Frequency of calving in PGF2a estrous synchronized cattle

by Robert Jay Kautz

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Animal Science
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Abstract:
Three consecutive years of calving records were analyzed to evaluate the frequency of calving for synchronized versus control cattle. Reproductive performance including mean day of calving , length of the calving season and statistical differences between number of calves born during selected days of the calving season were analyzed , for PGF2α. synchronized (n = 511) and non-synchronized control (n=401) cows. Controls were artificially inseminated (AI) 8-12 hours after first observation of standing estrus. Synchronized cattle received PGF2α (25 mg. free acid) either in the p.m. of day 4 (1 9 75) or the a.m. of day 5 (1976 and 1977) of breeding unless they had been observed in standing estrus prior to these times. Inseminations to detected estrus continued in treated cattle until 80 + 4 hours post PGF2α treatment. After this time all remaining animals were inseminated and recorded as non-estrus bred. Breeding seasons consisted of 25 days AI plus 20 days natural service (1 975 and 1 976) or 8.5 days AI plus 48.5 days natural service (1977). During the 1975 breeding season a group of two-year-old first calf cows were also tested. During the 1977 breeding season the cattle were divided into two synchronized groups and one control group. Treatment 1 (T1 = AILAIE) consisted of AI at standing estrus up to day 5 of the breeding season, then on the a.m. of day 5 an injection of PGF2 followed by AI at standing estrus up to 80+4 hours post estrus detection. Treatment 2 (T2=LAIE) consisted of an injection of PGF2α during the a.m. of day 5 of the breeding season followed by AI at standing estrus up to 80+4 hours post estrous detection. Results for 1976 showed that the mean day of calving was significantly different ($p < .05$) for both groups of cows tested. The mean day of calving for mature cows was 24.5 days for synchronized versus 28.3 days for controls. For synchronized two-year-olds the mean day of calving was 21.5 days versus 27.9 days for controls. The mean day of calving was not significantly different ($p>.05$) for the 1977 calving season. During 1978 the mean days of the calving season were T1=22.2, T2 = 20.7, and C = 25.3 days respectively. A significant difference ($p<.05$) occurred for Tg versus C only. Significant differences ($p< .05$) occurred during days 11-20 and 21-50 for mature cows and during days 1-10 and 11-20 for two-year-old cows during the 1976 calving season. During 1977 significant differences were recorded during days 11-20 and 21-40 for AI sired calves. A signiicant difference ($p<.05$) was recorded in 1 978 during days 1-5 for T2 versus T1 and C.

FREQUENCY OF CALVING IN $PGF_{2\alpha}$ ESTROUS

SYNCHRONIZED CATTLE

by

Robert Jay Kautz

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I would like to dedicate this thesis to the memory of my father, Kenneth L. Kautz, and Dr. E. L. Moody. My father was involved in agriculture his entire life and had a great deal of influence on my college career. Dr. Moody was the major influence on my attending graduate school and had a special understanding of students and the problems they encounter in college. This thesis is written as much for them as it is for me.

VITA

Robert Jay Kautz was born January 10, 1956, in Estherville, Iowa. He received elementary and secondary education in Hamilton, Montana, graduating in May 1974.

He enrolled at Colorado State University in September 1974. In the fall of 1975 he enrolled at Montana State University and received a bachelor of science in animal science in June 1979. In September of 1979 he started work towards a master of science degree in the Animal and Range Science Department at Montana State University.

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ABSTRACT

Three consecutive years of calving records were analyzed to evaluate the frequency of calving for synchronized versus control cattle. Reproductive performance including mean day of calving, length of the calving season and statistical differences between number of calves born during selected days of the calving season were analyzed, for $PGF_{2\alpha}$ synchronized (n=511) and non-synchronized control (n=401) cows. Controls were artificially inseminated (AI) 8-12 hours after first observation of standing estrus. Synchronized cattle received $PGF_{2\alpha}$ (25 mg. free acid) either in the p.m. of day 4 (1975) or the a.m. of day 5 (1976 and 1977) of breeding unless they had been observed in standing estrus prior to these times. Inseminations to detected estrus continued in treated cattle until 80±4 hours post $PGF_{2\alpha}$ treatment. After this time all remaining animals were inseminated and recorded as non-estrus bred. Breeding seasons consisted of 25 days AI plus 20 days natural service (1975 and 1976) or 8.5 days AI plus 48.5 days natural service (1977). During the 1975 breeding season a group of two-year-old first calf cows were also tested. During the 1977 breeding season the cattle were divided into two synchronized groups and one control group. Treatment 1 (T_1 = AILAIE) consisted of AI at standing estrus up to day 5 of the breeding season, then on the a.m. of day 5 an injection of PGF_2 followed by AI at standing estrus up to 80±4 hours post estrus detection. Treatment 2 (T_2=LAIE) consisted of an injection of $PGF_{2\alpha}$ during the a.m. of day 5 of the breeding season followed by AI at standing estrus up to 80±4 hours post estrous detection. Results for 1976 showed that the mean day of calving was significantly different ($p<.05$) for both groups of cows tested. The mean day of calving for mature cows was 24.5 days for synchronized versus 28.3 days for controls. For synchronized two-year-olds the mean day of calving was 21.5 days versus 27.9 days for controls. The mean day of calving was not significantly different ($p>.05$) for the 1977 calving season. During 1978 the mean days of the calving season were T_1=22.2, T_2=20.7, and C=25.3 days respectively. A significant difference ($p<.05$) occurred for T_2 versus C only. Significant differences ($p<.05$) occurred during days 11-20 and 21-50 for mature cows and during days 1-10 and 11-20 for two-year-old cows during the 1976 calving season. During 1977 significant differences were recorded during days 11-20 and 21-40 for AI sired calves. A signiicant difference ($p<.05$) was recorded in 1978 during days 1-5 for T_2 versus T_1 and C.

