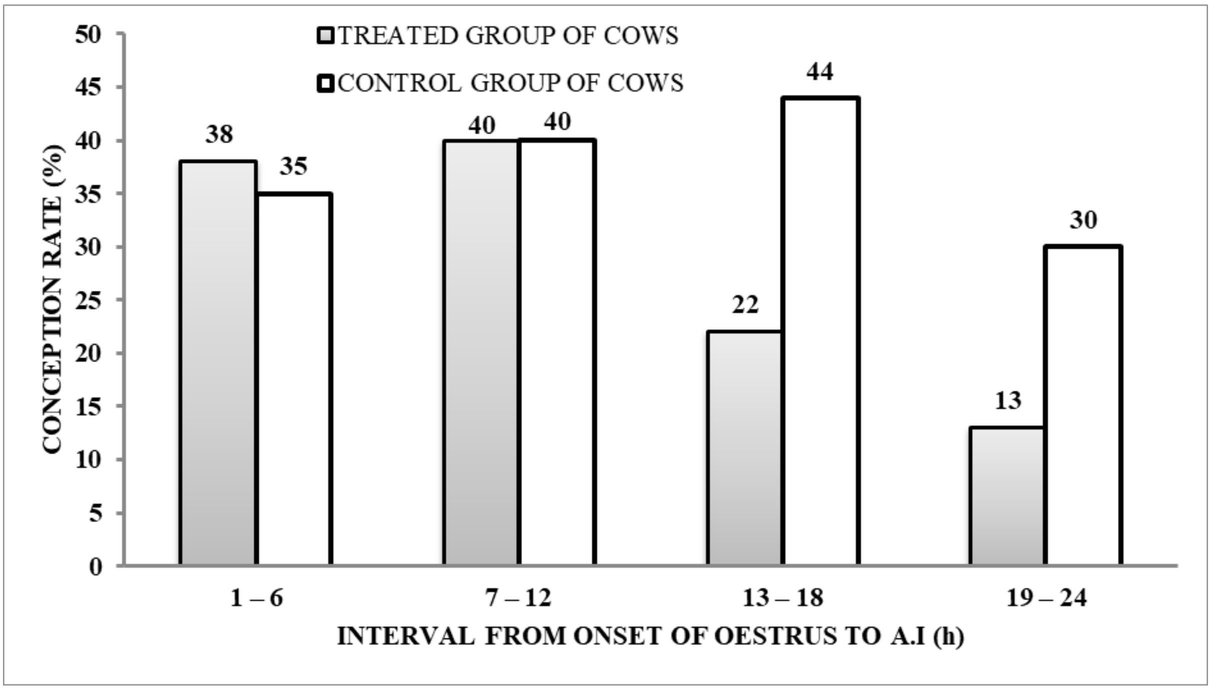

Figure 1. Effect of Interval from Onset of Oestrus to Insemination on Conception rate in Holstein-Friesian cows inseminated with frozen-thawed semen

Table 1. Influence of time of A.I on the conception rate in Holstein – Friesian cows

Treatment	**Time from onset of oestrus to AI (h)**				**Total**
	1 – 6	**7 – 12**	**13 – 18**	**19 – 24**	
		No. conceived/Total No.			
Control	**19/54 (35)**	**20/50 (40)**	**27/50 (44)**	**7/23 (30)**	**73/188 (39)**
Treated	**10/26 (38)**	**12/30 (40)**	**6/30 (22)**	**2/16 (13)**	**30/99 (30)**
Total	**29/80 (36)**	**32/80 (40)**	**33/88 (38)**	**9/39 (23)**	

The influence of time of insemination on the conception rate is shown in table 1. Conception rate was 9% higher in the control group of cows compared to the prostaglandin $F_2\alpha$ treated cows. Chi-squared comparison showed that there was no significant association (p>0.75) between the control and treated cows in the conception rate at different insemination intervals for the overall.

