Controlled Breeding of Dairy Heifers: Observations over a Five Year Period

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Abstract

Over a five year period from 1979 to 1983, 191 Holstein-Friesian heifers were artificially inseminated at present times following estrus synchronization with two injections of prostaglandin analogue 11 days apart. The heifers were not selected prior to synchronization and no heat detection methods were used. Overall conception rates for the five year period were 59.8% on timed inseminations; however, the pregnancy rates ranged from 50% in Years 3 and 5 to 76.2% in Year 4. The average interval from first to last calving for groups of heifers which conceived to synchronized insemination was 19 days. There was no significant difference in conception rates between heifers that were greater than 16 months of age and those less than 16 months old.

Introduction

Intensified management systems, such as are found in large dairy farms with confinement housing, can lead to difficulties in maintaining desirable herd reproductive efficiency (1). A considerable amount of time is required to observe animals for behavioural signs of estrus. The economic advantages of early postpartum breeding and reduced open intervals are well documented (2, 3). Estimates of economic loss in cows with open intervals that exceed 85 days postpartum are significant (4, 5).

In a similar context, the age at first calving can exert a profound effect on lifetime profitability of dairy cattle (6). It is generally recommended that heifers are bred to calve between 24 and 28 months of age (7). Replacement heifers of breeding age are often housed in barns or on pastures that may be some distance from the location of the milking herd. It is common for them to be observed only once daily, usually at feeding time. During pasture season, heifers may not be observed for intervals of several days at a time.

The bovine estrus cycle can be regulated by the administration of prostaglandin F_2alpha or one of its analogues (8). Programs for controlled breeding usually involve injection of a prostaglandin product at 10 to 12 day intervals, so that most treated individuals will show estrus at a predetermined time (9, 10). In theory, this system of planned insemination has great promise as a management tool. Groups of heifers can be mated when their age and size characteristics and the available labour are at an optimum. The additional investment for prostaglandin product would be outweighed by reduced labour costs and improved profitability of heifers calving at the desired age. Fertility of the estrus following treatment with prostaglandin F_2alpha or its analogues appears to be normal (11, 12). However, the pregnancy rates following synchronization will vary depending upon the program used. In recent studies in both dairy heifers (13) and lactating dairy cows (14), the first service conception rates were lower in animals synchronized by double prostaglandin injection than in controls bred at a naturally occurring estrus. The major reasons for the lower pregnancy rates with prostaglandin synchronized estrus has been improperly timed insemination (13, 15). The day of the cycle on which the prostaglandin is administered has been shown to affect the time from injection to standing estrus (16, 17). The recommended interval from the second prostaglandin injection to the fixed time insemination in dairy heifers is 60 to 72 hours (16, 17).

This report presents the conception rates resulting from prostaglandin-controlled breeding in dairy heifers, over a five year period; from 1979 to 1983. The relationship of due dates to the actual calving date of the synchronized heifers is also described. The effect of age at the time of estrus synchronization on resulting conception rate is outlined. The measurements for climatic factors, such as rainfall and environmental temperature, for the year's observed are presented.

Materials and Methods

Routine Procedures

Holstein replacement heifers from a large dairy research unit were used in the experiment. At 10 to 12 months of age, they were moved from the main housing unit and milking facility to a location approximately 40 km away. During the winter months, the heifers were confined to large loose pens and were fed grain and mixed legume hay. In late May, the heifers were put on a grass-legume pastures and were rotated through several pasture fields as needed. If pasture diminished in late summer, they were given supplementary grain.

The milking herd was organized on a block calving rather than on a continuous calving basis, with three main breeding periods commencing in March, June and November of each year. All matings were by artificial insemination with frozen semen. Services were available for six consecutive weeks during each breeding season. Inseminations in the replacement heifer group were provided during the same time periods, in order to accommodate the batch calving system of the milking herd.

Synchronized Groups

In each of the five years studied, synchronization involved a regimen of two injections of prostaglandin, beginning in late June or early July. Each heifer was injected intramuscularly with 500 ug cloprosterol[1]. The heifers were not observed for estrus and were not inseminated following the first injection. At 11 days subsequent to the initial treatment, all heifers received a second intramuscular injection of 500 ug cloprostenol. All heifers were inseminated at a fixed time without estrus detection. The number of inseminations and the exact times used did not remain consistent throughout the five years. In Year 1 (1979) and Year 2 (1980), two fixed-time inseminations were used, at 72 and 96 hours following the second cloprostenol injection. In Year 3 (1981), Year 4 (1982) and Year 5 (1983), the heifers were inseminated at one fixed-time, 76 hours after the second treatment.