CHAPTER 1

INTRODUCTION

Beef and dairy producers in the United States are now employing prostoglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) and its analogues for estrous synchronization in conjunction with artificial insemination. Systems studied have included single and double injection systems. One disadvantage of the single injection system is that it fails to manipulate cattle during days 1-4 and 17-21 of the estrous cycle. Double injection systems (involving two injections of $PGF_{2\alpha}$ 10 to 12 days apart) have been developed to allow manipulation of these groups. However, a double injection system will increase the number of times animals are handled and increase costs during breeding. Several recent studies have shown that a single injection of 25 mg. $PGF_{2\alpha}$ intramuscularly produces more calves per unit of semen, and is lower in total cost and cost per pregnancy than a double injection system (Vennes 1981; Whitman, 1981). Total artificial insemination pregnancy rates are comparable for single and double injection systems (Vennes, 1981). However data concerning the frequency of calving during the calving seasons is obscure. The objectives of this study were to compare synchronized to control calving seasons and statistical differences in numbers of calves born during selected days of the calving season, for $PGF_{2\alpha}$ synchronized versus non-synchronized cows.

CHAPTER 2

ESTROUS SYNCHRONIZATION

Progesterone Injections

Christian and Casida (1948) showed that 14 daily injections of progesterone in corn oil suppressed estrus and prevented ovulation during the treatment period. Willett (1950) conducted a similar study to determine the fertility of yearling heifers artificially inseminated at first estrus following progesterone injections. Beginning on the 14th or 15th day of the estrous cycle and continuing for 13 to 17 days, daily injections of 50 to 100 mg. were used. Animals were bred at observed standing estrus and again 24 hours later. The average interval from the last treatment to estrus was 5 days with a range of 4 to 7 days. Out of 22 total breeding 11 pregnancies were obtained. Ulberg et al. (1951) in a similar study observed that dosages of 50 mg. were effective in inhibiting estrus and ovulation if administered before estrus occurred. To inhibit follicular growth, injections must be started before day 15 of the cycle. Smaller doses prevented estrus and ovulation; however, follicles developed and ovulation occurred when treatment ceased. Dosages less than 12.5 mg. were reported to have little if any effect. Hansel and Trimberger (1952) showed that small dosages of progesterone (5 to 10 mg.) administered at the beginning of the estrous cycle significantly reduced the length of estrus and the time from end of estrus to ovulation. Nellor and Cole (1956) showed that a single injection of 540 to 1120 mg. of crystalline progesterone in starch emulsion was capable of preventing estrus and ovulation when administered at any time during the estrous cycle when treatment was given. In 95 percent of the heifers examined, ovulation occurred following the controlled estrus. All heifers examined at the post injection estrus were shown to have single or multiple ovulations, but a low conception rate (17 percent) was obtained with this method of treatment.

Ulberg and Lindley (1960) found that daily injections of 12.5 mg. of progesterone inhibited estrus and ovulation, but had a depressing effect upon pregnancy rates in animals inseminated during estrus following treatment. A single injection of 0.5 to 1.0 mg. estradiol benzoate (EB) three days after the last injection of progesterone initiated estrus and ovulation without a further detrimental effect on pregnancy rate. Hansel et al. (1961) attempted to alter the estrous cycle using progesterone and oxytocin injections. Twenty-six of 27 heifers came into estrus in an 8 day period. Fourteen of these 26 expressed estrus in 3 days. Of the 26 animals bred 50 percent conceived at first service. Pregnancy was checked by rectal palpation 60 days after AI, and calving dates confirmed earlier pregnancy diagnoses.

Wiltbank et al. (1965) conducted three trials using a progesterone and estradiol combination, and a progesterone and acetophenone derivative of 16α-17α dihydroxy-progesterone (AD) either alone or in combination with estradiol enanthate (ENT). Synchronization varied from 70 to 100 percent, however, fertility in the treatment groups was lower than controls in all trials. Woody et al. (1967) showed that ten daily injections of 100 mg. of progesterone reduced estrus cycle length from 20.7 days in controls to 16.7 days in treated cows.

Oral Progesterone Compounds

Oral progestatinal compounds were studied in the 1960s to try to circumvent the labor of daily progesterone injections for estruos synchronization. The four compounds most studied were:

1. 6α-methyl-17α-acetoxy progesterone (MAP).
2. 6-chloro-Δ^6-17 acetoxy progesterone (CAP).
3. 6α-methyl 6-dehydro-11-methylene-17-acetoxy-progesterone (MGA).
4. 16α-17=dihydroxy progesterone acetophenonide (DHPA)

Nellor et al. (1960) observed that MAP fed as part of the normal ration at levels ranging from 0.2 to 0.8 mg. MAP/pound body weight daily by twice a day feeding for 15 to

20 days inhibited estrus at all levels of treatment regardless of the stage of the estrous cycle when treatment started. However, ovulation without estrus occurred at the 0.2 mg. level, and at levels of 0.4 mg. or greater complete inhibition of follicular growth occurred during the treatment period. Estrus occurred 4 to 5 days after the end of the treatment period with the 0.4 mg. dosage. As the dosages increased, the duration from the end of treatment to start of estrus increased. Similar results were reported by Nelms and Combs (1961), Zimbelman (1961) and Fahning et al. (1966) all using MAP.