3.2 Influence of Season and Time of Insemination During Oestrus on the Conception Rate

The influence of winter, hot dry summer and hot wet summer on the conception rate is shown in table 2. Winter yielded the highest conception rate of 51% compared to 33% during the hot dry summer and 20% during the hot wet summer. Inseminations at 13-18 hours after onset of oestrus in the control group of cows yielded conception rates of 67% in winter, 40% during the hot dry summer and 18% during the hot wet summer. Inseminations at 13-18 hours after onset of oestrus in the prostaglandin $F_2\alpha$ treated cows yielded conception rates of 36% in winter, none during the hot dry summer and 11% during the hot wet summer. Chi-squared comparison among three seasons showed that there was no significant association (p>0.75) between the control and treated cows in the conception rates at different insemination intervals.

Table 2. Influence of Season and Time of Insemination during Oestrus on the Conception rate in Holstein – Friesian cows

Season	Treatment	Time from onset of oestrus to AI (h)				Total
		1 – 6	7 – 12	13 – 18	19 – 24	
		No. conceived/Total No.				
Winter	Control %	6/13(46)	10/18(56)	16/24(67)	4/7(57)	36/62(58)
	Treated %	4/9(44)	7/13(54)	5/14(36)	2/8(25)	18/44(41)
	Total %	10/22(39)	17/31(55)	21/38(55)	6/15(40)	54/106(51)
Hot dry summer	Control %	11/28(39)	9/20(45)	8/20(40)	2/11(18)	30/79(38)
	Treated %	2/6(33)	1/6(17)	0/4(00)	0/40(00)	3/20(15)
	Total %	13/34(38)	10/26(38)	8/24(33)	2/15(13)	33/99(33)
Hot wet summer	Control %	2/13(15)	1/12(8)	3/17(18)	1/5(20)	7/47(15)
	Treated %	4/11(36)	4/11(36)	1/9(11)	0/4(00)	9/35(26)
	Total %	6/24(25)	5/23(22)	4/26(15)	1/9(11)	16/82(20)

The conception rate in winter for the control group of cows was 58% compared to 41% in the prostaglandin $F_2\alpha$ treated cows. A higher conception rate of 67% in the control group of cows compared to 36% in the treated cows occurred when inseminations were at 13-18 hours after onset of oestrus in winter. Chi-squared comparison during winter showed that there was no significant association ($p>0.9$) between the control and treated cows in the conception rates at different insemination intervals. The conception rate in the hot dry summer for the control group of cows was 38% compared to 15% in the prostaglandin $F_2\alpha$ treated cows. A higher conception rate of 45% in the control group of cow compared to 17% in the treated cows occurred when inseminations were at 7-12 hours after onset of oestrus. Chi-squared comparison during the hot dry summer showed that there was no significant association ($p>0.9$) between the control and treated cows in the conception rate at different insemination intervals. The conception rate in the hot wet summer for the control group of cow was 15% compared to 26% in the prostaglandin $F_2\alpha$ treated cows. Conception rate was generally poor for the control group of cows during the hot wet summer compared to the prostaglandin $F_2\alpha$ treated cows, chi-squared comparison during the hot wet summer showed that there was no significant association ($p>0.9$) between the control and treated cows in the conception rate at different insemination intervals.

3.4 Influence of Days Postpartum and Time of Insemination during Oestrus on the Conception Rate

The conception rates for different postpartum insemination intervals are shown in table 3. The conception rate at 41-60 days postpartum for the control group of cows was 23% compared to 26% in the prostaglandin $F_2\alpha$ treated cows. At 41-60 days postpartum the conception rate appeared optimal when the control and treated cows were inseminated at 19-24 hours after onset of oestrus. Chi-squared comparison at 41-60 days postpartum showed that there was no significant association ($p>0.9$) between the control and treated cows in the conception rates at different insemination intervals. The conception rate at 61-80 days postpartum for the control group of cows was 30% compared to 43% in the prostaglandin $F_2\alpha$ treated cows. A higher conception rate of 50% in the control group of cows compared to none in the treated cows occurred when inseminations were at 19-24 hours after onset of oestrus. A higher conception rate of 75% in the treated cows compared to non in the control group of cows occurred when inseminations were at 1-6 hours after onset of oestrus. Chi-squared comparison at 61-80 days postpartum showed that there was no significant association ($p>0.75$) between the control and treated cows in the conception rates at different insemination intervals.

