

EFFECT OF GnRH, BREEDING WEIGHT,
FRAME, CONDITION AND AGE ON PREGNANCY RATES
IN ESTRUS SYNCHRONIZED BEEF HEIFERS

by

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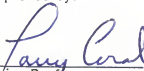
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Review of Literature

Reproductive management to improve production in beef cattle.

It is a common practice of the beef cattle industry to breed heifers to calve at 2 yr of age. However, to achieve this goal, heifers must be cycling and conceive early in the breeding season. Gonadotropin releasing hormone (GnRH) might be used as a management tool to enhance early conception rates in heifers bred to calve as 2 yr olds, and, in so doing, provide an alternative to increasing the plane of nutrition to achieve high pregnancy rates. Smith et al. (1979) stated that heifers which fail to reach puberty prior to, or early in, their first breeding season cannot become pregnant early, yet the economic feasibility of having heifers reach the weight at which a high proportion will reach puberty by 13 to 16 mo of age is questionable.

Grass et al. (1982) contended that every day a heifer is maintained before giving birth to a calf decreases her lifetime efficiency, and reducing age at puberty would increase economic efficiency of calf production by decreasing the age at first calving or by increasing the calving percentage among heifers bred to calve as 2 yr olds.

Lesmeister et al. (1973) studied the effects of first calving date on lifetime production in beef heifers. Heifers initially calving earlier tended to calve earlier throughout the remainder of their

productive lives than heifers initially calving later. Additionally, calves born earlier grew significantly faster from birth to weaning than calves born later, and earlier calving heifers had higher average annual lifetime calf production than late calving heifers. These investigators suggested that managing and breeding heifers such that they calve early in the season should contribute profit in the cow-calf operation.

Effects of gonadotropin releasing hormone on conception.

Conflicting reports concerning conception rate as affected by GnRH exist. In a study by Schels and Mostafawi (1978), normally cycling Holstein-Friesian cows were given .125 mg synthetic GnRH intramuscularly at first service only. The objective of this investigation was to use GnRH to trigger release of endogenous luteinizing hormone (LH) and induce ovulation of mature Graafian follicles in an attempt to bring time of insemination and ovulation into a favorable correlation. The results showed that 58.7% of the GnRH treated cows were diagnosed pregnant after one insemination, compared to 49.5% in the untreated control group. When data from four services were combined, total pregnancy rate was 8.3% higher for the GnRH treatment group than for the controls, and services per conception were improved from 1.49 for controls to 1.39 with GnRH treatment. It was concluded that GnRH administration at the time of estrus could improve herd fertility through its inducing effect on follicle rupture and regulatory influence on ovarian function.

Nash et al. (1980) gave lactating Holstein and Brown Swiss cows saline or 100 or 250 µg GnRH intramuscularly on d 13, 14 or 15 postpartum. Injection of 250 µg GnRH resulted in significantly shorter intervals from calving to conception, significantly higher first service conception rate and significantly lower services per conception. Overall conception rates were also significantly improved by treatment with 250 µg GnRH. It was, therefore, concluded that administration of GnRH 2 wk postpartum may induce early cyclic activity and subsequently increase fertility in dairy herds under good reproductive management.

Nakao et al. (1983) reported that 100 µg GnRH analog given intramuscularly to Holstein-Friesian cows at first insemination significantly improved first service pregnancy rate by 7.5% when compared to a placebo injected group.

Lee et al. (1983) conducted three studies in which 100 µg GnRH analog or 2 ml saline solution was administered intramuscularly to: 1) postpartum dairy cows on d 14 postpartum and at first postpartum breeding, 2) repeat breeder dairy cows at third breeding, and 3) dairy heifers at first breeding. In postpartum cows, when GnRH was given at first breeding, conception rates were significantly higher when compared to the saline injected control group. Gonadotropin releasing hormone at 14 d postpartum also gave increased fertility, although not significantly different from controls. Conception rates were 15 to 18% higher for cows given GnRH whether at 14 d postpartum or at first postpartum breeding. For repeat breeder cows, conception rates for cows given GnRH were 25% higher than the controls. Conception

rates in heifers did not significantly differ between treatments. It was noted that the improved conception rates in cows treated with GnRH provided strong evidence that GnRH elicited some physiologic effect that led to improved fertility. These investigators further suggested that for cows which do not conceive, delayed ovulation or insufficient LH to stimulate the series of events that culminate in ovulation, may be an important factor to be considered. Additionally, it was proposed that GnRH given at breeding is between the endogenous surge of LH and ovulation. Therefore, it was suggested that GnRH could produce a secondary surge of LH to enhance luteinization of granulosa cells which ensure adequate production of progesterone to maintain early pregnancy.

In a trial conducted by Maurice et al. (1982) repeat breeder cows were injected with 100 µg GnRH or saline within 10 min after the third insemination. The difference between treatment groups was highly significant, with 71% of cows injected with GnRH conceiving vs 46% conception in the saline injected control group. It was concluded that GnRH at insemination can lead to improved fertility in repeat breeder cows.

In a study involving lactating Holstein cows, Stevenson et al. (1984) reported that conception rate at first service was not improved with administration of 100 µg GnRH, but that repeat services, i.e., second and third services, were improved by nearly 21% when compared to saline treated controls. All services combined, GnRH treated cows had improved conception of 13% above controls. It was noted that repeated GnRH treatment of the same cow at consecutive

services may have contributed to improved conception. Furthermore, the authors speculated that GnRH likely acts through its effects on LH and follicle stimulating hormone (FSH) release which may affect time of ovulation, fertilization rates, corpus luteum development, progesterone secretion and(or) embryonic survival or directly affect the female reproductive tract.

To determine the effectiveness of GnRH in improving fertility in conjunction with synchronization, Anderson et al. (1982) synchronized Holstein heifers with a norgestomet implant¹ and estradiol injection. They either inseminated 8 to 16 h after an observed estrus for 5 d after implant removal, time inseminated at 48 h post implant removal, or injected 150 µg GnRH intramuscularly 40 h after implant removal and inseminated 8 h later. Estrus occurred within 5 d of implant removal in 88.7% of the SMB treated heifers implanted at random stages of the estrous cycle. In contrast to the reports cited above, GnRH did not cause any beneficial effect on fertility in this study.

In a study by Zaied et al. (1976), beef cows synchronized with SMB were bred either 12 h after the onset of estrus or injected 30 h after implant removal with 125 µg GnRH and bred 12 h later. These researchers noted that the treatments appeared to induce estrus in anestrus, lactating cows. However, pregnancy rates for cows

¹ Synchro-Mate-B® (SMB), CEVA Laboratories, Inc., Overland Park, Kansas.

receiving GnRH did not significantly differ when compared to other treatment groups.

Spitzer (1982) conducted a study to evaluate the effectiveness of SMB and GnRH on inducing a fertile estrus and(or) ovulation in prepuberal beef heifers. Treatment groups were: 1) SMB and inseminated 12 h after detected estrus, 2) SMB and inseminated 48 h after implant removal, 3) SMB and 125 µg GnRH intramuscularly at 30 h after implant removal and inseminated 12 h later, and 4) untreated controls. Results showed that heifer age had no significant effect on estrous response or pregnancy rate. Weight was a significant source of variation on interval from start of breeding to pregnancy. The general trend in all SMB treated groups was that heavier weight groups had higher pregnancy rates. Gonadotropin releasing hormone treatment did not appear to be beneficial and, in fact, was associated with reduced pregnancy rate. The authors speculated that the negative response to GnRH might have been due to the timing of LH release relative to estrus. It was concluded that a large percentage of the prepuberal heifers were induced into estrus with SMB treatment; however, pregnancy rates were low. These researchers recommended that heifers should be of sufficient age and weight to reach puberty prior to SMB treatment if acceptable pregnancy rates are desired.

Use of GnRH in the treatment of ovarian cysts. Gonadotropin releasing hormone has been shown to be therapeutic in cows suffering from ovarian cysts. Bierschwal et al. (1975) reported a study in

which 100 µg dosage of synthetic GnRH aided in the establishment of normal estrous cycles, as evidenced by a positive response in 82% of dairy cows diagnosed as having ovarian cysts. Subsequent fertility was also aided, as evidenced by 87% conception in those cows which responded positively to GnRH treatment.