Graves and Dzuik (1968) used human chorionic gonadotrophin (HCG) after treatment with MAP. A 60 hour interval from withdrawl of MAP to the HCG injection with an interval from HCG to insemination showed the best results. Graves et al. (1974) observed good results feeding MAP in conjunction with an intramuscular injection of estradiol 17β. Twenty-seven of 29 cows exhibited estrus between 24 and 216 hours after MAP withdrawl.

Van Blake et al. (1962) fed CAP at varying levels 0.3 to 0.025 mg./pound/head/day. All levels proved to be effective in inhibiting estrus. Treated animals exhibited estrus in a range of 4 to 13 days after withdrawl, with animals in the lower levels showing estrus earlier in the post treatment period. No animal conceived when bred at synchronized estrus in the 0.3 mg. group.

Studies done by Van Blake et al. (1963) and Wagner et al. (1963) showed similar results as those stated above. Wagner et al. (1968) observed that CAP treated heifers had a lower fertilization rate and a lower 60-day pregnancy rate.

Hansel et al. (1966) reported that in cows fed MAP and CAP satisfactory estrous synchronization was obtained, but fertility at the syncronized estrus was higher in MAP fed cattle than in those fed CAP. Fertility was uniformly high at the estrus subsequent to synchronization.

Wiltbank and Kasson (1968) successfully synchronized estrus by feeding DHPA in conjunction with an injection of estradiol valerate (EV). Results showed that approximately the same percentages of treated animals were in estrus in a 3-day period as compared to control animals in estrus in a 21-day period. The conception rate after one breeding at the synchronized estrus was lower than that of the control animals.

Zimbelman and Smith (1966) studied dosage effect and route of administration of MGA. Oral doses of 0.25 to 8 mg. MGA daily inhibited estrus and ovulation. Intravenous (IV) injections of 0.4 mg. daily were shown to inhibit ovulation. Lower doses by either IV or oral administration were shown to inhibit estrus but not ovulation. MGA was reported to be approximately 300 to 900 times as potent as MAP, but only 10 to 15 times as potent when compared by IV.

Young et al. (1967) reported that 0.4 mg. MGA was the minimal effective dose for suppression of estrus. Roussel and Beatty (1969) reported a 93 percent occurrence of estrus after feeding MGA at 1.0 mg./head/day for 14 consecutive days, and an overall conception rate (first and second service) of 60 percent as compared to 53 percent for control animals.

Subcutaneous Implants

Subcutaneous implants, and intravaginal sponges and pessaries using progestational compounds, or in conjunction with injections of estradiol were studied in order to learn the feasibility of this type of estrus synchronization.

Dzuik et al. (1966) observed that silicone rubber implants impregnated with MGA synchronized estrus in 64 percent of the 70 cows tested. A subcutaneous implant containing 17-ethyl 19 nortestosterone (Nilevar) was studied by Wiltbank et al. (1971) to determine its effectiveness at estrous synchronization and fertility at the synchronized estrus. Of the 15 heifers that were implanted for 16 days 87 percent showed estrus in 96 hours after implant removal compared to 93 percent of the 42 heifers which were implanted for 9 days and received an injection of EV on the day of implantation. The percent of heifers pregnant at synchronized estrus was greater in the group implanted for 9 days. Pregnancy in the 9-day group was approximately the same as that of the controls. An injection of 2 mg. of estradiol 17β into heifers 24 hours after implant removal, which had been present for 9 days and had received an injection of EV on the day of implantation caused 98 to 100 percent of cycling heifers to show estrus in a 48-hour period and 100 percent to ovulate in 36 hours.

Whitman et al.(1972) reported that estrus could be effectively synchronized using an ear implant (SC21009) and an injection of 6.5 mg. EV without lowering fertility. A level of 7.5 mg. EV improved synchronization but decreased fertility. Similar results were shown by Burrell et al. (1972).

Woody and Pierce (1974) studied the effect of day of initiation of treatment on estrous cycle synchronization using norethandrolone implants and EV injections. Heifers implanted prior to 10 days postestrus had longer return intervals than those implanted after 10 days postestrus.

Intravaginal sponges containing progesterone were studied by Carrick and Shelton (1967). Bunched sponges were found to be retained longer than cylindrical sponges. Sponges containing 100 mg. progesterone inhibited estrus and ovulation in the majority of the animals. Within five days of cessation of treatment estrus occurred in 55.6 percent of the animals. Fertility after treatment with the sponges was reported as unsatisfactory and was not superior to fertility reported after intramuscular treatment or feeding of progesterones. Sreenan and Mulvehill (1975) reported differences in percentages of retention of pessaries between 20 and 10 days (86.7 percent) and (93.6 percent) respectively. Lower calving rates were observed in heifers inseminated in estrus following the 20-day period, while those bred at interval with the 10-day treatment were slightly higher than those of control heifers.

