INDUCED CALVING AND ESTRUS SYNCHRONIZATION
IN BEEF CATTLE

by

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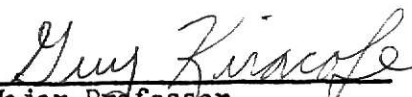submitted in partial fulfillment of the

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Endocrine basis for Parturition. The necessity of a functional hypothalamic-pituitary-adrenal axis in the fetus of cattle and sheep for normal parturition has been confirmed by various researchers. Kennedy et al. (1957) discovered that parturition was delayed in cattle by adeno-hypophysial aplasia which caused adrenal hypoplasia. Liggins et al. (1967) reported prolonged gestation in sheep after fetal hypophysectomy which resulted in hypoplasia of the fetal adrenal glands. Liggins et al. (1972) further showed that stimulation of the developing fetal hypothalamic-pituitary-adrenal system by administering adreno-corticotrophic hormone (ACTH) to the sheep fetus during the last one third of pregnancy resulted in premature parturition. The researchers concluded that this data supports the hypothesis that parturition in the sheep is controlled by the fetal adrenal cortex through its secretion of glucocorticoids. Based on the reports of prolonged gestation in cattle, a similar conclusion seems likely in this specie (Wagner, 1970).

The end of gestation and the onset of parturition are characterized by dramatic changes in hormone secretion. Progesterone levels remain high throughout gestation and are being produced by the corpus luteum, the adrenal gland and the placenta. Smith et al. (1973) found that serum progesterone levels of the cow remained at 7.6 ± 0.9 ng/ml until 2 days before parturition, then fell to 0.6 ± 0.1 ng/ml at parturition. Parturition occurs in sheep in the presence of substantial progesterone concentration in peripheral circulation (Thompson and Wagner, 1974). The level was

found to be approximately 8 to 10 ng/ml within 24 hours of parturition, but had decreased to less than 1 ng/ml by 24 hours post-lambing.

There is a gradual increase in estrogens throughout pregnancy in most mammals and a sharp increase occurs a few days prepartum. Smith et al. (1973) showed that estradiol and estrone levels in the cow increased linearly from 26 to 5 days before parturition, but had doubled by 2 days prepartum. He further reported an equally sharp drop by 1 day postpartum to about 1/6 the level seen 1 day prepartum.

Corticoid levels have been observed in some species and a rather sharp increase occurs just prior to parturition. Adams and Wagner (1970) reported that corticoid levels in the cow begin a significant rise by 4 days prepartum. Smith et al. (1973) found that the increase in serum gluco-corticoids occurs approximately 12 to 18 hours before parturition and then declines rather rapidly to its prepartum level shortly after parturition. Thompson and Wagner (1974) reported a similar occurrence in sheep while Molokwu and Wagner (1973) found that the corticoid increase in swine occurs as early as 3 days prepartum and then follows the same trend as that seen for cattle and sheep.

According to Wagner (1974), prostaglandins must be considered relative to parturition because of their effects. Increased prostaglandin production by the uterus follows the rise in fetal glucocorticoids and can be produced by administration of exogenous glucocorticoids. Prostaglandins may exert an effect on myometrial activity, cause a decrease in progesterone production, effect an oxytocin release, and stimulate estrogen production by the placenta.

The fetal adrenal gland of the sheep doubles in size during the last 10 days before parturition which is a probable result of increased adrenal

stimulating hormones from the fetal pituitary gland (Liggins et al. 1972).
In the same work a several fold increase in the plasma concentration of
corticoids of the fetus was noted in the 3 to 4 days prior to parturition.
This rise is also seen when glucocorticoids are infused to immature fetal
lambs (Liggins, 1969). This infusion leads to premature parturition as
would be expected if the fetal corticoids are the signal for the onset
of labor.

For a hypothetical model of the hormonal relationships which occur
at parturition see Wagner (1974). A knowledge of these relationships is
essential in order to understand how various substances are used for
induction of parturition.

Induced Parturition. The parturition inducing effect of some glu-
cocorticoids was discovered in the late 1960's (Brown et al. 1970). Before
that time corticoids had been used in veterinary medicine for treatment of
such problems as musculoskeleton, pregnancy toxemia, shock, fractures, etc.
However, since the parturition inducing effect of corticoids was discovered,
numerous workers have reported on the use of various compounds in the
initiation and control of parturition. Adams (1969) was one of the first
to confirm the corticoid inducing effect when he used intramuscular
injections of dexamethasone on 22 cows. In another experiment, Adams
and Wagner (1970) induced calving within 72 hours in 46 of 54 cows after
a 20 mg dexamethasone injection given intramuscularly. The mean gestation
length was 274 days and the mean interval from injection to fetal expulsion
was 49 hours.

The same sequence of events that occur in natural parturition seem to
occur when parturition is induced with exogenous glucocorticoids. Jochle
(1971) stated that administration of corticoids to cattle late in pregnancy

acts as a premature signal which normally comes from the fetal adrenal. His observations following corticoid administration, namely the drop in plasma progesterone levels, the dramatic rise in estrogen levels, and the high corticoid blood levels are much the same as occurs in non-induced parturition. Jochle explained that increasing estrogen levels reach a critical point and act along with the rise in corticoids to shut off the source of progesterone. The removal of the progesterone block on the myometrium and its sensitization by available estrogens for oxytocic activities create conditions mimicking normal parturition.

Fylling (1971) was able to induce lambing in three ewes with an intravenous injection of 0.25 mg of ACTH followed by a daily injection of 10 mg of dexamethasone given intramuscularly for 4 days. However, he failed to induce lambing in two eves given 6 mg of dexamethasone daily for 4 days. Bosc (1972) induced lambing using an 8 or 16 mg intramuscular injection of dexamethasone. Parturition followed approximately 50 and 48 hours post-injection when the gestation length was 144 days.

Alm et al. (1972) treated 12 mares with 100 mg of dexamethasone once a day for 4 days beginning 18 days prior to an expected foaling date of 338 days gestation. The treated mares responded by foaling 10 ± 1.6 days early.

Jochle (1971) reported that neither dexamethasone of flumethasone would induce parturition in swine. However, North et al. (1973) did shorten gestation by administering 70 mg of dexamethasone intramuscularly on days 101, 102, and 103 of gestation. This treatment caused parturition at an average gestation of 112.6 days while the control animals farrowed at 114.7 days of gestation. Killian and Day (1974) administered 10 mg of prostaglandin $F_2\alpha$ to 15 sows and gilts on either 111, 112 or 113 days of gestation.

Parturition occurred in 87% of the animals 24 to 36 hours following the injection.