The conception rate at 81-100 days postpartum for the control group of cows was 37% compared to 29% in the prostaglandin $F_2\alpha$ treated cows. The conception rate ranged from 43% at 1-6 hours to 20% at 19-24 hours after onset of oestrus in the control group of cows. The treated group of cows had the highest conception rate of 50% at 7-12 hours compared to none at 13-18 hours after onset of oestrus. Chi-squared comparison at 81-100 days postpartum showed that there was no significant association ($p>0.75$) between the control and treated cows in the conception rate at different insemination intervals.

The conception rate at 101-120 days postpartum for the control group of cows was 32% compared to 17% in the prostaglandin $F_2\alpha$ treated cows. At 101-120 days postpartum, conception rate appeared to be optimal when the treated cows were inseminated at 7-12 hours after onset oestrus. Chi-squared comparison at 101-120 days postpartum showed that there was no significant association (p>0.5) between the control and treated cows in the conception rate at different insemination intervals.

Table 3. Influence of days postpartum and time of insemination during oestrus on the conception rate in Holstein – Friesian cows

Days postpartum	**Treatment**	**Time from onset of oestrus to AI (h)**				**Total**
		1-6	7-12	13-18	19-24	
		No. conceived/total No.				
41 – 60	Control %	2/10 (20)	1/9 (11)	3/10 (30)	1/1 (100)	7/30(23)
	Treated %	3/10 (30)	1/6 (17)	1/4 (25)	1/3 (33)	6/23(26)
	Total %	5/20 (25)	2/15 (13)	4/14 (29)	2/4 (50)	13/53(25)
61 – 80	Control %	0//2 (00)	4/12 (33)	3/11 (27)	1/2 (50)	8/27(30)
	Treated %	3/4 (75)	5/12 (50)	5/13 (38)	0/3 (00)	13/30(43)
	Total %	3/6 (50)	9/22 (41)	8/24 (33)	1/5 (20)	21/57(37)
81 – 100	Control %	3/7 (43)	3/8 (38)	4/10 (40)	1/5 (20)	11/30(37)
	Treated %	2/5 (40)	3/6 (50)	0/3 (00)	1/7 (14)	6/21(29)
	Total %	5/12 (42)	6/14 (43)	4/13 (31)	2/12 (17)	17/51(33)
101 – 120	Control %	3/5 (60)	2/6 (33)	2/8 (25)	0/3 (00)	7/22(32)
	Treated %	0/0 (00)	1/2 (50)	0/4 (00)	0/0 (00)	1/6(17)
	Total %	3/5 (60)	3/8 (38)	2/12 (17)	0/3 (00)	8/28(29)
121 and over	Control %	11/30(37)	10/15(67)	15/22(68)	4/12 (33)	40/79(51)
	Treated %	2/7 (29)	2/6 (33)	0/3 (00)	0/3 (00)	4/19(21)
	Total %	**13/37(35)**	**12/21(57)**	**15/25(60)**	**4/15(27)**	**44/98(45)**

The conception rate at 121 and over days postpartum for the control group of cows was 51% compared to 21% in the prostaglandin $F_{2}\alpha$ treated cows. The highest conception rate of 68% occurred in the control group of cows when insemination was at 13-18 hours after onset of oestrus. The conception rate also appeared to be optimal when the treated cows were inseminated at 7-12 hours after onset of oestrus. Chi-squared comparison at 121 and over days postpartum showed that there was no significant association (p>0.9) between the control and treated cows in the conception rate at different insemination intervals.