Cantley et al. (1975) intramuscularly injected dairy cows diagnosed as having ovarian cysts with 0, 50, 100 or 200 µg synthetic GnRH. Plasma LH was significantly increased on d 0 after GnRH. Additionally, plasma progesterone levels in cows that responded to treatment were higher when compared to those of cows that did not respond to treatment. Seventy-two percent of the GnRH treated cows responded positively to treatment and returned to estrus 20.1 ± 1.5 d after GnRH administration.

Kittok et al. (1973) administered three doses of GnRH intravenously at 120 min intervals to lactating Holstein cows diagnosed as having ovarian follicular cysts. Gonadotropin releasing hormone treatment produced an LH surge similar to the preovulatory surge of the bovine. All cystic cows exhibited standing estrus 20 to 24 d after GnRH treatment.

Effect of GnRH on luteinizing hormone release and ovulation.

Although the mechanism of GnRH action is as yet unclear, it has been suggested that GnRH at the time of insemination probably increases and(or) initiates the characteristic preovulatory LH surge which, in turn, induces ovulation at an optimum time for fertilization to occur. Chipepa et al. (1977) conducted a study with mature lactating cows in

which saline or 2 mg GnRH analog were administered intramuscularly. Although GnRH did not improve conception rates in this study, GnRH produced a serum LH peak in all cows within 1 h postinjection. The authors theorized that GnRH may make it possible to synchronize the onset of the preovulatory LH surge and that this could synchronize ovulation.

In a trial conducted by Kinder et al. (1975), Angus heifers were given either 1 ml acidified saline or 150 µg GnRH at 4 h intervals on d 16 through 19 of the estrous cycle (96 h). The GnRH treatment group had a significantly greater postinjection mean serum LH concentration than the control group.

With lactating Holstein cows, Britt et al. (1974) administered either 100 µg GnRH or saline in a subcutaneous gelatin capsule ear implant on d 14 postpartum. Gonadotropin releasing hormone treatment significantly increased serum LH concentrations and significantly shortened the interval to first ovulation. It appeared, however, that the LH spike occurred later than normal, suggesting that the gelatin capsule retarded the release of GnRH. The authors also noted that the size of the previously gravid horn decreased more rapidly during the week following GnRH treatment, possibly due to the influence of progesterone resulting from the CL induced by the LH response after GnRH.

Kittok et al. (1972) demonstrated with Holstein cows with ovarian follicular cysts that three 100 µg intravenous injections of GnRH at 120 min intervals could produce an increase in serum LH after each injection. These investigators suggested that prolonged or

repeated administration of GnRH may be necessary to elicit a surge of LH comparable to the normal ovulatory surge.

Fernandez-Limia et al. (1977) synchronized three successive estrous cycles in beef cows and heifers using prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$). The purpose of this experiment was to test the effect of GnRH on the occurrence of estrus and to investigate the practicality of inducing an LH surge just prior to the normal spontaneous surge. An intramuscular injection of 50 μ g of GnRH analog was administered to one group 64 h after $PGF_{2\alpha}$. Gonadotropin releasing hormone effectively induced preovulatory surges of LH which were considerably greater in magnitude but slightly shorter in duration than the spontaneous surges in the untreated controls. It was concluded that GnRH was effective in producing early, timed preovulatory LH surges or potentiating incipient spontaneous preovulatory LH surges and, therefore, may be a valuable aid in improving fertility in $PGF_{2\alpha}$ synchronized beef cows.

Kaltenbach et al. (1974) synchronized estrus in beef heifers using a progestational compound. These heifers then received saline or 250 μ g GnRH intramuscularly 24 h post implant removal or the same dosage of GnRH 36 h post implant removal. An additional group of heifers received an identical dosage of GnRH 60 h after a single $PGF_{2\alpha}$ injection. It was concluded that GnRH can stimulate release of LH and FSH in heifers, and that synchronization of ovulation can be obtained with GnRH when used in conjunction with either progestational compounds or $PGF_{2\alpha}$.

Cumming et al. (1977) estrus synchronized cows with cloprostenol and administered 250 µg luteinizing hormone releasing hormone (LH-RH) subcutaneously 52 h after the second cloprostenol injection. Endoscopic observations were made of the ovaries. In cows receiving LH-RH, ovulation occurred 78 to 84 h following the last injection of cloprostenol. Additionally, 90% of the cows receiving LH-RH treatment had ovulated within 6 h of the first animal. In the untreated control group, 90% of the ovulations had not occurred until 94 h after the last cloprostenol injection. Thus, it was concluded that LH-RH can shorten the interval from injection to ovulation in cloprostenol synchronized females.

Roche (1975) determined time of ovulation in Hereford heifers following treatment with progesterone and 100 µg GnRH administered intramuscularly 30 h after the progesterone treatment. Heifers were slaughtered at specified times after GnRH treatment, with the ovaries recovered and examined. A significantly higher number of GnRH treated heifers had ovulated 60 and 65 h following progesterone removal. It was concluded that GnRH can synchronize and hasten time of ovulation in heifers given progesterone.

Time of ovulation was determined by Roche (1977) in Hereford cross heifers which had been estrus synchronized with cloprostenol and given 100 µg synthetic GnRH 48 h following the last cloprostenol injection. The heifers were slaughtered 78 h after the last cloprostenol injection, and the reproductive tracts recovered. All GnRH treated animals that responded to prostaglandin ovulated by 78 h. It was concluded that GnRH significantly hastened and

synchronized ovulation when compared to untreated controls. However, controlling time of ovulation with GnRH did not increase pregnancy rate in heifers inseminated 72 h after cloprostenol treatment. The author implied that the fertility of prematurely ovulated eggs might be a factor.

In a trial with pregnant mare serum gonadotropin primed pigs, Baker et al. (1973) demonstrated that a single intramuscular or intravenous injection of greater than 1 mg GnRH can be used to consistently induce ovulation in the proestrus gilt. All gilts that ovulated showed an increase in serum LH concentration after GnRH treatment.

A study with golden hamsters by Arimura et al. (1971) showed that a subcutaneous injection of .179 nmole of synthetic GnRH induced LH release, and both .179 and .357 nmole dosages induced full ovulation.

Reeves et al. (1973) gave hens synthetic GnRH intramuscularly and concluded that mammalian GnRH induces LH release from the chicken pituitary in sufficient quantity to stimulate premature ovulation.

Blood progesterone and maintenance of the early embryo.

Embryonic mortality may be a major factor involved in reduced pregnancy rates in beef cattle. Another potential effect of GnRH is increased progesterone secretion from the CL resulting from the LH response to GnRH. This potential increase in blood progesterone might aid in the maintenance of the early embryo and, thus, increase

subsequent pregnancy rate. Carlson et al. (1971) administered LH via 5 mg subcutaneous injections to heifers. Luteinizing hormone significantly increased plasma progesterone concentrations in both hysterectomized and intact females.

Tanabe and Casida (1949) bred repeat breeding Holstein and Guernsey cows and slaughtered these cows either 3 or 34 d after breeding to determine fertilization rate and embryonic mortality rate. Of the cows slaughtered 3 d after breeding, 39.7% had fertilization failure. Of the cows slaughtered 34 d after breeding, 21.1% were found to have normal embryos. Thus, embryonic abnormalities and mortality was estimated to be 39.2% by d 34 after breeding.

Tanabe and Almquist (1953) inseminated repeat breeding, nulliparous dairy heifers and slaughtered the heifers 3 or 30 d postinsemination to determine the incidence of reproductive failures. Of those heifers slaughtered 3 d after insemination, examination of reproductive organs showed that no ova were found in 11.3% of the females. In the remaining females that yielded ova, 66.7% were fertilized, 23.8% were unfertilized, and 9.5% had degenerate or ruptured ova. Of the heifers slaughtered 30 d postinsemination, 30.6% of the heifers had normal embryos, 8.3% degenerated embryos, and 5.6% had no embryos. Thus, these researchers concluded that there appeared to be a high fertilization rate in infertile heifers with a subsequent high incidence of embryonic death the first month of pregnancy.