The phenomena of induced parturition seems to have drawn particular interest in the cattle industry, both dairy and beef. This seems to stem from attempts to control the entire management program. During the past 5 years, much has been learned relative to the time interval when parturition can be expected, the effects on the dam, and the effects on the viability and performance of the calf after induction of parturition. Adams and Wagner (1970) defined a successful induction with corticoids as having occurred within 72 hours post-injection. Osinga et al. (1971) used either 2.5, 5.0, or 10 mg injection of flumethasone to induce calving in 26 dairy cows 268 to 270 days gestation. Of the 26 cows, 23 calved within 3 days post-injection with an average of 47.7 ± 1.4 hours. The three animals that did not calve within 72 hours post-injection were given the 2.5 mg injection. He further reported that parturition was induced within 3 days in 3 of 5 and 4 of 6 cows that received either 5 or 10 mg of flumethasone orally. Wagner et al. (1974) reported that only 159 of 189 cows calved within 72 hours after a 20 mg dexamethasone injection; however, 100% of the cows calved within 72 hours after doses of 30, 50 or 60 mg. Beardsley et al. (1973) induced calving in 21 of 25 Holstein cows by giving dexamethasone at a dose level of 4.4 mg/100kg of body weight. Parturition occurred at 45.5 ± 12 hours after injection. Winter (1974) compared intramuscular and intravenous injections using 20 mg dexamethasone per injection. The cows were treated 7 to 14 days before the expected calving date. Parturition was induced an average of 52.5 and 57.4 hours post-injection in 81.8 and 83.3% of the cows in the two groups, respectively. Lauderdale (1974) administered various amounts of prostaglandin $F_2\alpha$ ($PGF_2\alpha$) intramuscularly

to 30 beef cows. The treatment did cause parturition, however, the response was variable with cows calving in a period of 2 to 8 days post-injection. Spears et al. (1974) administered either 20 mg of $PGF_2\alpha$ or a combination of 3 daily injections of estradiol valerate plus a 20 mg injection of $PGF_2\alpha$ with the third estradiol injection to two groups of beef cows. Only 14.2% of the $PGF_2\alpha$ injected cows calved early while 90.5% of the estradiol plus $PGF_2\alpha$ injected cows calved early at an average time of 42.8 ± 2.3 hours post-injection.

Side effects. There are some major side effects caused by using induced calving. The most serious effect is that retained placenta occurs in a high percentage of cases. The definition of a retained placenta varies, however, it is usually diagnosed if membranes are still observed 24 hours after delivery (Carroll, 1974). There is a problem in diagnosing a retained placenta in that some of the membranes may remain in the uterus although none are visible externally. Garverick et al. (1974) felt it necessary to examine cows by both rectal and vaginal exploration before classifying the cow as retained or non-retained.

Jochle et al. (1972) treated cows with progesterone both before and after a 10 mg flumethasone injection which was administered on day 270 of gestation. Their results showed an increase in the number of stillborn calves and a very high percentage of the cows experienced dystocia. In addition, no reduction in the occurrence of retained placenta was observed. Garverick et al. (1974) treated cows with 6 mg of estradiol benzoate in conjunction with a 20 mg injection of dexamethasone. Their results showed a significant reduction in the occurrence of retained placenta with only 32.3% of the animals retaining the fetal membranes in the estrogen treated group while 75% retained the placenta in the group that did not receive

estrogen in conjunction with a dexamethasone injection. This is contrary to the finding of LaVoie and Moody (1973) who administered varying levels of either estrone, estradiol-17α or estradiol-17β from 6 days prior to either $\frac{1}{2}$ day prior or 1 day after a dexamethasone treatment. Their results showed no decrease for the incidence of retained placenta which was 89.5%.

Welch et al. (1973) reported that induced calving in New Zealand is widely used being performed on more than 120,000 cows each year. He further reported on the use of three so-called long-acting corticoids: dexamethasone trimethylacetate (20 mg), triamcinolone acetomide (30 mg) or 10 mg of a flumethasone suspension. For all treatments, the average time to calving was 15 $\pm$ 8 days. He also reported that the main problem with long-acting corticoids was the high mortality rate which was reported as being 31.1, 31.5, and 44.6% for the three treatments, respectively. Bailey et al. (1973) administered 30 mg of dexamethasone trimethylacetate to 15 cows 240 to 252 days of gestation. The cows responded by calving an average of 12.1 days later. Only two of the cows retained the placenta.

The occurrence of retained placenta after induced calving seems to depend on the day of gestation. Wagner et al. (1971) reported that retained placenta occurred according to days of gestation at a rate of 66% < 270; 57% 270 to 274; 48% 275 to 279 and 26% > 280. This high occurrence of retained fetal membranes causes concern about the degree of postpartum fertility following induced calving. Marion et al. (1968) reported that a highly significant increase in the interval from parturition to uterine involution occurs following retained placenta. Their observations showed that the time to complete uterine involution after retained placenta was 45.1 $\pm$ 3.2 days and 50.1 $\pm$ 4.9 days for primiparous and pluriparous cows, respectively. Perkins and Kidder (1963) reported that uterine involution was complete by 37.7 days postpartum in cows that did not retain the placenta.

Erb et al. (1958) stated that young cows with retained placenta have an average of one less calf than comparable cows not retaining the fetal membranes. They further reported, however, that cows that do not develop genital disorders following retention of fetal membranes were nearly as fertile as cows not retaining the placenta; although genital disorders occurred 20% more often in cows that did retain the placenta. Jones et al. (1956) used furea, a drug containing 1.45% micropulverized nitrofurazone and 98.55% powdered crystalline urea, for treatment of cows with retained placenta. This drug was used after manual removal of the placenta had been accomplished. In all their cases, the condition improved rapidly and the treatment did effectively prevent endometritis. They further reported that the addition of urea is advantageous since it has a proteolytic and topical debriding effect and also a deoderizing effect. Rude (1959) also recommended insertion of furea boluses into the uterus following manual removal of the placenta. Following this procedure, 28 of 30 cows which had retained placenta became pregnant. Homan (1969) compared intrauterine infusions of nitrofurazone, proteolytic enzymes, and a combination of these in an effort to shorten postpartum interval from calving to conception in clinically normal cows. The interval was not shortened with any treatment and it was found that the nitrofurazone treated group had an interval from parturition to conception significantly longer than the other groups. The combination of nitrofurazone with proteolytic enzymes produced an interval comparable with the cows that received no treatment. He concluded that if nitrofurazone was to be infused intrauterine for retained placenta or impaired fertility that it should be combined with proteolytic enzymes if the interval from parturition to conception is to be kept at a minimum. Jochle (1971) stated that the best method for treatment of retained placenta is parental application of systemic antibiotics and to make no attempt to remove the placenta manually. His

experience shows that attempts to remove the placenta tends to increase the chances of causing metritis and pyometra. He further stated that spontaneous delivery of the membranes will usually occur within 8 to 10 days after induced calving or about the time normal parturition would have taken place if the cow had not been subjected to induced parturition.