3.5 Influence of Parity and Time of Insemination during Oestrus on the Conception Rate

The conception rates for different parity groups are shown in table 4. The conception rates for cows at parities 1 and 2 was 40% for the control group of cows, and 33% for the prostaglandin $F_2\alpha$ treated cows. The highest conception rate of 44% in the control group of cows compared to 15% in the treated cows occurred when inseminations were at 13-18 hours after the onset of oestrus. The highest conception rate of 47% in the treated cows compared to 38% in the control group of cows occurred when inseminations were at 7-12 hours after the onset of oestrus. Chi-squared comparison for parities 1 and 2 showed that there was no significant association (p>0.9) between the control and treated cows in the conception rate at different insemination intervals. The conception rate for cows of parities 3 and over was 38% for the control group of cows, and 28% for the prostaglandin $F_2\alpha$ treated cows. The highest conception rate of 44% in the control group of cows compared to 29% in the treated cows occurred when insemination were at 13-18 hours after the onset of oestrus. Furthermore, conception rate appeared to be optimal when the treated cows were inseminated at 1-12 hours after the onset of oestrus. Chi-squared comparison for parities 3 and over showed that there was no significant association (p>0.9) between the control and treated cows in the conception rate at different insemination intervals.

Table 4. Influence of parity and time of insemination during oestrus on the conception rate

Parity	**Treatment**	**Time from onset of oestrus to AI (h)**				**Total**
		1 – 6	**7 – 12**	**13 – 18**	**19 – 24**	
		No. conceived/Total No.				
1 and 2	Control %	15/40(38)	8/21(38)	16/36(44)	4/11(36)	43/108(40)
	Treated %	5/11(45)	7/15(47)	2/13(15)	2/10(20)	16/49(33)
	Total %	20/51(39)	15/36(42)	18/40(37)	6/21(29)	59/157(38)
3 and over	Control %	4/14(29)	12/29(41)	11/25(44)	3/12(25)	14/50(28)
	Treated %	5/15(33)	5/15(33)	4/14(29)	0/6(00)	14/50(28)
	Total %	9/29(31)	17/44(39)	15/39(38)	3/18(17)	44/130(34)