Prostaglandins

Prostaglandins (PGs) are so named because they were first detected in seminal plasma from the prostate gland. They are now known to be present in most mammalian tissues in very small amounts.

Their basic structure is that of a 20 carbon monocarboxylic acid containing an internal cyclopentane ring (Bohinski, 1979). There are six different series of PGs (A, B, C, D, E, F) which are differentiated by structural differences in the pentane ring (Lehninger, 1977) PG synthesis occurs from fatty acids with $PGF_{2\alpha}$ being derived from linoleic acid.

Since Babcock (1966) stated that PG may be the luteolytic factor in the bovine many studies have been done involving PG. Trials run in the early 70s showed that by infusing $PGF_{2\alpha}$ into the ipsilateral horn to the C.L. luteal regression occurred (Louis et al., 1972) and blood progesterone levels dropped (Liehr et al., 1972). Stellflug et al. (1973) showed that IM injections of $PGF_{2\alpha}$ decreased blood progesterone. Lauderdale et al. (1973) reported that fertility of cattle inseminated at estrus following $PGF_{2\alpha}$ was comparable to control animals. Hearnshaw et al. (1974) reported that subcutaneous injections of $PGF_{2\alpha}$ during mid cycle caused animals to show estrus 72 to 80 hours after treatment. Heersche et al (1974) reported similar results using synchromate B implants seven days prior to injection of $PGF_{2\alpha}$.

Graves et al. (1975) reported that estrus can be effectively synchronized with Norgestomet implants followed by administration of $PGF_{2\alpha}$ the day prior to implant removal. Administration of GNRH reduced the mean interval from implant removal to ovulation, reduced the variability in the interval from implant to ovulation, and suppressed occurrence of estrus.

Innskeep et al. (1975) showed higher conception rates in cows synchronized with $PGF_{2\alpha}$ and estradiol benzoate (EB) than when treated with $PGF_{2\alpha}$ only. He also reported a higher percentage of EB cows showing estrus 48 to 84 hours after treatment. Welch et al. (1976) reported similar results using EB with $PGF_{2\alpha}$.

Lambert et al. (1975) reported that the percent of cattle conceiving during the first ten days of the AI season in a $PGF_{2\alpha}$ treatment group was greater than in a non-treated control group. This trial showed that the average day of conception would move toward the beginning of the breeding season. Higgins (1981) demonstrated that the same pregnancy rates were achieved for cattle in a 10 day $PGF_{2\alpha}$ system as in a 21 day conventional system. The calves produced by synchronized cows were older and heavier than those produced by control cows. Cumulative preganancy rates were significantly different ($p<.05$) at day 10 but total pregnancy rates were not.

A major disadvantage with a single injection system utilizing $PGF_{2\alpha}$ is that cows within days 1-4 and 17-21 of the estrous cycle fail to respond to treatment. Double injection systems involving the administration of $PGF_{2\alpha}$ 10 to 12 days apart have been developed to allow manipulation of these groups of animals. Although all trials involved in this sudy are single injection breeding systems it should be noted that a double injection system may have affected some of the results of this study. A double injection system may cause more cows to be available to be bred and conceive earlier in the breeding season. A double injection system will shorten the breeding season but will increase the number of times cows must be handled compared to a single injection system. More calves may be born earlier during the calving season when compared to a conventional AI or a single $PGF_{2\alpha}$ treatment system, if there were a high percentage of cows cycling and these cows responded to one of the two $PGF_{2\alpha}$ treatments.

Moody and Lauderdale (1977) compared fertility of non-treated control and two $PGF_{2\alpha}$-treated (2x-25 mg. Tham salt) groups. Controls were bred at observed estrus and treated cattle were bred once at 80 hours following second treatment or by estrous detection. First service conception rates were significantly lower ($p<.001$) in appointment bred anmals than in controls, or treated animals bred at estrus. Burfening et al. (1978) compared conception rates of treated and non-treated control cows and heifers. Controls were bred at observed estrus. Treated heifers and cows were bred to an observed estrus following initial $PGF_{2\alpha}$ treatment. Cattle failing to exhibit estrus within the next 11 days were reinjected and appointment bred at 60 (heifers) and 84 (cows) hours post post $PGF_{2\alpha}$ injection. Analysis indicated that first service conception rates were lower ($p<.01$) for cows and heifers that were appointment bred than both treated cattle bred by estrus after first injection and controls. Johnson (1978) suggested the enhanced synchronization following second treatment (versus initial treatment) was due to relatively more animals being at a comparable stage of the estrous cycle at the time of second treatment.

Han (1981) demonstrated that estrous synchronization was improved with a dose of 25 mg. $PGF_{2\alpha}$ compared to a 15 mg. dose when all cattle were inseminated at approximately 80 hours after the second injection without estrus detection. Vennes (1981) compared a single injection system to a double injection system. More AI calves were produced per unit of semen in the single injection system than in the double injection system. Total AI pregnancy rates were not significantly different. Whitman (1981) reported similar results showing that single injection systems were lower in total cost and lower in cost per pregnancy than double injection systems.

CHAPTER 3

MATERIALS AND METHODS

Records from estrous synchronization trials conducted by the Animal and Range Sciences Department of Montana State University in conjunction with the Montana State Prison Ranch were used for this study. The calving records were from the spring calving herd for 1976 - 1978. Yearly estrous synchronization trials involved mature suckled cows aged 2 to 11 years that were over 45 days post partum. Records from 1976 - 1978 also included virgin heifers age 12 to 20 months. Mature cows were randomly assigned to a treatment based on previous calving dates while yearling heifers were assigned based on birth date (age).