Most workers have reported that fertility is not impaired following induced calving. Poncelet et al. (1974) stated that no significant differences occurred for fertility and percent pregnant between induced and non-induced cows. LaVoie and Moody (1974) reported no differences occurred in first service conception rates between induced and non-induced cows. Wagner et al. (1974) found no severe metritis cases following induced calving and reported that the number of days from calving to conception was 81 and 82 days for retained and non-retained animals, respectively.

A possible added cause to the number of retained placenta is that of increased dystocia. Carroll (1974) states that induced calving produced no decrease in difficulty of birth and in some instances dystocia is increased. Ball (1973) states that one of the most common sequelae to dystocia is retained placenta which may be associated with lowered conception. In studies reviewed by the American Breeders Service (1973), calving difficulty increases the percentage of cows that do not resume their normal estrual cycle before the end of the breeding season.

Another side effect of induced calving, as reported by Jochle (1973), is that the onset of milk production is somewhat slower than normal. Beardsley et al. (1973) induced parturition in 21 of 25 Holstein cows using dexamethasone. He found that the average daily milk production for the first 9 weeks was 24.7 and 27.6 kg for treated and non-treated animals, respectively. No differences in milk fat were found.

Effects on the Offspring. Another question governing the widespread use of induced parturition is the effect on the offspring. A consistent finding is the decrease in birth weight following induced parturition. Osinga et al. (1971) reported that the birth weight of dairy calves after induced calving was reduced 3.6 kg. Winter (1974) reported that a reduction of as much as 7 to 8 kg could be expected with induced parturition of beef cows. Wagner et al. (1974) found that birth weight of induced calves was highly correlated with the length of gestation with larger calves being born closer to term.

Survival and viability of induced calves does not seem to be decreased significantly from non-induced calves. Carroll (1974) reported that calf viability, like birth weight, is dependent on the duration of pregnancy. He found no trouble occurs when calves are born after 270 days, but a high death loss occurs when calving is induced prior to 260 days gestation.

There seems to be very little effect on the ability of induced calves to perform following birth. Beardsley et al. (1973) reported the average daily gain of dairy calves following induction was 1.39 pounds compared with 1.32 pounds for non-induced calves. LaVoie and Moody (1974) found the weaning weights between induced and non-induced calves to be comparable with the induced calves being slightly heavier.

Estrus Synchronization in Beef Cattle

The number of cows in a herd that shows estrus on any one day is proportional to the length of the estrous cycle; and any technique that significantly increases this number results in synchronization of ovarian cycles (Lamond, 1964). Estrus synchronization may be attained through inhibition of ovulation, induction of ovulation or induction of or delay of corpus luteum regression (Lauderdale and Zimbelman, 1974).

Progesterone, produced by a corpus luteum in a normal uncontrolled cycle, inhibits maturation of the Graafian follicles (Lamond, 1964.) Christensen et al. (1974) found the levels of progesterone in the serum of cycling beef cows to be the lowest during estrus and remained low until 4 days after estrus when it began increasing until it reached a peak on day 15 of the cycle. Exogenous as well as endogenous progesterone will inhibit ovulation and, therefore, control the estrus cycle of cattle (Lamond, 1964). Exogenous progesterone can be administered in a number of ways. Ulberg and Lindley (1960) injected varying amounts of progesterone in oil subcutaneously to virgin heifers. They found that 60, 83 and 80 percent of the treated animals showed estrus within 10 days after 14 daily injections of either 12.5, 25 or 50 mg per injection. Lamond (1964) stated that generally, doses of progesterone of more than 50 mg per day were detrimental to fertility.

Progesterone can also be administered orally. Hansel and Malven (1960) fed medroxyprogesterone acetate to two groups of 22 and 10 Hereford cows for 20 days. Nine of 22 and 7 of 10 came into estrus on the third and fourth

day following the end of the treatment. Van Blake et al. (1963) fed
6-chloro-Δ^6-dehydro-17-acetoxyprogesterone (CAP) to 69 Holstein heifers at
a rate of 0.02 mg per pound of body weight. The cycles were synchronized
within a period of 4 to 6 days after hormone withdrawal. Hansel ot al.
(1967) fed 6-methyl-17-acetoxyprogesterone (MAP) at an average rate of 240
mg/head/day for 18 days. Eighty-one of 96 cows came into estrus in a 9
day period following cessation of feeding. Roussel et al. (1969) fed
1mg/head/day of melengestrol acetate (MGA) for 14 days to 15 dairy heifers.
Ten of 15 showed estrus within 3 to 5 days following withdrawal of the MGA.

Another approach to provide exogenous progesterone is through the use
of various implants. Dziuk et al. (1967) used silicone rubber implants
impregnated with MGA. These implants were placed subcutaneously in the neck
and left in place for either 22, 43 or 64 days. Estrus was observed in 45
cows (64%) between 36 and 72 hours after implant removal. Lauderdale et al.
(1972) used polyurethane polymers containing MGA which were implanted into
the ears of 32 heifers for 14 days and 31 heifers for 28 days. Percent of
the heifers detected in estrus during days 2 to 6 after implant removal was
87.5 for both groups. Reynolds et al. (1973) used silicone rubber implants
impregnated with progesterone to synchronize estrus in 13 cows. The implants
were surgically placed subcutaneously in the neck and remained in place for
20 days. None of the cows showed estrus during the implant period, while
all cows had shown estrus by 62 hours following implant removal.

A fourth way that can be used for administration of progestogens is by
using intra-vaginal pessaries. Wishart and Hoskin (1968) treated 81 heifers
with intra-vaginal pessaries impregnated with 200 mg of SC9880 (17α-acetoxy-
9α-fluoro 11β-hydroxy-4-pregnene-3,20 dione). The pessaries were removed
21 days following insertion, however, only 66 of the 81 heifers had retained

the pessaries. Estrus was successfully blocked in all 66 of these heifers.

Lauderdale and Zimbelman (1974) concluded that although effective control of the estrous cycle can be attained with each of the progestogens and routes of administration studied; conception rate of cows inseminated at the first synchronized estrus is normally somewhat lower than that for untreated herdmate controls. However, conception rate of second synchronized estrus, occurring about one normal estrous cycle later, has usually been equal to or somewhat greater than untreated herdmate controls.