In Year 3 and Year 5, an additional breeding period was used. Between 18 and 24 days post-insemination, all heifers were removed from pasture, housed in the loose pens and exercise yard and observed intensively for signs of estrus. Any heifer showing signs of standing estrus was inseminated. Pregnancies resulting from this repeat breeding were not calculated in the conception rates resulting from synchronized estrus, however are commented on as separate data.

Climatic information such as the amount of precipitation and the mean daily temperature were derived from a nearby airport weather office (8 km). The relationship of the environmental conditions to conception rates over the five year period was compared.

One of the primary aims of controlled breeding of dairy heifers is to maintain a desirable age at first calving. In a practical context, the stimulus to use a controlled breeding in replacement heifers may be that a particular group are reaching an undesirably late breeding age. The effect of age at the time of estrus synchronization on resulting conception rates was compared over the five year period. An arbitrary age of 16 months was chosen to analyse the statistical differences between conception rates of different age groups using standard statistical procedures (ANOVA) (18).

[1]*Estrumate, ICI Pharmaceuticals, Mississauga, Ont.*

Results

The conception rates over the five year period of the study are presented in Table 1. Using two injections of prostaglandin analogue plus fixed time insemination, 114 of 191 (59.8%) conceived at the synchronized estrus. The pregnancy rates ranged from 76.2% in Year 4 to 50% in Years 3 and 5. In Year 3 and Year 5, seven and three heifers, respectively, became pregnant to breed in 22 days after the synchronized insemination. The inclusion of these heifers improved the overall conception rates for the entire breeding period to 67.5% in Year 3 and 61.5% in Year 5.

In each of the years studied, heifers that had conceived to synchronized insemination had relatively widespread calving dates (Table 1). For example, in Year 1 there was a 22 day interval between the calving dates of the first and last of 19 heifers inseminated at the same time. This interval began 13 days ahead of the expected (285 day) due date and continued until eight days beyond this date. A majority of the group (13 of 19) calved prior to due date. Similar findings are reported for the other four years.

TABLE 1. Five Year Comparison of Conception Rates after 2 Dose PG Treatment.

	1979	1980	1981	1982	1983	Totals
No. of heifers treated[a]	30	53	40	42	26	191
Time from treatment to insemination (hrs)	72 & 96	72 & 96	76	76	76	
No. of heifers pregnant to synchronized AI (%	19	30	20	32	13	114
Conception rate to synchronized AI	63.3	56.6	50.0	76.2	50.0	59.7
Days from first to last calving in synchronized heifers	22	16	17	24	10	
Days −/+ due date of actual calving date	—13 to +8	—8 to +7	—8 to +8	—9 to +15	—7 to +2	

[a]Heifers were treated with Estrumate (cloprostenol, 500 ug, two injections 11 days apart).

The conception rates of heifers greater than 16 months of age compared to those less than or equal to 16 months of age varied widely. However, these differences are inconsistent from year to year. In Years 1 and 3, younger heifers had superior conception rates. In Year 2, Year 4 and Year 5, conception rates were higher in the older heifers. Over the five year period, differences in conception rates between age groups were not statistically significant. ($p>0.05$).

TABLE 2. Effect of Heifer Age on Conception Rates.

	1979	1980	1981	1982	1983	Totals
A. ≤16 months						
No. of heifers	16	22	17	11	8	74
Conception Rate (%)	68.8	45.5	64.7	54.5	25.0	54.1[a]
(No. pregnant)	(11)	(10)	(11)	(6)	(2)	(40)
>16 months						
No. of heifers	14	31	23	31	18	117
Pregnancy Rate (%)	57.1	64.5	39.1	83.9	61.1	63.2[a]
No. pregnant	(8)	(20)	(9)	(26)	(11)	(75)

[a] Differences were not statistically significant ($p > 0.05$).

The prevailing climatic conditions for the five years studied are presented in Table III. Mean total rainfall per month for the past 16 years and means of the average daily temperatures for the past 14 years were calculated in order to provide some comparisons. In Year 4, which produced a considerably higher conception rate than other years, the mean temperature in May was much warmer than normal and in June was much cooler than normal. The mean was the same for both months (14.9°C). Also, rainfall in May and June was higher than the average for 16 previous years. In Year 3 and Year 5, which had the poorest conception rates, the mean daily temperature was cooler than average in May and warmer than average in June. The differences in mean temperatures from May to June was 5.9°C for Year 3 and 7.8°C for Year 5.