Predominant breeds used in the trials were Hereford and Hereford/Angus crosses. These cattle were managed under typical Montana range conditions. During the winter alfalfa hay was fed on an as needed basis. All animals were run together on native range during the breeding season. Cattle were assigned to either a treatment or a control group. All controls were artificially inseminated (AI) 8 to 12 hours after observed standing estrus. Treatment animals received $PGF_{2\alpha}$ 25 mg. free acid IM either in the evening of day 4 (1975) or in the morning of day 5 (1976-1977) of breeding unless they had been observed in estrus prior to these times. Breeding to detected estrus continued in treated cattle until 80$\pm$4 hours post $PGF_{2\alpha}$ at which time all remaining undetected animals were bred and recorded as nonestrus bred. Breeding consisted of 25 days AI plus 20 days natural service during 1975 and 1976. During 1977 the breeding consisted of 8.5 days AI plus 48.5 days natural service. Two treatment groups were tested in 1977. Treatment 1 (T_1; AILAIE) was artificially inseminated if cows showed standing estrus, then injected with $PGF_{2\alpha}$ in the morning of day 5, AI then continued at standing estrus until 80 hours when all cows not showing estrus were inseminated. Treatment 2 (T_2; LAIE) cows were given $PGF_{2\alpha}$ in the morning of day 5 and then artificially inseminated at standing estrus.

Initial AI services utilized Hereford or Angus semen, with individual AI bulls randomly assigned to treatments each year. During 1975 and 1976 cattle observed in estrus within 15 days of initial AI service were reinseminated with Red Angus semen. This was used as a genetic marker to aid in determining which AI service resulted in conception. For 1977 breeding season all repeat inseminations were with Red Angus semen in conjunction with observation and recording of natural service breeding dates for an additional 12.5 days for a total of 21 days estrus detection.

Day of conception for all cattle (cows and two-year-olds) was based on actual calving dates minus 285 days for cows or 280 days for two-year-olds gestation length. Calculated conception dates falling within ±10 days of AI breeding dates were considered as AI conceptions.

Length of the calving season was determined by the birth dates of the first and the last calf born during the season. The first calf born was assigned day 1 of the season with following days numbered consecutively until the last calf was born.

In the spring of 1976 the season started April 1st and continued until May 30th for a length of 60 days. The 1977 calving season started April 5th and continued until May 19th for a length of 45 days. The 1978 calving season started April 10th and continued until May 31st for a length of 52 days. All cows were checked daily and calving dates were recorded as first visual sighting of calf.

The median (50 percent of total calf crop born) calving date was calculated for each calving season for treated and control groups.

Chi square tests were used to analyze significant differences ($p<.05$) in the frequencies of calving tested at selected days of the calving season. Histograms were used to illustrate:

1. The percentage of treated versus control cows calving at 5-day intervals.

2. The percentage of AI sired calves born at 5-day intervals.

CHAPTER 4

RESULTS AND DISCUSSION

The spring cow herds for 1976, 1977 and 1978 were divided into treatment versus control groups. During 1976 there was also a treated versus control group of two-year-old first calf cows. Two treatments were used during 1978 AILAIE (T_1), and LAIE (T_2).

1976 Results

Two hundred and twenty calves were born to mature cows, 118 to treated cows and 102 to control cows. The length of the calving season in the treated group was 60 days versus 55 days for the control group. $PGF_{2\alpha}$ treatment affected the mean day of calving ($p<.05$), which was 24.5 and 28.3 days for treated and control groups respectively. There were 72 AI sired calves (61 percent) in the treatment group compared to 63 AI sired calves (62 percent) for the control group.

One hundred and sixty-seven calves were born to two-year-olds in 1976, 82 calves from treated cows and 85 calves from control cows. Since there were no differences in either the way the treatment was administered or the lengths of the AI season for treatment or control groups we can assume that due to synchronization the length of the calving season in the treatment group was 52 days compared to 68 days for the control group. Treatment affected ($p<.05$) the mean day of calving which was 21.5 versus 27.9 days for treated and control cows respectively. There were 56 AI sired calves (68 percent) born in the synchronized group and 52 AI sired calves (62 percent) born in the control group.

Chi square tests were used to determine if significant differences in the frequency of calving existed during the calving season. Table 1 illustrates significant differences ($p<.05$) occurred during days 11-20 and 21-50 of the calving season for both groups of mature cows tested. A higher percentage of synchronized cows calved by day 20 of the calvig season. Cumulative effects for mature cows illustrate that by day 20, 51 percent of all treated cows had calved compared to 34 percent for controls. When only AI sired calves were considered 83 percent of the treated group had calved by day 20 compared to 54 percent of the control group. Significant differences ($p<.05$) for two-year-olds occur during days 1-10 for all cows tested and when only AI calves were considered. Again more synchronized cows calved earlier in the calving season than did controls. Cumulative effects illustrate a significant difference ($p<.05$) for both groups during days 11-20. Fifty-five percent of the treated two-year-olds calved compared to 36 percent of the controls. When AI calves were

Table 1. Influence of Day of Calving Season on Number of Cows Calving, 1976 (%).