Wiltbank et al. (1961) conducted a study to determine the various points when reproductive failure occurs in the beef cow. Beef

cows were exposed to bulls for a breeding season of 75 d. Rectal examinations of the reproductive tracts were made at specified intervals to determine pregnancy, estimate embryo losses and when loss occurred. First service conception rates ranged from 39% to 80% at various pasture locations. Results showed that failure to conceive or embryonic death represented the most important factor in reduced calf crop.

Johnson et al. (1958) hypothesized that embryonic death might be a failure of the embryo to implant in the uterus. This failure could be a result of the uterus not being prepared for implantation. Since one of the conditions essential for implantation of ova is a uterine secretory condition dependent on progesterone, insufficient progesterone at nidation could be a major cause of repeat breeder cows and heifers. In this study, dairy cows and heifers received 100 mg reposital progesterone intramuscularly at 2, 3, 4, 6 and 9 d after breeding. Adminstrating progesterone increased breeding efficiency 28% over controls for first service conception. It was concluded that progesterone may have increased the secretion of endometrium (uterine milk), which may have aided nidation, reducing embryonic death.

Wiltbank et al. (1956) conducted a study to determine the effects of exogenous progesterone on embryonic survival in repeat breeding cows. Cows were bred 12 h after first observing heat and then injected daily with either 50 or 200 mg progesterone, starting 3 d after the beginning of heat until slaughter at 34 d postestrus. Although result showed that a higher percentage of progesterone

treated females had normal embryos at 34 d, the differences between treated and control groups in neither the 50 mg trial nor the 200 mg trial were statistically significant. However, they concluded that embryonic death could be a direct cause of lowered fertility in repeat breeding cows, and progesterone deficiency could be a possible explanation.

Henricks et al. (1970) studied serum LH and plasma progesterone concentrations during five estrous cycles of nonlactating dairy cows. Findings showed that LH concentrations as high as 100 ng/ml were obtained 3 to 6 h after the onset of estrus, and elevated levels lasted for 8 to 10 h. Plasma progesterone reached a peak at d 14 in pregnant cows and d 16 in nonpregnant cows. Progesterone concentrations were significantly higher from d 10 to 14 in pregnant cows than in nonpregnant cows.

Henricks et al. (1971) monitored concentrations of progesterone in peripheral plasma of beef heifers following mating. As early as 9 d after mating, progesterone concentrations in pregnant heifers were significantly higher than in heifers that returned to estrus. Over the first 15 d after mating, pregnant heifers had about 1.7 times more progesterone present than those that returned to estrus.

In a study involving crossbred beef cows and heifers, Maurer and Echternkamp (1982) synchronized all animals with $\text{PGF}_2\alpha$, bred to the next heat after the synchronized estrus, then slaughtered all animals 8 to 16 d after breeding to collect reproductive tracts and examine for embryos. Luteinizing hormone and progesterone profiles in peripheral blood were determined from onset of estrus until

slaughter with embryonic comparisons made among parous and nonparous females. Females with a normal embryo had a shorter interval from the onset of estrus to the LH peak and significantly greater LH peak height than females with unfertilized or degenerate embryos or no recovery of an oocyte or embryo. Additionally, females with a normal embryo had significantly higher progesterone concentrations in peripheral blood serum on d 3 and 6 following estrus than females with abnormal or no embryonic development. It was concluded that this hormonal asynchrony may produce an undesirable uterine environment for the male and female gametes or embryos, resulting in fertilization failure or embryonic death.

Estrus synchronization with progestin treatments. Progestin compounds such as SMB, which consists of 6 mg norgestomet implanted subcutaneously in the convex surface of the ear for 9 d and an intramuscular injection of 5 mg estradiol valerate and 3 mg norgestomet administered on the day of implant insertion, have been used to synchronize estrus in cattle. In trials conducted by Spitzer et al. (1978) with SMB, 85 to 100% of treated heifers had shown estrus by 120 h after implant removal. First service conception rate following treatment was somewhat variable among trials. However, it was concluded that the treatment was highly effective in synchronizing estrus in beef heifers.

The stage of the estrous cycle that a progestin treatment is used may influence the response. Woody and Pierce (1974) conducted two experiments to determine if the interval to estrus after estradiol

valerate and norethandrolone treatment was greater in heifers before 10 d postestrus than in heifers treated later in the estrous cycle. In experiment 1, dairy heifers were implanted with 250 mg norethandrolone for 9 d and injected with 5 mg estradiol valerate on d 2, 5, 8, 11, 14 or 17 after estrus. Those heifers implanted prior to 10 d postestrus had significantly longer intervals to estrus than those implanted after 10 d postestrus. In experiment 2, Holstein heifers were implanted either 2 or 14 d postestrus and were injected with estradiol valerate on the day of implantation. Implants were removed 9 d after insertion. Results showed that significantly more heifers responded to synchronization treatment when implanted 14 d postestrus as compared to those implanted 2 d postestrus.

Brink et al. (1985) estrus synchronized cows and heifers with SMB and artificially inseminated 48 h after implant removal. Stage of the estrous cycle when SMB treatment was initiated appeared to influence conception rate, as heifers started on SMB treatment before d 11 had a higher conception rate than those started after d 11 of the estrous cycle. Estrus was induced by SMB in some noncycling females, as evidenced by a conception rate of 42.5% in cows that were cycling vs 19.8% in cows that were not cycling prior to SMB treatment.

In a trial conducted by Miksch et al. (1978), in which cows were implanted with 6 mg norgestomet for 9 d and intramuscularly injected with 6 mg estradiol valerate and 3 mg norgestomet at the time of implantation, 93% of the cycling cows receiving the treatment exhibited estrus during the 5 d period following implant removal, as

did 85% of the anestrus cows. Most cows showed estrus between 36 and 60 h after implant removal, with first service conception rates being 68% and 60% for cycling cows and anestrus cows, respectively. It was concluded that treatment may have accelerated ovarian activity in some of the anestrus cows.

Gonzalez-Padilla et al. (1975a) studied changes in serum gonadotropin levels in prepuberal half-sib Angus heifers following the injection of progesterone, estradiol or a combination of the two in an attempt to correlate these changes with CL formation and the induction of estrous cycles. Heifers were treated with either 2 mg estradiol-17 β injected intramuscularly on d 0, 20 mg progesterone intramuscularly on d -2, or 20 mg progesterone on d -2 and 2 mg estradiol on d 0. Estradiol induced LH peaks 12 to 18 h following injection. Injection of progesterone alone had little or no effect on behavioral estrus or serum gonadotropin levels. Of the heifers receiving the combination of progesterone and estradiol, 75% developed a normal CL and returned to estrus on d 19 to 21. These results indicated an increased response to endogenous LH by prepuberal ovaries primed with progesterone.

Utilizing estrogen and progesterone, Gonzalez-Padilla et al. (1975b) explored the possibility of inducing puberty in prepuberal beef heifers by mimicking the changes in blood hormone levels near puberty. Heifers were treated with 5 mg estradiol valerate and 3 mg norgestomet intramuscularly and a 6 mg norgestomet implant was administered. The implant was removed 9 d later. In four different trials, by 4 d after implant removal, 79 to 94% of the heifers had

been observed in estrus. In two of these trials heifers were inseminated, with 43 and 56% pregnant to the induced puberal estrus. These results suggest that the treatment is effective in hastening the final events leading to puberty, and that it can be used effectively as a management tool to get a larger proportion of heifers pregnant early in the breeding season.