Another approach to synchronization of estrus is induction of corpus luteum regression. Hansel et al. (1961) used seven daily subcutaneous injections consisting of 100 U.S.P. units of oxytocin to recycle cows so that they could be bred during a predicted target period. Daily injections of oxytocin during the first 6 or 7 days of the estrous cycle prevents the formation of a normal corpus luteum and results in precocious estrus and ovulation at the eighth to tenth day of the cycle (Lamond, 1964). Early regression of the corpus luteum can be induced in heifers with a single injection of an estrogen (Wiltbank et al., 1961). Wiltbank and Kasson (1968) fed 400 mg of the progestational compound 16-alpha-17 dihydroxyprogesterone acetophenonide (DHPA) per head per day for either 7 or 9 days. On the second day of the DHPA treatment either 5 or 10 mg of estradiol valerate was injected to cause regression of any existing corpus luteum. Their results showed that 100% of the heifers treated exhibited estrus during a 48 hour period which began when the first heifer showed estrus. Lauderdale (1972) injected 30 mg of prostaglandin $F_2\alpha$ ($PGF_2\alpha$) subcutaneously to cows on one of the following days of the estrous cycle: group A- 2, 3 and 4: group B- 6, 7, 8 and 9 or group C- 13, 14, 15 and 16. For group A the corpus luteum life span was normal with the average interval to estrus being 17 days. However, in groups

B and C, the corpus luteum regressed within 2 to 4 days with the heifers
experiencing estrus. Exogenous $PGF_{2\alpha}$ induces luteal regression in cattle
during days 5 through 18 of the estrous cycle (Inskeep, 1973). Liehr
et al. (1972) infused 6 mg $PGF_{2\alpha}$ into the ipsilateral or contralateral
uterine horn in two groups of six heifers each on day 9 of the cycle. The
average length of the cycle was 11.4 for the ipsilaterally treated heifers
and 15.2 for the contralaterally treated heifers. Heersche et al. (1974)
injected 30 mg of $PGF_{2\alpha}$ in 5 ml of Tham buffer following a period of 7
days when the heifers were implanted with Syncro-Mate B, a progestogen
implant. Forty-seven of 50 heifers exhibited estrus during an 84 hour
period between 1 to 5 days after the $PGF_{2\alpha}$ injection.

Louis et al. (1974) has shown that an intrauterine administration of
$PGF_{2\alpha}$ causes events that do not differ significantly from normal estrous
cycles. In their experiments, both luteal diameter and progesterone levels
decrease rapidly by 48 hours post-administration. Estradiol increased from
5 to 12 pg/ml by 48 hours. A surge of LH was noted at 71 ± 4 hours with
standing estrus beginning at 72 ± 5 hours. Ovulation occurred at 95 ± 5
hours following $PGF_{2\alpha}$ administration. The events were the same no matter
which horn the $PGF_{2\alpha}$ was given in.

Roche and Crowley (1973) stated that although the estrous cycle can be
controlled, the number of cows that show heat within a given period of time
following any synchronization treatment has been inconsistent and fertility
to natural and artificial matings at this heat is lower than normal. Hansel
et al. (1961) found that only 50% of 26 heifers conceived to the first service
following a combination of progesterone and oxytocin injections. Wiltbank
and Kasson (1968) obtained a first service conception rate of 62% and 59%
in two different trials using DHPA along with a single estrogen injection.

The controls in the experiment had an 83% first service conception rate. When Wishart and Hoskin (1968) used intra-vaginal pessaries which contained a progestogen, only 43.7% of the heifers conceived to the first service. Reynolds et al. (1973) used progesterone impregnated silicone rubber implants and obtained only a 38% conception rate following implant removal. However, non-implanted controls had a 67% first service conception rate.

Conception has improved slightly with the use of prostaglandins. Lauderdale et al. (1974) obtained a 52.2% conception rate following a 30 mg injection of $PGF_2\alpha$ as compared with a 53.3% conception rate in the non-treated cows. Heersche et al. (1974) gave $PGF_2\alpha$ after cows had been implanted with Syncro-Mate B for 7 days. In their work, 30 of 47 synchronized heifers conceived to the first service (63.8%).

Roche and Crowley (1973) proposed that animals should be inseminated in relation to the time of ovulation rather than in relation to the time of heat with the purpose of increasing first service conception rate. They further stated that this necessitates precise control of the time of ovulation.

Christensen et al. (1974) found the luteinizing hormone (LH) level of cycling beef cows peaked 7.38 ± 5.15 hours after the onset of estrus and remained at this level for 12 hours, then dropped rapidly and remained at a low level until the next estrus. Kaltenbach et al. (1974) administered 1 mg of gonadotrophin releasing hormone (Gn-RH) in a single injection to individual heifers on days 16, 18 or 20 of the cycle. He observed increases in serum LH on all days with greatest response occurring on the day of estrus. Subsequently, 250 ug of Gn-RH was given (im) to five heifers 24 hours after removal of a progestogen implant. Mean duration of the induced LH surge was 7 hours. All heifers exhibited estrus and ovulated. The researchers

concluded that Gn-RH can be used to synchronize ovulation when used in conjunction with a progestational compound. Kinder and Ellington (1974) used ear implants containing 6 mg of Searle SC21009 progestogen with Pregnant Mare Serum Gonadotrophin (PMSG) and Human Chorionic Gonadotrophin (HCG) to study their effectiveness for control of the cycle in yearling beef heifers. In one trial, the animals were implanted for 16 days. When the implants were removed, the animals were injected subcutaneously with 500 IU PMSG. A high percentage of the heifers exhibited estrus during a 2 day period following the injection. In a second trial, cows were implanted for 16 days and 500 IU PMSG was given subcutaneously upon implant removal. In addition, a 1000 IU injection of HCG was administered 1 day following implant removal. Estrus was again observed in a high percentage of the animals. Graves and Dziuk (1968) fed MAP to cycling cows of mixed dairy breeding for 15 to 18 days. At predetermined times after the withdrawal of the MAP, the cows were injected (im) with 500 IU of HCG. They found the average time to ovulation following the HCG injection was 40 hours. The researchers concluded that if ovulation could be predicted, then insemination at some predetermined time could eliminate the need for estrus detection.

Roche and Crowley (1973) controlled estrus and the time of ovulation in 87 mature non-pregnant heifers by using silastic implants of MGA followed by an injection of HCG 48 hours after the removal of the implants. The heifers were allocated at random to three groups for insemination. Animals in groups 1 and 2 were inseminated once at 14 and 24 hours, respectively, after HCG while animals in group 3 were inseminated twice 14 and 24 hours after the HCG. All animals were bred without regard to estrus, however, only a 23% conception was obtained. Lauderdale et al. (1974) inseminated cows at 72 and 90 hours after a $PGF_2\alpha$ injection without regard to estrus. They obtained a 55.8% conception rate following this treatment.

INDUCED CALVING IN BEEF CATTLE

Introduction

Certain compounds have been found to induce parturition in farm animals. Numerous reports have been published on the use of these compounds and much has been learned relative to the role controlled parturition might have in the livestock industry.