Days of Calving Season		All 1976 Cows			AI Sired			
	n	0-10 days	11-20 days	21-50 days	n	0-10 days	11-20 days	21-40 days
Treated	118	13 (11)	47 (40)[a]	54 (46)[a]	72	14 (19)	46 (64)[a]	12 (17)[a]
Control	101	8 (8)	26 (26)[b]	63 (63)[b]	63	8 (13)	26 (41)[b]	28 (44)[b]
Cumulative Effects								
Treated	118	13 (11)	60 (51)[a]	114 (97)	72	14 (19)	60 (83)[a]	72 (100)
Control	101	8 (8)	34 (34)[b]	97 (96)	63	8 (13)	34 (54)[b]	62 (98)

Days of Calving Season		All Two-Year-Old Cows			AI Sired			
	n n	0-10 days	11-20 days	21-50 days	n n	0-10 days	11-20 days	21-35 days
Treated	82	22 (27)[a]	23 (28)	34 (41)	56	22 (39)[a]	23 (41)	11 (20)
Control	84	10 (12)[b]	20 (24)	46 (55)	52	10 (19)[b]	20 (38)	19 (35)
Cumulative Effects								
Treated	82	22 (27)[a]	45 (55)[a]	79 (96)	56	22 (39)[a]	45 (80)[a]	56 (100)
Control	84	10 (12)[b]	30 (36)[b]	76 (90)	52	10 (19)[b]	30 (58)[b]	51 (100)

[a,b]Means numbers within columns bearing different superscripts are significantly different. ($p<.05$)

considered, 80 percent of the treated group had calved by day 20 compared to 58 percent of the control group.

The percentage of treatment versus control cows (all) calving at 5 day intervals is illustrated in Figure 1. Twenty-six percent of the treated cows calved during days 11-15, versus 16 percent for the control group. This difference approaches significance (p=.056). This illustrates a peak in the calving for the treatment group due to synchronization. A second peak (13 percent) occurs during days 40-45 for the treatment group. The control group did not have one distinct peak during the calving season. The four peaks for the control group show a relatively steady birthrate after day 15 of the calving season. The greatest difference in peaks for the controls is approximately 7 percent. The peaks that occur for both groups at day 45 may be due to the repeat breeding that was used as a genetic marker to aid in determining which AI service resulted in conception. The peak for the treatment group would be smaller due to synchronization because more cows became pregnant early in the breeding season thus fewer of the treated cattle were available to come into estrus and be bred for subsequent calving at this time.

Figure 2 illustrates a similar relationship for two-year-olds. Again the treatment groups first major peak is a day 15, however, the second peak runs from days 35-40. The control group shows two definite peaks at days 25 and 45.

Figure 1. 1976 Cows Percent Calving Five Day Intervals. Treated=Solid Line, Control = Dash line.