Short et al. (1976) evaluated the effectiveness of different hormone treatments in inducing or synchronizing a fertile estrus in prepuberal heifers of varying ages and weights. Heifers were given one of five treatments: 1) 5 mg estradiol-17 β , 2) 2.1 g progesterone implant for 6 d and 5 mg estradiol-17 β injection 24 h after implant removal, 3) 6 mg progesterone implant for 6 d and injection of 3 mg progesterone and 5 mg estradiol valerate at the time of implanting, 4) 6 mg progesterone implant for 9 d and an injection of 3 mg progesterone and 5 mg estradiol valerate at the time of implantation, or 5) 6 mg progesterone implant for 9 d with an injection of 5 mg estradiol-17 β 24 h after implant removal. Results showed that treatment 2 significantly increased the number of heifers ovulating when compared to treatment 1. Treatment 2 also significantly increased the number of heifers showing estrus within 4 d as compared to treatments 1 and 3. Pregnancy rates for heifers receiving treatment 4 were significantly higher than those receiving treatment 5. These researchers concluded that a fertile estrus can be hormonally induced in prepuberal heifers of normal age (13 to 15 mo) and to a lesser degree in very young heifers (9 mo).

Smith et al. (1979) utilized SMB with puberal and prepuberal yearling heifers to determine if SMB could increase the occurrence of estrus and pregnancy in heifers of various breeds and weights. All heifers were artificially inseminated approximately 12 h after detection of estrus. Weight was an important factor in response to SMB. Treatment was effective in inducing estrus and pregnancy in heifers weighing over 250 kg; however, it did not induce a fertile estrus in many lighter weight heifers.

In an experiment involving postpuberal dairy heifers, Kazmer et al. (1981) estrus synchronized with SMB and inseminated either 12 h after the detection of estrus or 48 h after implant removal. Untreated control heifers were inseminated 12 h after the detection of estrus. First service pregnancy rates did not significantly differ among treatment groups. Intervals from implant removal until peak FSH and LH release were highly variable among SMB treated heifers. These researchers suggested that such variation among individuals in hormonal and behavioral events could contribute to a decrease in fertility at the controlled estrus. However, it was concluded from the results of this experiment that the SMB treatment was effective in suppressing estrus behavior and peak gonadotropin release until after the removal of the norgestomet implant.

Mares et al. (1977) estrus synchronized nursing beef cows with SMB and inseminated either by estrus or by time. Calves were separated from their mothers only in the group inseminated by time. Results showed that cows receiving the SMB treatment and time

inseminated had significantly higher pregnancy rates than cows receiving SMB and inseminated by estrus or nonsynchronized cows.

Spitzer et al. (1981) conducted trials with beef heifers to evaluate the effects of various breeding management methods on pregnancy rate at synchronized estrus. Their findings showed that first service pregnancy rate among SMB treated heifers bred 12 h after estrus was first detected did not significantly differ from heifers inseminated once 45 to 55 h after implant removal, regardless of occurrence of estrus. Thus, it was concluded that satisfactory pregnancy rates can be obtained in beef heifers treated with SMB and inseminated once between 45 and 55 h after implant removal without detection of estrus.

Estrus synchronization with prostaglandin- $F_{2\alpha}$.

Prostaglandin- $F_{2\alpha}$ is another product that has been used in the estrus synchronization of cattle. To evaluate $PGF_{2\alpha}$ in estrous synchronization of beef females, Burfening et al. (1978), conducted three trials. In trial 1, cycling, yearling Hereford heifers were injected twice 11 d apart with 25 mg $PGF_{2\alpha}$ intramuscularly and inseminated at either 72 and 96 h after the second injection or 80 h after the second injection. Within each treatment, 50% of the heifers received 100 μ g GnRH intramuscularly 60 h after the second $PGF_{2\alpha}$ injection. Seventy-one percent of the heifers were observed in estrus after the second injection. First service conception rate was significantly lower for those heifers bred at 80 h than for those bred at 72 and 96 h after $PGF_{2\alpha}$. There was no significant difference in

conception rate between groups receiving and not receiving GnRH. In trial 2, lactating Hereford cows were intramuscularly injected with 25 mg $\text{PGF}_{2\alpha}$. Those cows showing estrus 48 to 96 h postinjection were inseminated 12 h after observed in estrus. Cows not exhibiting estrus 48 to 96 h postinjection were injected again 11 d later, and 50% of these cows received 100 μg GnRH intramuscularly 72 h after $\text{PGF}_{2\alpha}$. All cows receiving a second $\text{PGF}_{2\alpha}$ injection were inseminated 84 h after the second injection. After the first $\text{PGF}_{2\alpha}$ injection, 49% of the cows exhibited estrus during the 48 to 96 h postinjection period. Sixty-one percent of the remaining cows exhibited estrus after the second $\text{PGF}_{2\alpha}$ injection. There was no significant difference in conception rate between cows receiving one $\text{PGF}_{2\alpha}$ injection and two $\text{PGF}_{2\alpha}$ injections. For cows receiving two $\text{PGF}_{2\alpha}$ injections, conception rate with GnRH was 54% compared to 64% for those not receiving GnRH. In trial 3, Hereford cows and heifers were assigned to the same treatments as in trial 2 except that no GnRH was given, and heifers were bred 60 h after $\text{PGF}_{2\alpha}$. During the 48 to 96 h first postinjection period, 46% of the females showed estrus; however, it was noted that the interval from injection to estrus was significantly less in heifers than in cows. Conception rates did not differ between synchronized females bred by estrus compared to untreated controls; however, conception rate in those females bred by appointment was significantly lower than either the controls or the group inseminated by estrus.

Tanabe and Hann (1984) injected $\text{PGF}_{2\alpha}$ intramuscularly at d 7, 11 or 15 of the estrous cycle in Holstein heifers. Estrus was

synchronized within an 8 h period in a progressively, but nonsignificantly, higher percentage of heifers with each advancing stage of the estrous cycle at which $\text{PGF}_2\alpha$ had been administered. Stage of cycle at which $\text{PGF}_2\alpha$ was injected also significantly influenced the time of estrus onsets, as evidenced by a wide variation in heifers exhibiting estrus within the 24 h period from 32 to 56 h postinjection. Pregnancy rate, however, was similar for all treatment groups.

King et al. (1982) gave cycling beef females two injections of 25 mg $\text{PGF}_2\alpha$ 11 d apart. Results showed that females injected on d 5 to 9 of the estrous cycle had a significantly shorter interval to estrus than did those injected on d 10 to 15 of the estrous cycle. Conception rate when inseminated 80 h after the last $\text{PGF}_2\alpha$ injection was significantly lower for heifers injected early in the cycle than for heifers injected late in the cycle. Additionally, there was a trend toward lower conception in all cows injected early in the estrous cycle compared with that of cows injected later. It was concluded that $\text{PGF}_2\alpha$ treatment was not as effective in regressing the CL in early cycle as it was in late cycle females.

Factors influencing conception rates in beef cattle. Many factors, including nutritional level, stress and season of the year, can directly or indirectly affect conception rates in beef cattle. To investigate the effects of short term undernutrition on ovarian function, fertilization rate and embryonic survival, Hill et al. (1970) bred Angus and Hereford heifers with previous normal estrous cycles.

Approximately 17 days prior to breeding, control heifers were started on a ration to achieve average daily gains of .57 kg/hd. The undernourished group were fed a reduced amount of the control diet (about 85% of the estimated daily maintenance requirements for both energy and protein) and had an average daily loss in body weight of .23 kg/hd. Heifers were then slaughtered 3, 8, 13 or 18 d after mating, and reproductive tracts were recovered and examined. Undernourished heifers had significantly lower plasma progesterone values on d 10 and 15 of the estrous cycle before mating. Additionally, the CL from undernourished heifers were significantly lighter in weight than those from controls at 8 and 13 d after mating. When results from slaughter groups were combined, control heifers had a significantly higher pregnancy rate than the undernourished heifers.

Bond et al. (1958) severely restricted the protein and energy intake of heifers of previous normal estrous activity. Estrous cyclicity and ovarian activity in these heifers was shown to cease following the restricted dietary regimen.

Fleck et al. (1980) examined the effect of growth rate from birth through 30 mo of age on the reproductive performance of Polled Hereford heifers bred to calve at 2 yr of age. After weaning, the heifers were fed high roughage diets to produce average daily gains of .09 to .9 kg/hd/d. All heifers were bred artificially at first service. Results showed that low gains during the first winter as weanlings resulted in significantly lower first service conception rate

as yearlings when compared to those heifers which achieved high gains during the same time period.