This phenomenon has been widely researched in the bovine and although parturition can be predicted within a reasonable proximity; the range is still too wide to warrant its use as a practical management tool. Also, the handling and treatment of cows with retained placenta is a problem. Retained placenta occurs in a high percentage of cases and must be managed properly if reproductive efficiency is to be maintained.

The purposes of this study were to:

(1) Determine if a combination of dexamethasone and prostaglandin $F_2\alpha$ could be used to accurately predict the time of parturition in beef cattle.

(2) Study the effects of intrauterine infusions of proteolytic enzymes and nitrofurazone as compared to a systemic antibiotic for treating retained placenta.

(3) Study the effect of induced calving on calf viability and performance.

(4) Study the effects of induced calving and retained placental treatment on subsequent postpartum fertility.

Materials and Methods

Fifty-six pluriparous Polled Hereford cows 3-9 years of age were used in this study. The cows were bred either artificially or naturally. Bulls were fitted with a chin ball marking harness and cows were checked for breeding marks. Cows were pregnancy diagnosed twice between 50 and 120 days post-breeding to verify breeding dates.

Originally, four hormone treatments were used to induce calving. The treatments were: (A) dexamethasone, (B) prostaglandin $F_2\alpha$ ($PGF_2\alpha$), (C) dexamethasone plus $PGF_2\alpha$ 40 hours later, (D) $PGF_2\alpha$ plus dexamethasone 40 hours later. All hormone treatments were given intramuscularly at 275 ± 1 days after breeding. The dosage was always 20 mg of dexamethasone and 30 mg of $PGF_2\alpha$. An additional treatment, dexamethasone plus $PGF_2\alpha$ 30 hours later, was added and designated "treatment E" during the experiment.

All cows were palpated per rectum just prior to each treatment and only cows approaching parturition were used. Cows were allowed to calve in a small pasture where observations were made concerning ease of calving and calf viability. Assistance was given when necessary and ease of calving was scored as follows: 1 - no difficulty, no assistance, 2 - minor difficulty, no assistance, 3 - minor difficulty, hand assistance, 4 - moderate difficulty, puller or jack used, 5 - major difficulty, jack or puller used and longer than 30 minutes to complete pull, 6 - caesarean. Abnormal presentations were noted as they occurred, but were not included in calving difficulty evaluation. Also, calf viability scores were recorded as follows: 1 - nursed immediately, 2 - lethargic, but suckled unassisted, 3 - required assistance to suckle, 4 - died shortly after birth, 5 - stillborn. Birth weights were recorded

for all calves within 12 hours after birth.

All cows that had not expelled the placenta on the day following parturition were allotted at random to three treatment groups: 1 - intramuscular injections of 20 cc per day of Combiotic for 3 days, 2 - intrauterine infusions of 100 mgα-Chymotrypsin plus 100 mg collagenase (Worthington Bio. Chem. Corp. Freehold, N. J.) and 25 ml nitrofurazone (0.2% Furacin solution, Eaton lab; Norwich, N. Y.) made up to 100 ml with sterile saline. This was given each day for 3 days and was followed on the fourth day with a 6 g infusion of Lactinex granules (Hynson, Westcott and Dunning, Inc. Baltimore, Md.) dissolved in 25 ml of sterile saline, 3 - intrauterine infusions of 25 ml of nitrofurazone made up to a volume of 100 ml with sterile saline was given each day for 3 days.

Days to placental expulsion were noted for each of the three treatment groups. Cows were also examined rectally at approximately 3 and 5 weeks postpartum. At these two examinations, an assessment was made as to the diameter of the uterine horns and the significant structures present on the ovaries were scored as follows: 1 - corpus luteum, 2 - follicles > 12 mm diameter, 3 - follicles < 12 mm diameter and 4 - no significant structures. These data were also used in comparing the three postpartum treatment groups.

Subsequent fertility for the induced cows was recorded as well as a comparison of the two month weights of the calves.

Control data was collected for all observations from cows that calved during the same time period as the treated cows.

Results and Discussion

The time of calving in response to the various treatment groups is shown in table 1.

TABLE 1. INDUCTION OF CALVING AFTER TREATMENT
WITH DEXAMETHASONE AND/OR PROSTAGLANDIN $F_2\alpha$

Group	No. of Cows	Hours From Treatment to Fetal Expulsion Mean ± S.D.
Dexamethasone	5	43.1±13.77
Dexamethasone plus prostaglandin $F_2\alpha$ 30 hours later	7	46.6±10.85
Dexamethasone plus prostaglandin $F_2\alpha$ 40 hours later	9	44.9±5.37
Prostaglandin $F_2\alpha$ plus dexamethasone 40 hours later	11	75.3±9.87
Non-induced controls	12	-----
Dexamethasone calved before 40 hours	8	35.2±3.34
Prostaglandin $F_2\alpha$ calved before 40 hours	4	38.7±2.36

Non-treated cows had an average gestation of 283.4 days compared with 277 for induced cows indicating calves were induced an average of 6 days early. The mean time to calving in group A was 43.1 ± 13.77 hours which agrees

with previous reports (Adams, 1969; Adams and Wagner, 1970). In groups where dexamethasone and prostaglandin were combined (C and D), there was a trend for calving to occur over a shorter range of time than in group A. This is indicated by smaller standard deviations. Eight of nine cows in group C calved an average of 44.9 ± 5.37 hours after treatment with seven of nine calving within 5 hours after receiving the prostaglandin injection. A positive response to treatment was not attained in one cow in group C since parturition did not occur within 72 hours after treatment (Adams and Wagner, 1970). This cow calved 80 hours after treatment. The mean time to calving in group D was 75.3 ± 9.87 hours which was significantly longer (P<0.05) than the mean for any other group. Mean calving time is similar to results obtained by Lauderdale (1974) who observed calving an average of 3 days after administration of a single dose of $PGF_2\alpha$. However, his range in calving time was quite variable compared to these results using $PGF_2\alpha$ followed by dexamethasone. A caesarean was performed on one cow in group D which had not calved but was in labor 100 hours post-treatment.

Eight cows which received dexamethasone calved before receiving prostaglandin. These cows calved 35.2 ± 3.34 hours post-injection. Since prostaglandin appeared to induce labor immediately in seven cows that had not calved 40 hours after dexamethasone administration, the injection of prostaglandin was moved back to 30 hours following dexamethasone (group E). The formation of group E was an attempt to further synchronize calving. If $PGF_2\alpha$ would induce labor 30 hours after dexamethasone, good calving predictability could be obtained. Apparently, injection of $PGF_2\alpha$ at 30 hours post-dexamethasone was not capable of inducing labor at this time as indicated by the larger standard deviation (10.85). Results indicate that it takes about 40 hours for corticoids to initiate the changes necessary for labor in the cow and that prostaglandin is not effective until these changes have taken place.