4. Discussion

The results on the relationship between conception rate and time of insemination during oestrus demonstrated that insemination of the control group of cows at 13-18 hours after onset of oestrus yielded the highest conception rate of 44%. Insemination of both control and prostaglandin $F_2\alpha$ treated cows at 7-12 hours after onset of oestrus gave equal conception rates of 40%. These results agree with the previous work of Demirci *et al* (1992) who reported the highest conception rate of 63.89% when insemination was at 13-18 hours after onset of oestrus compared to inseminations carried out earlier or later than this time. Nebel et al (2000) obtained the optimum time of insemination at 5-17 hours after standing oestrus. Maatje et al (1997) reported the highest conception rate at 6-17 hours after onset of oestrus. Other workers found that insemination earlier than 13 hours after onset of oestrus yielded the highest conception rate. Hall et al (1959) reported that fertility was highest for insemination made at 7-12 hours after onset of oestrus. Deinhardt and Mulller (1978) reported the highest conception rate of 66% when insemination was at 12 hours compared to those at 13-18, 19-24, and over 24 hours after onset of oestrus. Other workers failed to detect the exact time interval when insemination would give the best conception rate. Carpenter (1976) reported that conception rates were not affected by the interval between detection of oestrus and time of insemination up to about 20 hours. Diniz et al (1983) noticed no significant differences in conception rates to inseminations carried out at 8-10, 10-12, 12-14, or 14 hours and later after the start of overt oestrus. The comparison of conception rates between control and treated cows showed that control cows had higher conception rate than treated cows. These results disagree with what was reported in the literature. McIntosh et al (1984) reported an increase in the conception rate by 4 to 7% in the prostaglandin $F_2\alpha$ treated cows than the control group of cows. The conception rate in the treated cows declined rapidly after 12 hours from onset of oestrus. This is in agreement with Mukasa et al (1989) who reported that conception rate in 3 prostaglandin $F_2\alpha$ treated cows inseminated at 6, 12, or 18 hours after onset of oestrus were 56, 33, and 33% respectively. Other workers noticed no effect of prostaglandin $F_2\alpha$ treatment on the conception rate. Armstrong *et al* (1989) reported that conception rate was not affected by prostaglandin $F_2\alpha$ treatment. The results on the influence of season and time of insemination during oestrus on the conception rate showed that winter (November to February) had the best conception rate in both control and treated cows compared with those of hot dry summer (March to June) and hot wet summer (July to October). These results agree with most of the reports in the literature. Gusmao (1975) reported the best conception rates from November to February. Rodriguez (1980) noticed that cows mated in January to February at average temperature of 15.9-16.9^{o} C had better conception rates than those mated in July to August at average temperatures of 31.5 – 32.5^{o} C. Lopez (1987) reported the highest conception rates of 68.53, 81.65 and 66.66% in November, December, January, and February compared to other months of the year. Monty and Wolff (1974) noticed the lowest fertility during very hot months of July, August and September. Rodriguez et al (1980) reported higher conception rates in the dry than the rainy season. High environmental temperatures and humidity were confirmed by many workers as the responsible causes of low conception rates. Vincent (1972) reported that heat stress lowered conception rates, induced abortion and increased prenatal mortality. Lozano et al (1992) reported that fertility was adversely affected by increases in temperature and rainfall. The differences in conception rates as attributed to changes in hormonal secretions during periods of increasing or decreasing ambient temperature were noticed by some workers. Rosenberg *et al* (1977) reported a conception rate of 51% in summer compared to 75% in winter, and in cows inseminated in summer, the conception rate was related to the progesterone curve in the cycle proceeding insemination. The conception rate at 121 and over days postpartum was the highest compared to those at earlier postpartum intervals. This was followed by conception rate at 61-80 days postpartum, and conception rate at 41-60 days postpartum was the least. The highest conception rates found in this investigation agree with some reports in the literature. Schermehorn *et al* (1984) reported the highest conception rate of 54-64% between 120 and 150 days postpartum. Elochevskii (1970) showed that cows inseminated at 121-180 days postpartum gave the highest conception rate of 62-70%. Other investigators found the highest conception rate at 61-90 days postpartum. Krasnow (1970) found the highest conception rate of 74.8% at 61-90 days postpartum. Martynov and usoljceva (1971) reported the highest conception rate at 41-60 days postpartum. The low conception rate at 41 – 60 days postpartum in our result could be attributed to the negative energy balance and rate of mobilization of body reserves from cows during this time period. The conception rate in cows at parities 1 and 2 were higher compared to those at parities 3 and over. This agrees to what is reported in the literature. Plasse et al (1978) reported the highest conception rate of 55.74% at parity one. Kumar (1982) reported that reproductive performance was best at parity two. Izaike *et al* (1984) reported the highest conception rate of 63.6% at parity one. A few investigators reported the highest conception rate in multiparous cows. Godffrey *et al* (1989) reported the highest conception rate in multiparous cows and lowest conception rate in nulliparous heifers. Padzo *et al* (1993) reported the highest conception rate of 75-79.1% in cows at 4-7 years of age.

5. Conclusion

This study showed that the optimum time of insemination with the highest conception rate was at 13-18 hours after onset of oestrus in the control group of cows. Prostaglandin $F_2\alpha$ treated cows gave desirable conception rates when inseminations were at 7-12 hours after onset of oestrus compared to later hours. The results of this investigation are the product of a single herd of Holstein-Friesian dairy cows housed in a loose housing system with concrete floor. It is known that many factors are likely to affect the reproductive capacity of the Holstein-Friesian cows under tropical conditions. The authors do not know the extent to which these results and conclusions can be generalized to other herds with other management routines and systems. It would be of benefit if extensive investigations are carried out on oestrus detection and the timing of insemination after onset of oestrus within and among herds in other situations. The exact cause of poor conception rates in relation to the timing of insemination postpartum should be investigated by first considering the conditional status of the cow, ambient temperature and relative humidity at the time of insemination.

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