Suboptimal energy diets (85% NRC requirement) were fed to beef females by Hixon et al. (1981). All females were estrus synchronized with SMB and inseminated 48 h following implant removal. Blood plasma was monitored for concentrations of progesterone and LH. Cyclicity prior to SMB treatment was determined by plasma progesterone levels 10 d and immediately prior to implantation. If progesterone concentrations were greater than 1 ng/ml at one or both blood sampling times, the females were assumed to be cycling. Heifers not cycling prior to implantation had a significantly lower first service conception rate in comparison to cycling females. First service conception rate was reduced if the preovulatory LH peak occurred other than 33 to 36 h following removal of the implant. The apparent stress of collecting blood samples around the time of the LH surge reduced fertility; however, there was no apparent effect on estrus behavior. It was suggested that stress be avoided when synchronizing animals. It was further suggested that one possible method to improve first service conception rate would be the administration of GnRH 32 to 34 h following implant removal in order to induce the LH peak at 33 to 36 h.

Hardin and Randel (1983) utilized prepuberal Simmental X Brahman-Hereford heifers to determine the effects of epinephrine (E), norepinephrine (NE), GnRH or combinations of GnRH + E and GnRH + NE on serum LH concentrations. The following five treatments were

administered intramuscularly: 1) 100 µg GnRH at 0 min, 2) 50 mg NE at -15 and 0 min, 3) 50 mg E at -15 and 0 min, 4) 100 µg GnRH at 0 min and 50 mg NE at -15 and 0 min or 5) 100 µg GnRH at 0 min plus 50 mg E at -15 and 0 min. Blood samples were collected and analyzed for LH. Results showed that treatment with NE or E alone had no significant effect on serum LH concentration. Treatment with GnRH resulted in a significant increase in serum LH by 15 min postinjection; however, concomitant treatment with NE or E significantly reduced the magnitude of the serum LH response to GnRH. Thus, it was concluded that the adrenal catecholamines E and NE had a detrimental effect on in vivo bovine LH release.

Martin et al. (1981) examined the effects of the stress of repeated laparoscopy on the preovulatory surge of LH and ovulation in seasonally anovular ewes, using the introduction of rams as a stimulus for ovulation. Plasma cortisol levels were used as an indicator of stress. There was a transient rise in plasma cortisol following a single laparoscopy, and repeated laparoscopy induced and maintained elevated plasma cortisol levels. The number of ewes which experienced LH surges and ovulation was significantly reduced by repeated laparoscopy. These researchers suggested that stress may have been acting at either the ovarian level, where it prevented the secretion of estradiol in response to the ram induced pulses of LH, or at the hypothalamic level, where it may have prevented the positive and negative feedback of estradiol.

Mares et al. (1961) studied first service conception rate in beef cows and heifers. Conception rate in heifers was found to be

significantly affected by season of birth. Results showed a significantly higher conception rate in fall born heifers than in spring or summer born heifers. These researchers hypothesized that this significant effect of season of birth on first service conception in heifers may be due to the seasonal influence at a critical growth stage, season at the time of insemination, or any other confounded factor, since the heifers were bred at a constant age which could induce seasonal variations in all aspects of development from birth to conception. Additionally, in cows, conception rate was significantly affected by sire line.

Factors affecting the onset of puberty in heifers. Such variables as season of birth, photoperiod, nutritional level, age, weight, growth rate and breed or heterosis can influence the onset of puberty in heifers. Grass et al. (1982) studied factors influencing age of puberty in heifers. Results showed that heifers fed a high level of nutrition reached puberty before heifers fed low level diets. Additionally, winter born heifers were significantly older at puberty than spring born heifers. It was suggested that the relationship between birth date and age at puberty was influenced by season at the time of puberty attainment.

Schillo et al. (1983) conducted an experiment to test the hypothesis that seasonal changes in the environment during the first and second 6 mo of life influence age at puberty in heifers. Angus X Holstein heifers born in either March or September were reared under natural conditions until 6 mo of age. These heifers were placed in

environmental chambers which were programmed to simulate seasonal changes in temperature and photoperiod in the sequence of either spring, summer and autumn or autumn, winter and spring. Heifers born in September reached puberty at significantly younger ages than those born in March, and exposure to the spring, summer and autumn sequence of environmental conditions significantly hastened the onset of puberty regardless of birth date. Mean concentrations of serum LH between 6 and 7 mo of age were significantly greater for heifers born in September than those born in March. Average daily gain from 6 to 9 mo of age was significantly greater for heifers exposed to the autumn, winter and spring sequence of environmental conditions than for the spring, summer and autumn group. Prolactin concentrations paralleled patterns of temperature and day length, being high during long photoperiods and warm temperatures. These authors suggested that environmental chamber conditions may have influenced age at puberty by affecting the maturation of the positive and negative feedback systems of estradiol. It was suggested that season may have influenced age at puberty through affecting serum concentrations of LH or prolactin or growth rate. These investigators concluded that although cattle are not seasonal breeders, the results of this study demonstrated that season of birth and season of attainment of puberty influence age at puberty in heifers.

Hansen et al. (1983) conducted two experiments to determine if exposure of prepuberal heifers to supplemental lighting hastens the onset of puberty. In experiment 1, heifers were exposed to either 18 h light/d or natural photoperiods from 22 wk of age until puberty. In

experiment 2, heifers were exposed to the same treatment as in experiment 1 from 24 wk of age and bred at all estrous periods until conception. Results from both experiments showed that age at first ovulation and first estrus were significantly less for heifers exposed to supplemental lighting than those exposed to natural photoperiods. However, though not significant, services per conception tended to be greater, and percentage conception at first service lower, for heifers exposed to supplemental lighting than those maintained under natural conditions in experiment 2. It was, therefore, concluded that age at puberty in the bovine female can be altered by photoperiod, but that conception rate might be reduced in heifers exposed to supplemental lighting.

Petitclerc et al. (1983), to examine the effects of photoperiod and plane of nutrition on growth and puberty, subjected prepuberal Holstein heifers to photoperiods of 8 h light:16 h dark or 16 h light:8 h dark and either a high or low plane of nutrition. The heifers on the low plane of nutrition were fed to achieve a body growth rate of approximately .7 kg/d, and those on the high plane of nutrition were fed to achieve a growth rate in excess of 1 kg/d. Average daily gains of heifers subjected to 16 h light:8 h dark were significantly greater than those of heifers exposed to 8 h light:16 h dark. There was no photoperiod by plane of nutrition interaction. Prolactin in serum was significantly greater when exposed to longer periods of light and for heifers on the high plane of nutrition. These researchers suggested that prolactin changes might be involved in hastening onset of puberty in cattle. However, the interval from the start of the

experiment to puberty was significantly shortened for heifers on high nutrition or when exposed to longer periods of light. It was postulated that longer exposure to light may stimulate growth rate by increasing feed intake and efficiency. Therefore, it was concluded that stimulation of body growth by manipulating photoperiod could prove to be a useful management tool in cattle production.

In a study conducted by Crichton et al. (1959), dairy heifers were fed at one of four nutritional levels: 1) a continuous high plane of nutrition from birth to first calving, 2) a high plane for the first 44 wk followed by a low plane until 2 mo before calving, 3) a continuous low plane from birth until 2 mo before calving or 4) a low plane for the first 44 wk followed by a high plane until first calving. Findings showed that all groups reached sexual maturity at approximately the same weight but at different ages. The order in which the groups reached sexual maturity was 1, 4, 3, 2.

Short and Bellows (1971) conducted an experiment with beef heifers to determine the effect of feeding for high, medium or low average daily gains from 7 to 12 mo of age on subsequent reproductive performance. Feed level had a marked influence on age at puberty; as feed level increased, age at puberty decreased. Age at puberty was highly correlated with body weight. Significantly fewer heifers on the low level of feed exhibited estrus before the end of the breeding season compared to both medium and high feed level groups. Likewise, pregnancy rates for heifers in the low feed level group were significantly lower.