Four cows originally assigned to group D calved before receiving dexamethasone. It is possible that only cows that have already initiated some endocrine mechanisms for parturition respond to $PGF_2\alpha$. This may contribute to the variability of $PGF_2\alpha$ inducing parturition. Assays for $PGF_2\alpha$ have detected this hormone only near the time of labor (Liggins et al. 1972). The addition of group E and the fact that 12 cows calved before receiving a second injection of either dexamethasone or $PGF_2\alpha$ in groups C and D, respectively, necessitated the deletion of group B from the study due to lack of cows. A test for homogeneity for time of calving in groups A, C, D and E revealed no significant differences among treatment groups.

No difference in calving ease was observed among treatment groups. Twenty percent of the cows did require assistance, however, the number of extremely difficult pulls was small. When all induced cows were compared to the non-induced controls, the calving ease scores were identical (1.7). One caesarean was performed. These findings agree with Carroll (1974) who stated that induced calving produces no decrease in difficulty of birth. Carroll (1974) also found no decrease in calf viability when calves were born after day 270 of gestation. In this study, viability of calves did not differ among treatment groups. One stillbirth was observed, however, seven calves died shortly after birth. An overall comparison between induced and non-induced calves revealed calf viability scores of 1.7 and 1.2, respectively, indicating that induced calves were less viable.

Table 2 shows the comparison of birth weights and 60-day weights between induced and non-induced calves. Birth weights were decreased for induced calves which agrees with previous reports (Osinga et al. 1971; Winter, 1974). Wagner et al. (1971) found that birth weight was highly correlated with length of gestation.

TABLE 2. COMPARISON OF BIRTH WEIGHT AND 60-DAY WEIGHT
BETWEEN INDUCED AND NON-INDUCED CALVES

| | BIRTH WEIGHT (kg) | |
	Induced	Non-Induced
Polled Hereford	30.7	33.7
½ Simmental	34.8	43.6[a]

| | 60-DAY WEIGHT (kg) | |
	Induced	Non-Induced
Polled Hereford	63.3	73.5
½ Simmental	84	74[a]

[a]These calves were sired by a different bull than induced calves.

Polled Hereford and one-half Simmental calves born from induced parturition
were born an average of 6 and 8 days earlier than non-induced calves. These
calves weighed an average of 3.0 and 8.8 kg, respectively, less than non-
induced calves. This weight difference was maintained through 60 days of
age in the Polled Hereford calves while the one-half Simmental induced calves
were heavier at 60 days than the non-induced one-half Simmental calves. These
findings agree with previous reports of Beardsley et al. (1973) and LaVoie
and Moody (1974) who found no significant differences in the average daily
gain between induced and non-induced calves.

Retained placenta occurred in 88% of the cows that were induced and in
8.7% of the non-induced cows. The results of the retained placental treat-
ments are shown in table 3. There was no difference in time to expulsion of
the placenta among groups. Jochle (1973) stated that after parental applica-
tion of antibiotics, the placentae of most animals will be delivered spon-
taneously within 8 days after induction ⸺ mostly around calculated normal
termination of the gestation period. This would compare favorably with this
study since calving was 6 days early and mean interval from calving to

TABLE 3. EFFECTS OF RETAINED PLACENTAL TREATMENT ON UTERINE AND OVARIAN FUNCTION

Treatments	No.	Days to Placental Expulsion	3 Weeks			5 Weeks		
			% With Expected Uterine Size[a]	% With Fluid or Pus	Ovarian Function Score[b]	% With Expected Uterine Size[a]	% With Fluid or Pus	Ovarian Function Score[b]
Combiotic (1m)	13	6.44	60	30	2.70	20	10	2.40
Intrauterine infusion of Nitrofurazone	13	6.08	23	54	3.07	31	38	2.61
Nitrofurazone plus enzyme plus Lactinex Intrauterine	10	6.37	70	30	3.44	70	20	2.66
Non-retained	9	--	33	33	2.50	22	11	2.77

[a] Based on an external diameter of the uterine horns of 60 mm at 3 weeks and 40 mm at 5 weeks.
[b] Scored as CL=1, follicles >12mm=2, follicles <12mm=3 and no significant structures=4.

placental expulsion was about 6 days. The figures for the expected size
of the uterine horn were obtained from work done by Marion and Gier (1968).
They found at 3 and 5 weeks postpartum that the diameter of the regressing
uterine horns should be approximately 60 and 40 mm, respectively. Overall
uterine and ovarian conditions were most desirable in the Combiotic treated
group. Uterine regression in this group occurred rapidly with few cows
having fluid or pus present in the uterus. In addition, the ovarian score
(more large follicles and ovulations) was higher for this group being com-
parable to the non-retained animals. Uterine regression in the nitro-
furazone plus proteolytic enzyme group was slightly faster than the Combiotic
treated group, however, there was less ovarian activity particularly at 3
weeks postpartum. Uterine infusions of nitrofurazone alone yeilded slower
uterine regression and had a larger number of cows with fluid and pus in the
uterus. These results are similar to those obtained by Homan (1969).
Nitrofurazone is a recommended treatment for impaired fertility, retained
placenta and uterine bacterial infection. However, sexual rest is recommended
following its use which may indicate irritation and slow healing action by
nitrofurazone. Three cows had clinically abnormal uteri following retained
placenta. One was diagnosed as metritis while the other two had small bits
of placenta retained within the uterus which became walled-off and blocked
one uterine horn.

Subsequent fertility for all cows is shown in table 4. Subsequent
fertility was not closely correlated to rate of uterine regression and
ovarian activity at 3 and 5 weeks postpartum. Cows treated with nitro-
furazone alone required less time from calving to conception and had the
highest percent conceived to the first service. Total conception rates were sim-
ilar in all groups even though first service conception was low for animals
treated with either Combiotic or nitrofurazone plus enzymes and Lactinex.

TABLE 4. COMPARISON OF POSTPARTUM FERTILITY
IN COWS AFTER VARIOUS TREATMENTS FOR RETAINED PLACENTA

Treatment	No.	Days From Calving to Conception	First Service Conception (%)	Total Conception (%)[a]
Combiotic (im)	13	95.8	15.1	84.6
Intrauterine infusion of Nitrofurazone	13	80.5	54	84.6
Nitrofurazone plus enzyme plus Lactinex Intrauterine	10	105.3	20	90
Avg.		92.9	31	86
Induced Non-retained	6	91.6	83.3	100
Non-induced Non-retained	12	97.2	66.7	100
Avg.		95.3	72	100

[a]Percent of cows conceiving during a 63 day breeding period.