TABLE 3. Effect of Climatic Conditions on Conception Rates.

		1979	1980	1981	1982	1983	Avg.
Conception Rate (%)		63.3	56.6	50.0	76.2	50.0	
Total Rainfall							
	May	85.8	70.6	52.0	90.4	140.2	76.2[a]
	June	85.8	75.0	74.2	117.4	54.6	74.9
	July	29.6	82.8	77.0	75.6	96.2	74.6
	Aug.	89.9	47.4	93.0	152.7	81.5	84.2
per month of pasture season (mm)							
Average daily temp. (°C)							
	May	11.3	13.2	11.2	14.9	9.9	12.4[b]
	June	16.8	15.0	17.1	14.9	17.7	16.9
	July	19.9	20.0	19.9	19.7	21.3	19.7
	Aug.	17.7	20.7	18.6	16.4	19.3	18.6

[a] Mean rainfall (mm) per month for the period 1968-1983.
[b] Mean daily temperature (°C) per month for the period 1970-1983.

Discussion

The overall conception rate for the 191 heifers on the controlled breeding program of the current five year study was 59.8%. This rate is similar to or slightly less than the pregnancy rates reported in other studies (9, 13, 14, 17). There is agreement that improvements in these results are needed. It is important to give careful consideration to several aspects of trial design when comparing the results of field studies. The selection of heifers prior to synchronization (9), the day of the cycle on which treatment was administered (16), inclusion of a heat detection program in the protocol (14) and the interval from treatment to timed insemination (17) have all been shown to affect the resulting pregnancy rates.

In the current study there was no selection of heifers prior to synchronization. All available heifers of appropriate size and age characteristics were used in the program. The prevalence of anestrus due to ovarian inactivity or ovarian pathology was unknown, as rectal examinations and/or progesterone profiles were not performed prior to treatment. The elimination of those heifers showing no evidence of cyclic activity could greatly increase conception rates (15, 19).

Variability in the day of the cycle on which the synchronizing prostaglandin injection was administered would be reduced using the 11-day double injection protocol. However, heifers could still range from Day 7 to Day 13 of the cycle. It has been shown that considerable differences occur in the interval from injection to the onset of standing estrus depending upon the day of the cycle at treatment (16, 17). Timed insemination at 60 hours after treatment was appropriate for heifers treated on Day 7 of the cycle as opposed to larger intervals if treatment was later in the cycle. In the current study, in Years 1 and 2, timed inseminations at 72 and 96 hours with no repeat services were used. In Years 3, 4 and 5, one insemination at 76 hours was used. Even with the double prostaglandin injection protocol, it is conceivable that the interval to timed insemination was too long in many of the heifers synchronized.

There was no heat detection utilized in the current study. Heifers were inseminated according to a pre-arranged timed insemination schedule. However, in Year 3 and Year 5 some heifers conceived to re-insemination at the subsequent standing estrus (7 and 3, respectively). The results of several studies indicate that increased conception rates will result when insemination is done according to the observation of standing estrus (13, 14, 15, 17, 19, 20).

Many dairymen express that their facilities and labour are not equipped for large numbers of heifers calving at one time. It is encouraging that in each of the five years studied, there was a considerable time period from first to last calving (mean interval of 19 days) with an even distribution over the calving period. The incidence of dystocia or other periparturient problems was not significantly different from problems occurring with any group of heifers mated at naturally occurring estrus.

The differences in conception rates between older (>16 months of age) and younger heifers were not significant, however there was a trend towards improved conception rates in the older heifers. It could not be determined if this trend was the result of larger numbers of non-cycling animals in the younger group of if the fertility of inseminations was higher. Other studies of the effect of age of dairy heifers on conception rates were not found.

No conclusions can be drawn from the comparison of climatic data among different years. It is interesting, however, that the year experiencing the most comfortable temperature climate produced the highest conception rates (Year 4). Temperatures were steady throughout May and June (14.9°C average in both months). This was higher than the 16-year average for May and lower than the 16-year average for June.

The lack of a control group of heifers inseminated at naturally occurring estrus makes it difficult to draw conclusions concerning the effects of various factors on fertility after synchronization. Conception rates could have been as variable from year to year with normal breeding practices. However, the results of the current controlled breeding study suggests that planned insemination following prostaglandin synchronization can be a viable method of breeding dairy heifers. There is a need for further study in order to elucidate synchronization techniques and related factors that will result in high fertility rates and still dispense with the necessity of heat detection.

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