Arije and Wiltbank (1971) studied the effects of sire, growth rate, weaning weight and birth date on age and weight at puberty in Hereford heifers. Findings showed that sires significantly influenced age and weight at puberty. Heifers born late in the calving season were significantly younger and significantly lighter at puberty, while high preweaning growth rate and heavy weaning weights were associated with earlier puberty and significantly heavier weight at puberty. Faster growing heifers from weaning to puberty were significantly heavier and older at puberty.

Laster et al. (1972) examined weight and age at puberty in beef heifers. Findings showed a correlation between age and weight at puberty of .23. Heifers reaching puberty by 15 mo of age were significantly heavier at the beginning of the breeding season than those that did not reach puberty by 15 mo of age.

A study was conducted by Wiltbank et al. (1969) to determine if level of nutrition had a differential effect on age and weight at puberty in straightbred and crossbred heifers. Heifers were assigned to either a high level or low level of nutrition. The average daily gain from 6 to 12 mo of age was significantly higher for heifers on the high level of nutrition as compared to those on the low level of nutrition. There was a significant difference between breed groups in rate of gain. Heifers on the high level of feed were significantly heavier at puberty than heifers on the low level of feed. Crossbred heifers on the high level of feed were heavier at puberty than the straightbred heifers, yet age at puberty was the same. Thus, it was

concluded that an interaction between level of nutrition and breed of heifer existed for age and weight at puberty.

Wiltbank et al. (1966) studied the effects of heterosis on age and weight at puberty in beef heifers. Findings showed that heterosis had a significant effect on age at puberty. Furthermore, analysis showed that age at puberty decreased 18.7 d/.1 kg increase in average daily gain from birth to weaning, and age at puberty decreased 41.2 d/.1 kg average daily gain from weaning to 396 d of age at a low level of nutrition. There was, however, no effect of postweaning average daily gain on age at puberty among heifers on a high level of nutrition. These researchers speculated that after a certain critical weight is reached, postweaning average daily gain has little or no effect on age at puberty.

Ferrell (1982), to evaluate the effects of breed and postweaning nutritional level, characterized by postweaning rate of gain, on the onset of puberty and reproductive performance, fed Angus, Hereford, Red Poll, Brown Swiss, Charolais and Simmental heifers to achieve low gains (.4 kg/d), medium gains (.6 kg/d) or high gains (.8 kg/d) postweaning. The rate at which heifers reached puberty significantly differed due to breed and postweaning gain. Both heifer breed and postweaning nutritional level were highly significant sources of variation in mean age and weight at puberty. These results provide further evidence that breeds differ in the age and weight at which they attain puberty. They suggested that breeds that have been selected for high levels of milk production reach puberty at a younger age and lighter weight than breeds that have

been selected solely for beef production. Heifers fed to gain at the low rate were significantly older and weighed significantly less at puberty than those fed to gain at the high rate. Within each heifer type, breeds of heifers that reached puberty at a younger age tended to have a higher pregnancy rate than those that reached puberty later. Maximum pregnancy rate occurred at a condition score of 6.7 (on a scale of 1 = extremely thin, 9 = extremely fat), suggesting that pregnancy rates of extremely thin or fat heifers were not as great as those of heifers having a moderate amount of condition at breeding. Moreover, it was suggested that moderate underfeeding or overfeeding during the postweaning period may have a prolonged influence on the productive performance of heifers.

Nelsen et al. (1982) collected weights and hip heights quarterly from 9 through 66 mo of age on cows of Angus, Brahman, Hereford, Holstein and Jersey breeds and all possible two breed crosses therein. The objective of this study was to determine the effects of heterosis on growth and maturation patterns of cattle. Overall results showed that heterosis was negative for age at puberty and positive for weight and height at puberty. Breed type, nutritional level and month of birth were also significant sources of variation for age at puberty in this study.

With Angus, Brahman, Hereford, Holstein and Jersey and all possible two breed crosses therein, Stewart et al. (1980) studied puberal characteristics of heifers. Results showed that breed effects were a significant source of variation for all characters studied. Heterosis was not significant for puberal age when heifers received

complete diets; however, pastured crossbred heifers were significantly younger at puberty than straightbred heifers. The average heterotic effect was positive in all instances. It was concluded that there was significant heterosis effect on puberal weight and height.

Dow et al. (1982) studied puberty traits in straightbred and crossbred beef heifers to determine age of puberty in heifers of divergent breed types, including *Bos taurus* and *Bos taurus* X *Bos indicus* crosses. Results indicated that breed group was a significant source of variation in heifer weight and age at puberty, and heterosis was significant for both of these traits.

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EFFECT OF GnRH, BREEDING WEIGHT,
FRAME, CONDITION AND AGE ON PREGNANCY RATES
IN ESTRUS SYNCHRONIZED BEEF HEIFERS

Introduction

Conflicting reports concerning the effects of gonadotropin releasing hormone (GnRH) on conception rate exist in the literature. Some studies have shown significant improvement in conception rate with the use of GnRH in postpartum dairy cows (Schels and Mostafawi, 1978; Nakao et al., 1983; Nash et al., 1980; Lee et al., 1983). Similar increases in conception rates have been shown in work with repeat breeder dairy cows following GnRH administration (Maurice et al., 1982; Lee et al., 1983; Stevenson et al., 1984). In contrast, however, studies showing little or no effect of GnRH on conception rate have been conducted with dairy heifers (Anderson et al., 1982; Lee et al., 1983) and beef cows (Zaied et al., 1976). An actual decrease in conception rate was observed after GnRH administration in prepuberal beef heifers estrus synchronized with Synchronate-B® (SMB) by Spitzer (1982).

The exact mechanism by which GnRH might affect conception rate is as yet not fully understood. Gonadotropin releasing hormone might act through its effects on endogenous lueinizing hormone and(or) follicle stimulating hormone release from the anterior pituitary, affecting time of ovulation, fertilization rate,

corpus luteum development or progesterone secretion, or GnRH could be acting through a direct effect on the female reproductive tract. The actual mode of GnRH action needs further study.

Other major factors shown in previous work to affect conception rate and(or) the onset of puberty include prebreeding weight gains (Hill et al., 1970; Short and Bellows, 1971; Fleck et al., 1980), breeding weight (Arije and Wiltbank, 1971; Short and Bellows, 1971; Laster et al., 1972), and condition at breeding (Ferrell, 1982).

Several reports have shown that for maximum efficiency, heifers should calve at 2 yr of age, and, to do so, must be cycling and conceive early in their first breeding season as yearlings (Lesmeister et al., 1973; Smith et al., 1979; Grass et al., 1982). GnRH might be a useful management tool to increase early conception in some yearling beef heifers under an estrus synchronization program.

The primary objective of this study was to determine the effect of GnRH on conception rates in yearling beef heifers estrus synchronized with SMB or prostaglandin- $F_{2\alpha}$. An additional objective of this study was to evaluate the influence of weight, frame, condition and age at breeding on subsequent pregnancy rates to AI.

Materials and Methods

Spring trial with SMB. Three field trials were conducted in 1984 utilizing 169 spring born, yearling beef heifers. All heifers received SMB treatment, which consisted of 6 mg norgestomet implanted subcutaneously in the convex surface of the ear for 9 d and an intramuscular injection of 5 mg estradiol valerate and 3 mg norgestomet on the day of implant insertion. Beginning approximately 24 h following norgestomet implant removal, heifers were observed for estrus. Those showing heat 24 to 36 h after implant removal were artificially inseminated 12 h after estrus was first detected. Those heifers which did not show heat by 36 h were time inseminated at approximately 48 h following implant removal, regardless of occurrence of estrus. Records were kept on all heifers exhibiting estrus by 48 h. All heifers were allotted at breeding to either an untreated control group or a treated group which received 100 µg GnRH (2 ml Cystorelin®²) subcutaneously at the time of artificial insemination (AI). Hip height measurements were recorded on all heifers at breeding. The same Angus sires were used at the three locations. Subsequent calving data were collected

² CEVA Laboratories, Inc., Overland Park, Kansas.

to determine conception rates.