Although the healing action of nitrofurazone is slow, it is apparent that animals do respond when given a period of sexual rest. However, when proteolytic enzymes and Lactinex are added to nitrofurazone for treatment, the regression rate of the uterus is rapid but a longer period of sexual rest is needed. Days from calving to conception was approximately one cycle longer for this group. These results are not consistent with data reported by Homan (1969). He showed a significantly longer interval from calving to conception in cows treated with nitrofurazone while cows treated with nitrofurazone plus enzymes had intervals that were equal to non-treated animals. However, Homan did not use Lactinex. Further work is needed to determine if Lactinex was detrimental in the nitrofurazone plus enzyme treatment. It is possible that the postpartum palpation did not yield an accurate evaluation

of the healing action of nitrofurazone. The low ovarian score may have been a result of further uterine distension caused by the infusions.

Induction of parturition had no effect on subsequent fertility. Six cows that were induced but did not retain the placenta had higher conception rates (both first service and total) than induced-retained animals. While there was no difference between retains and non-retains in days from calving to conception, the first service conception rate for cows that retained the placenta was lower.

Summary

Twenty mg of dexamethasone im at 275 ± 1 days of gestation was effective in inducing calving. The mean interval $\pm$ S.D. from injection to expulsion of the calf was 43.1 ± 13.77 hours. An injection of 30 mg of $PGF_2\alpha$ 40 hours after dexamethasone was effective in increasing the predictability of calving time (44.9 ± 5.37). $PGF_2\alpha$ 30 hours after dexamethasone or dexamethasone 40 hours after prostaglandin was less effective (46.6 ± 10.85, 75.3 ± 9.87, respectively).

Calving ease was not different between induced and non-induced cows. Calf viability was lower for induced calves.

Combining prostaglandin with dexamethasone did not decrease the incidence of retained placenta as it occurred in 88% of the induced cows. No difference in average days to placental expulsion occurred among treatment groups. Rectal palpations at 3 and 5 weeks postpartum showed that cows treated with im injections of Combiotic and intrauterine infusions of nitrofurazone plus proteolytic enzymes plus Lactinex granules had faster uterine involution and more ovarian activity than cows treated with intrauterine infusions of nitrofurazone alone. Combiotic treated cows had less fluid and pus present in the uterus than cows receiving nitrofurazone plus enzymes plus Lactinex. These results indicate that an intrauterine treatment was no more effective than a systemic antibiotic for treatment of retained placenta. However, intrauterine nitrofurazone treated cows had higher first service conception rates and conceived sooner than the other two groups. Cows with retained placentae had lower first service and total conception rates than non-induced cows.

ESTRUS SYNCHRONIZATION IN BEEF CATTLE

Introduction

An estrogen injection will cause early regression of the corpus luteum
in cattle (Wiltbank et al. 1961). However, the onset of estrus following
such a treatment has been variable. Progestogens given alone for 2 to 3
weeks can synchronize estrus in cows but the conception rate at the
synchronized estrus has generally been low (Lamond, 1964). However,
conception has been comparable to controls when estrogen is given in con-
junction with a short term (9 to 10 days) progestogen treatment (Wiltbank
and Kasson, 1968). In some instances, cows treated in this manner may not
show the characteristic signs of estrus following treatment. Roche (1974)
found that this low estrus response was partly due to the estrogen injection
causing immediate ovulation in those cows which are in the follicular
phase of the cycle. He found that incorporating progesterone into the
estrogen injection was effective in blocking the ovulatory effect of the
estrogen. However, some cows will be synchronized, ovulate, and still not
show signs of heat. Therefore, it may be advantageous to breed according to
expected time of ovulation rather than according to estrus to insure highest
fertility.

The purpose of this study was to determine if acceptable fertility could
be obtained when cattle were inseminated at predetermined times following
treatment with an estrogen-progestogen injection and a progestogen implant.
Fertility of these cows was compared to cows synchronized and bred artificially
according to estrus and non-synchronized cows bred naturally.

Materials and Methods

Ninety-nine Polled Hereford cows (19 two-year-old heifers and 80
cows 3 to 9 years of age) were used in this study. Forty-three of the
cows had previously been used in an induced calving study in which retained
placentae occurred in 37 cows. Cows were assigned randomly within age,
induced calving and presence or absence of retained placenta to breeding
groups.

Treatment was started on May 25, 1974; thus, random stages of the
cycle were represented at the beginning of the treatment. The ovaries
of all animals were palpated per rectum previous to the initiation of the
study so that only cycling animals were used. Ear implants containing
6 mg of Searle SC21009 progestogen (Syncro-Mate B) were used in combination
with a 2 ml intramuscular injection containing 3.0 mg estradiol valerate
and 1.5 mg SC21009 progestogen in sesame oil. The implant and the injection
were administered on the same day to 83 animals with the implant being
left in place for 9 days. Sixteen additional animals were used as controls
and received no treatment.

Following removal of the implant, the treated cows were equally divided
into four breeding groups. Cows in groups A, B and C were bred artificially
at 48, 54 and 60 hours, respectively, following implant removal. Although
these cows were bred without regard to estrus, the number of cows observed
in estrus at each breeding time was noted. Cows in group D were bred
artificially approximately 12 hours after the onset of estrus during a five
day period following implant removal. Any cows in this group that had not

shown estrus by pm of the fifth day were considered not synchronized. The 16 control animals were pasture bred to the same bulls used in A.I. and constituted group E.

On the sixth day after removal of the implants, all animals were divided into four groups and turned out with one bull per group. Each bull was equipped with a chin ball marking harness and breeding dates for subsequent cycles were recorded based on breeding marks. The length of the breeding season was 63 days.

The uterus of each cow was palpated per rectum at approximately 50 and 85 days after artificial insemination to determine pregnancy. Fertility was calculated based on the number of cows pregnant to the synchronized insemination (groups A-D) and compared to the number of cows conceiving during the first 21 days of the breeding season (group E). In addition, total conception rate at the end of the breeding season was compared between groups.

Results and Discussion

First service conception rates were significantly lower (P<0.005) in cows that were synchronized and bred artificially (groups A, B, C and D) than in the naturally mated, non-synchronized cows (group E). However, conception rates at the end of the breeding season were not different (table 5).

TABLE 5. COMPARISON OF CONCEPTION RATES IN COWS
AFTER SYNCHRONIZATION OF ESTRUS
WITH SYNCROMATE B AND ESTRADIOL VALERATE

Time of Artificial Insemination	No.	First Service Conception (%)	Total Conception (%)[a]
48 hours after implant removal	19	26.3	78.9
54 hours after implant removal	21	23.8	95.2
60 hours after implant removal	21	38.1	85.7
12 hours after observed in estrus	21	33.3[b]	95.2
Non-synchronized pasture bred naturally	16	68.8	93.7

[a]Percent of cows conceiving during a 63 day breeding period.
[b]Three cows did not exhibit estrus within 5 days after implant removal and were not included in first service conception rate.