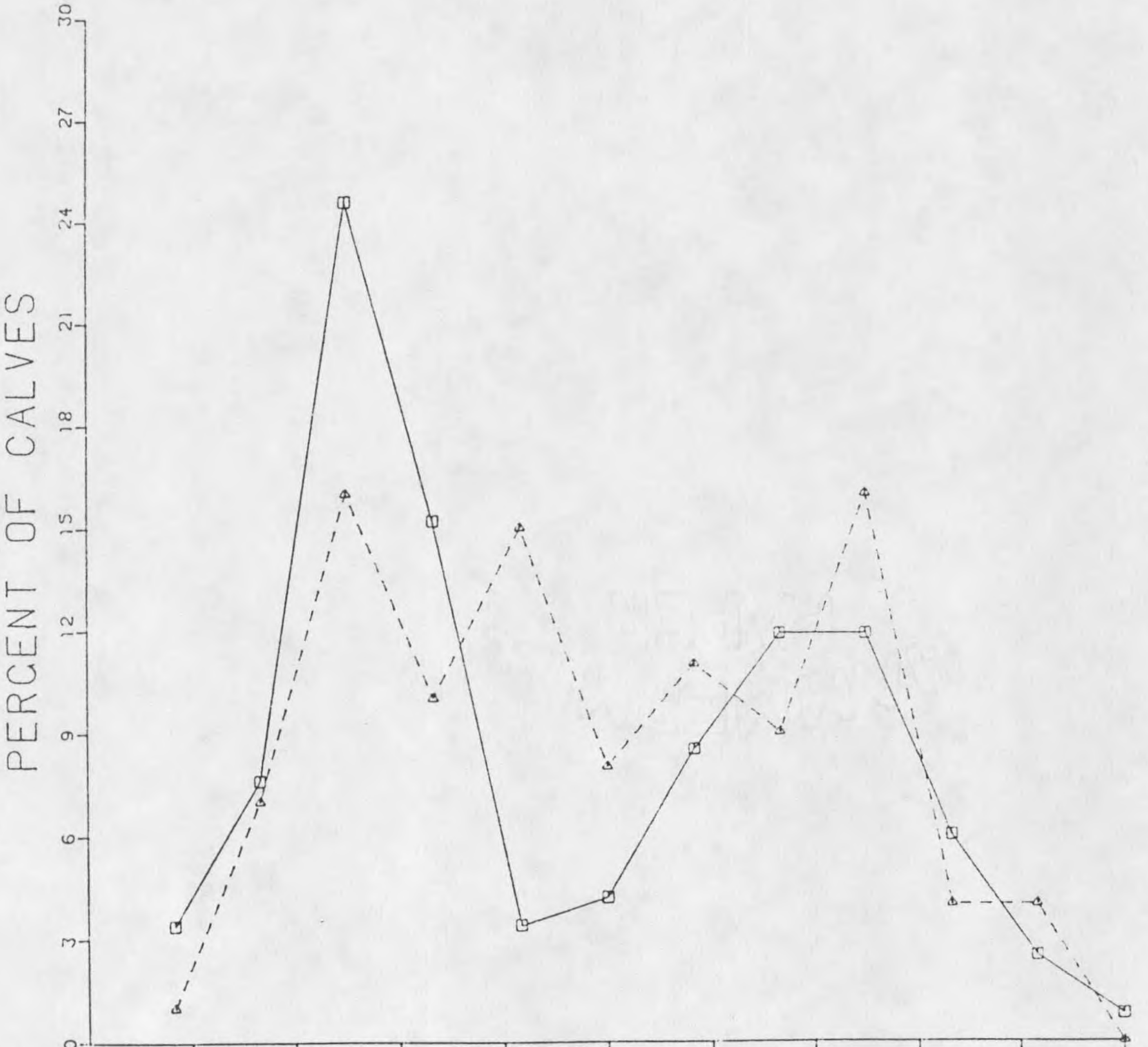
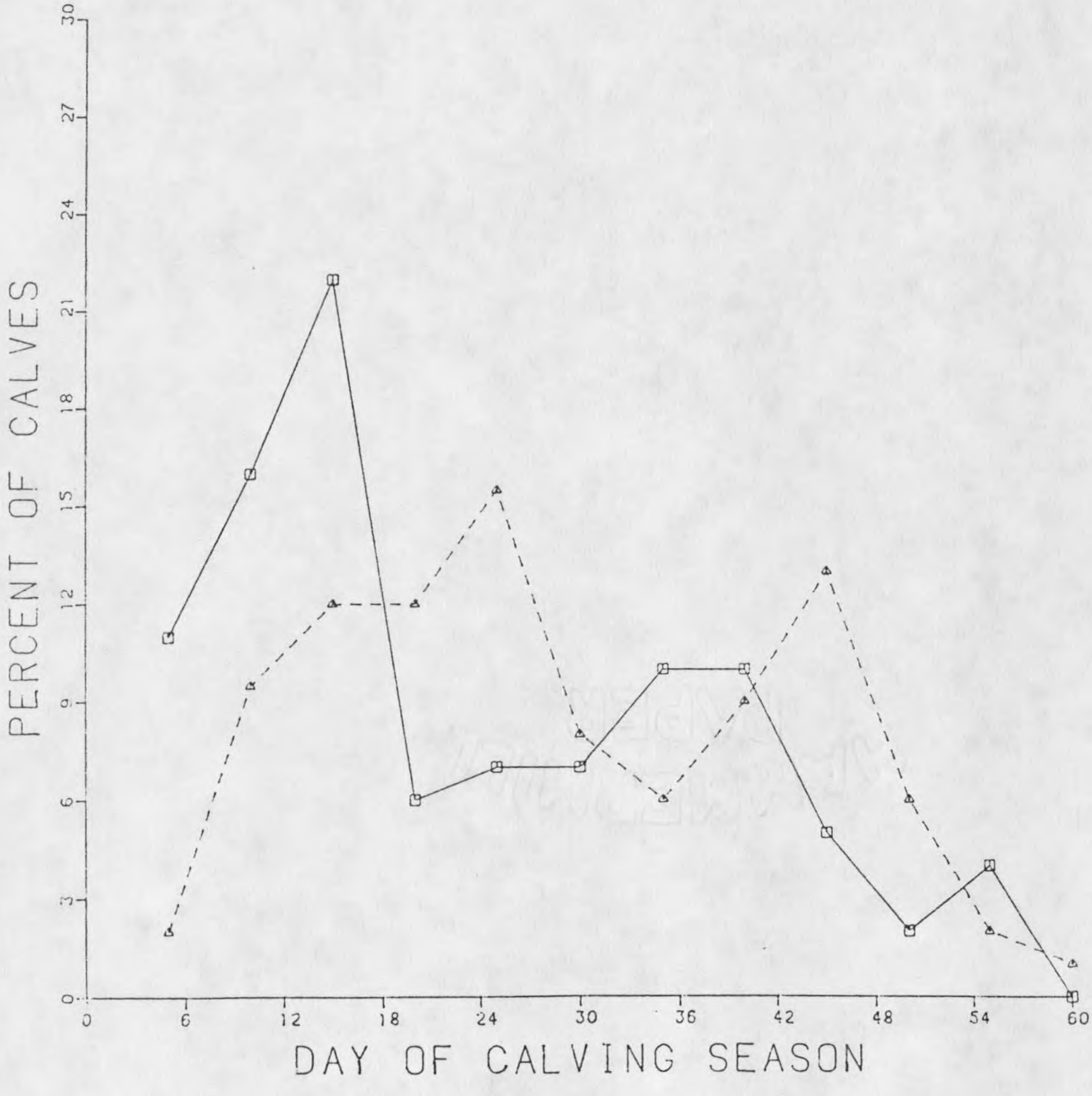


Figure 2. 1976 Two-Year-Olds Percent Calving Five Day Intervals. Treated=Solid Line, Control=Dash Line



Again this second peak may be due to repeat breeding with the genetic marker. Figure 2 also illustrates a difference of 9 percent at day 5 of the calving season. this would correspond to Table 1 which shows a significant difference ($p<.05$) by day 10 of the calving season.