At one of the three field trials, thirteen Hereford and 45 crossbred heifers located on a commercial ranch in central Kansas were utilized. Following the initial insemination, all heifers returning to estrus 19 to 22 d later were rebred 12 h after heat was detected. Heifers were treated identically at first and second service. Eight AI service sires were used. Two technicians performed first service inseminations, and an additional technician performed all second service inseminations. Approximately 1 wk following second service, Angus bulls were turned in with the heifers until the end of the breeding season. Birth date information was recorded, and the heifers were weighed on the day of first breeding.

At a second commercial ranch, in northeast Kansas, forty-seven Hereford and 22 Red Angus X Hereford heifers were utilized. On the day of breeding, heifers were weighed. Seven AI service sires were used, with three technicians performing inseminations. Approximately 1 wk following artificial insemination, heifers were exposed to Longhorn bulls until the end of the breeding season.

At the third location, thirty-nine Beefmaster cross and 4 Longhorn cross heifers were utilized on a commercial ranch in southern Kansas. Seven AI service sires were used, with three technicians performing inseminations. Beefmaster X Longhorn bulls were turned in with the heifers approximately 1 wk following artificial insemination.

Fall trial with SMB. Two additional field trials utilizing SMB and GnRH, administered in the same manner as previously described for spring trials, were conducted utilizing 268 fall born, yearling beef heifers. Heifers were observed for estrus 24 to 48 h following implant removal, and occurrence of estrus was noted. At first service, all heifers were time inseminated to the same AI sire 48 h after implant removal. Heifers were not exposed to bulls following artificial insemination. At breeding, hip height measurements were recorded on all heifers. Pregnancy examinations, via rectal palpation, were performed to determine conception rate 70 to 112 d postinsemination.

One of the locations was a commercial ranch in southern Kansas, where twenty-seven Hereford and 15 Hereford X Angus heifers were utilized. First service inseminations were performed by three technicians. Any heifers returning to estrus 21 to 23 d following first breeding were rebred 12 h after heat was detected. An additional technician performed all second service inseminations. Weights were recorded on all heifers 41 d prior to first breeding. Birth date and birth weight information was collected on heifers, and adjusted breeding weights were calculated for use in analysis.

At a second commercial ranch, in southeast Kansas, 226 crossbred heifers were utilized. To determine if the heifers were cycling, 4 to 5 d prior to SMB implantation, jugular blood samples were collected from 176 heifers, and heat detection aids³ were put

on all the heifers. Immediately prior to implantation, a second jugular blood sample was collected from these same 176 plus 50 additional heifers. All blood samples were subsequently assayed and quantified for serum progesterone by radioimmunoassay procedures described by Stevenson et al. (1981). If serum progesterone concentrations were greater than 1 ng/ml at one or both of the sampling times, or if heifers had activated heat detection aids, those heifers were assumed to be exhibiting ovarian cycles. Any heifer with less than 1 ng/ml serum progesterone at both sampling times and a nonactivated heat detector was considered prepuberal or noncyclic. Of those heifers from which blood was sampled only once, only heifers with an elevated serum progesterone level were included in the results of this study. Six technicians performed first service inseminations. Weight at first breeding was recorded for all heifers. Heifers returning to estrus 17 to 20 d after first service were rebred, 12 h after observed estrus, receiving the same GnRH treatment at second service as at first service. One previously employed technician performed 60% of the second service inseminations, and an additional technician performed the remaining second service inseminations.

³ KAMAR Heatmount Detectors®, KAMAR, Inc., Steamboat Springs, Colorado.

Trial with PGF₂ α . At another commercial ranch, in southwest Kansas, estrus was detected on 184 fall born, yearling Angus heifers for 5 d. Heifers showing estrus during this time were artificially inseminated 12 h after the onset of estrus. On d 6, 25 mg PGF₂ α (5 ml Lutalyse^{®4}) was administered intramuscularly to heifers which did not exhibit estrus during the initial 5 d period. Heifers which exhibited estrus by 12 d after PGF₂ α injection were artificially inseminated 12 h after the onset of estrus. Those heifers which did not exhibit estrus after PGF₂ α were given a second injection 12 d after the first injection and were then inseminated by estrus. All heifers, as in the previously described trials, were allotted to either an untreated control group or a GnRH treated group at the time of insemination. Over a 65 d breeding season, heifers which returned to estrus were rebred, and approximately 70 % of the heifers which received GnRH at first service were treated identically at second service. The remaining heifers which had received GnRH at first service received no GnRH at second service. Additionally, no heifers received GnRH at third service. All control heifers were treated similarly at all services. Five Angus AI service sires were used, and five technicians performed inseminations. Heifers were not exposed to bulls during the breeding season. All heifers were pregnancy examined via rectal palpation 40 d following the last insemination. Sixty-three percent of the heifers

⁴ Upjohn, Kalamazoo, Michigan.

were weighed 45 d prior to the beginning of the breeding season. Birth date and birth weight information was collected on these heifers, and adjusted breeding weights were calculated for use in analysis. Hip height measurements, taken at breeding, were recorded for 75 PGF₂ α synchronized heifers.

Statistical analysis. Treatment responses involving categorical explanatory variables were analyzed using the Statistical Analysis System (SAS) (Barr and Goodnight, 1976) Chi-square procedure. Continuous explanatory variable effects were analyzed using the Logist procedure⁵. Additionally, correlation coefficients between continuous variables were determined by the correlation procedure of the SAS. Means were separated by the predicted difference option of the SAS General Linear Model procedure.

⁵ Harrell, F. E. Clinical Biostatistics. Duke University Medical Center, Durham, North Carolina.

Results and Discussion

Effect of GnRH - trial with SMB. The administration of GnRH at breeding did not significantly affect first or second service conception rates, all data combined (table 1). These results are in agreement with other studies (Chipepa et al., 1977; Roche, 1977; Anderson et al., 1982; Lee et al., 1983) in which no significant effect of GnRH administration on conception rates at first breeding of heifers was observed. However, in this trial, those heifers not observed in estrus prior to timed insemination, had higher conception. ($P < .05$) if injected with GnRH at first service than comparable control heifers (table 2). This increased conception rate could be due to the inducing effect of GnRH on follicle rupture, which brings time of insemination and ovulation into a favorable correlation, as suggested by Schels and Mostafawi (1978). Another possible explanation for increased conception following GnRH treatment might be that GnRH caused a secondary endogenous surge of LH, which enhanced luteinization of granulosa cells to ensure adequate progesterone production to maintain early pregnancies, as hypothesized by Lee et al. (1983). The increased conception in this trial in the heifers bred by appointment with no observed estrus may relate to the GnRH induced LH release, as shown by others (Kittok et al., 1972; Britt et al., 1974; Kinder et al., 1975;

TABLE 1. EFFECT OF GnRH ON FIRST AND SECOND SERVICE CONCEPTION RATES (%) OF SMB SYNCHRONIZED HEIFERS.

	GnRH	Control
First service conception rate	20.71	17.79
No. heifers	41/198	37/208
Second service conception rate	28.57	33.33
No. heifers	4/14	7/21

TABLE 2. EFFECT OF GnRH ON FIRST SERVICE CONCEPTION RATE (%) IN SMB SYNCHRONIZED HEIFERS BRED BY APPOINTMENT OR BY ESTRUS.

	GnRH			Control		
	Bred by estrus	Bred by appointment	Total	Bred by estrus	Bred by appointment	Total
<u>Estrus observed</u>						
First service conception rate	22/35	25/93	23/21	21/65	28/21	23/53
No. heifers	19/85	7/27	26/112	21/97	11/39	32/136
<u>No estrus observed</u>						
First service conception rate		17.44 ^a	17.44 ^a		6.94 ^b	6.94 ^b
No. heifers		15/86	15/86		5/72	5/72
Total		19.47			14.41	

a,b Values on the same line with different superscripts differ ($P < .05$).