The synchronization procedure may have been detrimental to conception at first service, however; due to the lack of artificially bred controls, it is

difficult to determine if the decrease in conception is due to the synchronization procedure or to artificial insemination. There was an indication that the appointed matings at 48, 54 and 60 hours post-treatment were too early since slightly more cows conceived at 60 hours and more cows were in estrus at the time of insemination (57.9, 38.1 and 23.8% for groups A, B and C, respectively). In addition, the average time of estrus in group D was 69.3 hours with 48% having shown estrus 48 to 60 hours after implant removal. However, those bred at estrus did not have a significantly higher conception rate than the appointed matings.

No cows showed estrus during the implant period and the estrogen injection did successfully regress the corpra lutea as revealed by palpation when the implants were removed. Three of 21 cows in group D did not show estrus during the 5 day period after implant removal. These cows were designated as not synchronized and were not used in the calculation of first service conception rate. One cow in group A lost her implant during the 9 day implant period and was deleted from the experiment.

It is interesting to note that of the 82 treated cows, 73 were pregnant at the end of the breeding season. Of these 73, 39 or 53.4% conceived at the estrus immediately following the synchronized estrus.

This hormone treatment appeared to be effective in synchronization of estrus but first service conception rate with artificial insemination was low (30%) as compared with non-synchronized, naturally mated cows (68.8%). Mating at predetermined times of 48, 54 or 60 hours post-treatment was as effective as inseminating according to estrus.

Summary

An estrus synchronization treatment consisting of a 9 day Syncro-Mate B ear implant and an estrogen-progestogen injection was administered on the same day to 83 cycling Polled Hereford cows. An additional 16 cows received no treatment. Treated cows were inseminated at either 48, 54 or 60 hours or 12 hours after the onset of estrus following implant removal. Control cows were pasture bred by a bull.

The treatment appeared to be effective in synchronizing estrus, however, first service conception rates for all synchronized cows were significantly lower when compared to naturally bred non-synchronized cows. First service conception rates were 26.3, 23.8, 38.1, 33.3 and 68.8% for the 48, 54, 60, estrus and naturally bred cows, respectively. Conception at the estrus subsequent to the synchronized estrus was not affected by the treatment. No differences in conception rates were obtained among groups for the breeding season. Average conception rate for all cows was 89.7%.

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INDUCED CALVING AND ESTRUS SYNCHRONIZATION
IN BEEF CATTLE

by

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Induction of Calving

Fifty-six pluriparous Polled Hereford cows 3 to 9 years old were used in an induced calving study. Forty-four were given various treatments at 275 ± 1 days of gestation and 12 cows served as non-induced controls. Treatments (im injections) were as follows: (A) 20 mg dexamethasone (dexa), (B) 30 mg prostaglandin $F_2\alpha$ ($PGF_2\alpha$), (C) dexa + $PGF_2\alpha$ 40 hours later, (D) $PGF_2\alpha$ + dexa 40 hours later. Observations were made for length of time from first treatment to calving, ease of calving, calf viability, days to placental expulsion, rate of uterine involution and ovarian function. Eight of 17 and 4 of 15 cows calved before receiving a second injection of either dexa or $PGF_2\alpha$ in groups C and D, respectively. An additional treatment, dexa + $PGF_2\alpha$ 30 hours later, was added and designated "treatment E" during the experiment. These occurrences necessitated deletion of group B. Mean time of calving after treatment was significantly longer in group D ($P<0.05$), but the range in which calving occurred was smaller in group C. Hours $\pm$ standard deviation from first treatment to calf expulsion were: (A) 43.1 ± 13.77, (C) 44.9 ± 5.37, (D) 75.3 ± 9.87 and (E) 46.6 ± 10.85.

Treatment did not affect calving ease, however, calf viability was lower for induced calves. Induced calves weighed less at birth but weight gain from birth to 60 days was not different from non-induced calves.

Retained placenta occurred in 88% of the cows in which calving was induced. Cows with retained placenta 24 hours after calving were randomly allotted to three treatment groups: (A) 20 cc Combiotic im for 3 days, (B) intrauterine infusions of nitrofurazone in sterile saline for 3 days,

(C) intrauterine infusions of nitrofurazone + 100 mg α-chymotrypsin and 100 mg collagenase in sterile saline for 3 days followed on day 4 with an infusion of 6 g of Lactinex granules in sterile saline. Time of placental expulsion was not different between groups. Rectal palpations were made at 3 and 5 weeks postpartum to estimate uterine involution rate and ovarian function. Groups A and C had more ovarian function and smaller uteri than group B. However, group B required less time to conception and had a higher first service conception rate. Percent of cows pregnant by the end of a 63 day breeding season did not differ between groups. Cows without retained placenta had higher first service conception rates and higher total conception than cows that did retain the placenta.

Estrus Synchronization

Ninety-nine Polled Hereford cows (19 two-year-old heifers and 80 cows 3 to 9 years old) were used in an estrus synchronization study. Treatment consisted of ear implants of Syncro-Mate B plus a 2 ml im injection containing 6 mg estradiol valerate and 2 mg progestogen (SC21009). The implant and injection were administered on the same day to 83 animals. The implant was removed 9 days later. Sixteen animals received no treatment.

Following implant removal, the treated cows were equally divided into four breeding groups. Cows in groups A, B and C were bred 48, 54 and 60 hours, respectively, after implant removal without regard to estrus. Cows in group D were bred artificially approximately 12 hours after the onset of estrus if they exhibited estrus within 5 days of implant removal. The 16 control cows were pasture bred with a bull and constituted group E.

One cow in group A lost her implant and was deleted from the experiment. No significant differences were noted in first service conception rates for the cows in groups A to D as follows: 26.3% (5/19), 23.8% (5/21), 38.1% (8/21)

and 33/3% (6/18). Three cows in group D did not show estrus during the
5 day insemination period and were classified as not synchronized. Eleven
of 16 control cows (68.8%) conceived to the bull during the first 21 days
of the breeding season. This was significantly different (P<0.005) than the
synchronized groups. The occurrence of estrus at the three appointed
inseminations decreased as time increased (11, 8 and 5 for groups A, B
and C, respectively) indicating that breeding may have been too early.
Conception during a 63 day breeding season for groups A to E were as follows:
78.9% (15/19), 95.2% (20/21), 85.7% (18/21), 95.2% (20/21) and 93.7% (15/16).
These values were not significantly different (P>0.75).