Figures 3 and 4 illustrate the relationship of treated versus control cows, and treated versus control two-year-olds percent AI sired at 5 day intervals. Both figures illustrate that due to synchronization more treated cows were born every 5 days of the calving season up to day 15 than controls. Peaks occur during days 11-15 for both treatment groups. From Table 1 and Figures 1-4 we can see that synchronization caused more calves to be born by day 20 of the calving season. Synchronization caused a significant difference ($p<.05$) in cumulative results for both mature cows and two-year-olds by day 20 of the calving season.

<u>1977 Results</u>

Two hundred and seventy-three calves were born during the 1977 calving season, 143 to treated cows and 130 to control cows. The length of the calving season in treated cows was 43 days versus 45 days for control cows. Treatment did not affect the mean day of calving ($p<.05$) which was 23.7 days for treated cows versus 24.2 days for the controls. There were 100 AI sired calves (70 percent) in the treatment group versus 98 AI sired calves (75 percent) in

Figure 3. 1976 Cows AI Sired Five Day Intervals.
Treated=Crosshatch, Control=Open Block

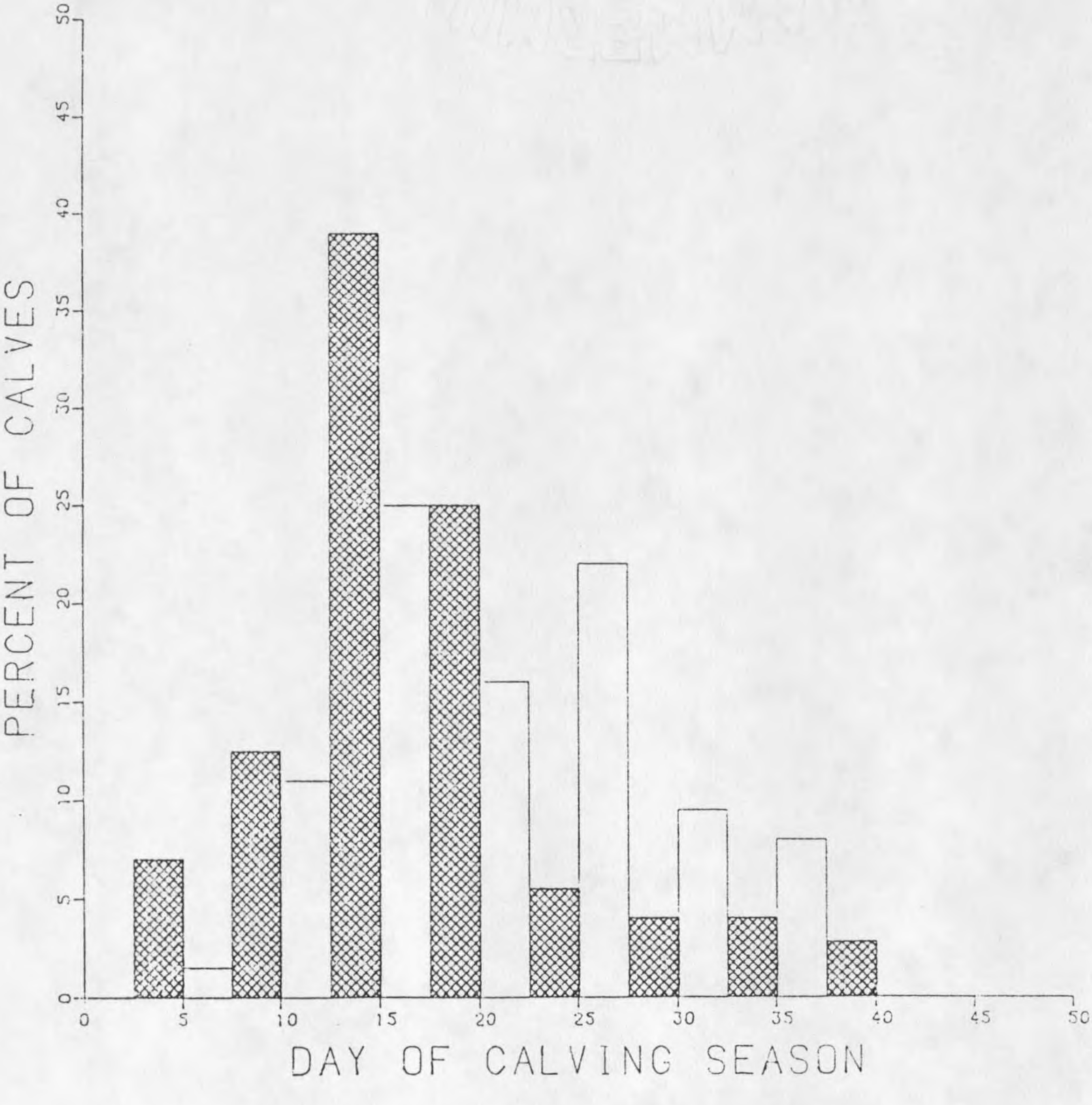


Figure 4. 1976 Two-Year-Olds AI Sired Five Day Intervals. Treated=Crosshatch, Control=Open Block