Chipepa et al., 1977; Fernandez-Limia et al., 1977), which has led to the subsequent rupture of follicles, as previously shown in trials with cattle (Kaltenbach et al., 1974; Roche, 1975; Cumming et al., 1977; Roche, 1977), with proestrus gilts (Baker et al., 1973) and with hens (Reeves et al., 1973), thus bringing ovulation and insemination into a proper time perspective. Additionally, embryonic mortality has been shown to be a major factor in reduced pregnancy rates in cattle (Tanabe and Casida, 1949; Tanabe and Almquist, 1953; Wiltbank et al., 1961). Increased plasma progesterone following GnRH administration, as shown by Carlson et al. (1971), may have led to reduced embryonic mortality in these heifers, as shown in previous work (Wiltbank et al., 1956; Johnson et al., 1958; Henricks et al., 1970; Henricks et al., 1971; Maurer and Echternkamp, 1982).

Stevenson et al. (1984) suggested that repeated GnRH treatment at consecutive services might affect conception rate; however, no significant differences between groups receiving GnRH at first service only, both first and second service and the control group were observed in this trial (table 3).

Allotment of noncycling heifers did not significantly differ between treatment groups (table 4). GnRH treatment had no significant effect on first service conception rate in the noncycling heifers (table 5).

TABLE 3. EFFECT OF GnRH TREATMENT AT CONSECUTIVE SERVICES ON SECOND SERVICE CONCEPTION RATE (%) OF SMB SYNCHRONIZED HEIFERS.

	GnRH at first service only	GnRH at first and second service	Control
No. heifers	0/3	4/14	7/18
First service conception rate	0.00	28.57	38.89

TABLE 4. ALLOTMENT OF NONCYCLING^a, SMB SYNCHRONIZED HEIFERS.

	GnRH	Control
No. Heifers	56/198	57/208
% Noncycling	28.28	27.40

^a Cycling = having greater than 1 ng/ml serum progesterone and(or) an activated heat detector prior to SMB treatment.

TABLE 5. EFFECT OF GnRH AND THE OCCURRENCE OF ESTRUS ON THE PREGNANCY RATE (%) OF NONCYCLING^a, SMB SYNCHRONIZED HEIFERS.

	Treatment group		Observed estrus	
	GnRH	Control	Yes	No
No. heifers	2/56	2/57	1/54	3/59
First service conception rate	3.57	3.51	1.85	5.08

^a Cycling = having greater than 1 ng/ml serum progesterone and(or) an activated heat detector prior to SMB treatment.

A higher percentage of heifers showing heat ($P < .10$) were randomly allotted to the control group (table 6). First service pregnancy rate was affected by the occurrence of heat, with heifers that showed estrus having higher conception ($P < .01$) than those that did not show estrus (table 7). First service conception rate did not significantly differ, however, between heifers inseminated by appointment and those inseminated by estrus (table 8), in agreement with results reported by Spitzer et al. (1981) in work with beef heifers. Results reported by Mares et al. (1977), with cows, showed a higher pregnancy rate in those inseminated by time.

A factor affecting conception rates in this trial may have been the poor response to the SMB synchronization treatment. In this trial, 61.08% of the SMB treated heifers showed estrus. This is somewhat lower than the response reported after synchronization with a progestin by Spitzer et al. (1978), where estrus detection occurred for 120 h after norgestomet implant removal, and Miksch et al. (1978), when estrus detection occurred for 5 d post implant removal. One possible explanation for poor synchronization response may have related to some of the heifers being noncyclic.

Effect of breeding weight, frame, condition and age - trial with SMB The means and ranges for measurements taken at breeding in this trial are summarized in table 9. Breeding weight

TABLE 6. ALLOTMENT OF HEIFERS SHOWING ESTRUS.

	GnRH	Control
No. heifers	112/198	136/208
% Showing estrus	56.57 ^a	65.38 ^b

a,b Values with different superscripts differ ($P < .10$).

TABLE 7. FIRST SERVICE CONCEPTION RATE (%) OF SMB SYNCHRONIZED HEIFERS AS AFFECTED BY THE OCCURRENCE OF ESTRUS.

	Estrus observed	No estrus observed
No. heifers	58/248	20/158
First service conception rate	23.39 ^a	12.66 ^b

a,b. Values with different superscripts differ ($P < .05$).

TABLE 8. FIRST SERVICE CONCEPTION RATE (%) IN SMB SYNCHRONIZED HEIFERS BRED BY APPOINTMENT OR BY ESTRUS.

	Bred by estrus	Bred by appointment
No. heifers	40/182	38/224
First service conception rate	21.98	16.96

TABLE 9. WEIGHT, HIP HEIGHT, WEIGHT:HEIGHT RATIO AND AGE AT BREEDING.

	n	Mean	SE	Range
Weight, kg	346	277	2.1	198 - 389
Hip height, cm	406	115	.20	105 - 132
Weight:height ratio, kg:cm	346	2.4	.01	1.8 - 3.5
Age, d	79	431	2.2	372 - 464

influenced first service conception rate, as did condition at breeding, computed as a weight:hip height ratio as described by Dunn et al. (1983). Several researchers (Hill et al., 1970; Short and Bellows, 1971; Fleck et al., 1980) have shown that low prebreeding gains can significantly influence yearling pregnancy rates. In this trial, heifers heavier than the mean weight at breeding had a higher first service conception rate ($P<.05$) than lighter weight heifers (table 10). Heifers shorter than the mean hip height tended ($P<.10$) to have a higher first service conception than taller heifers (table 10). Ferrell (1982) reported that heifers of moderate condition at breeding had higher conception rates than thin heifers. Similarly, in this trial, heifers with a higher weight:height ratio had a higher first service conception rate ($P<.05$) than did heifers with lower ratios (table 10).

The percentage of heifers showing heat was also significantly affected by weight, condition and age at breeding. A higher percentage of heifers heavier than the mean weight showed estrus ($P<.01$) compared to the lighter weight group (table 10). Likewise, more heifers in the high weight:height ratio group exhibited estrus ($P<.01$) than in the low weight:height ratio group (table 10). A higher percentage of the older group of heifers showed heat ($P<.01$) when compared to the younger heifers (table 10).

TABLE 10. EFFECT OF BREEDING WEIGHT, HIP HEIGHT, WEIGHT:HEIGHT RATIO AND AGE ON PREGNANCY RATES (%) AND OCCURRENCE OF ESTRUS (%).

	Weight, kg		Height, cm		Ratio, kg:cm		Age, d	
	>Mean	<Mean	>Mean	<Mean	>Mean	<Mean	>Mean	<Mean
Group average	311	247	119.2	111.9	2.7	2.1	442	409
First service conception rate	24.84 ^a	11.92 ^b	20.27	17.93	23.72 ^a	12.63 ^b	28.30	23.08
No. heifers	38/153	23/193	45/222	33/184	37/156	24/190	15/53	6/26
Second service conception rate	34.62	12.50	19.05 ^c	50.00 ^d	37.50	10.00	55.56	40.00
No. heifers	9/26	1/8	4/21	7/14	9/24	1/10	5/9	2/5
Overall pregnancy rate to AI	30.72	12.44	22.07	21.74	29.49	13.16	37.74	30.77
% Showing estrus	69.28 ^e	56.13 ^f	58.11	64.67	70.51 ^e	55.20 ^f	84.91 ^e	57.51 ^f

a,b Values on the same line and within a measurement with different superscripts differ ($P<.05$).

c,d Values on the same line and within a measurement with different superscripts differ ($P<.10$).

e,f Values on the same line and within a measurement with different superscripts differ ($P<.01$).

Correlation coefficients between the various measurements taken at breeding are listed in table 11. Weight and hip height at breeding had a correlation of .25 ($P < .01$). Weight and condition at breeding were found to have a correlation of .96 ($P < .01$). Age and hip height were found to have a correlation of .36 ($P < .01$). Additionally, a significant correlation of -.30 was found for age and condition in this trial.

The AI service sires used in this trial influenced first service conception ($P < .01$) (figure 1); however, this may have been due to the fact that 2 of 10 sires were bred to extremely low numbers of heifers, and 1 sire was used exclusively at two ranches where conception rates were lowest.

There were no significant differences in first service conception rate due to AI technician or to breed of heifer.

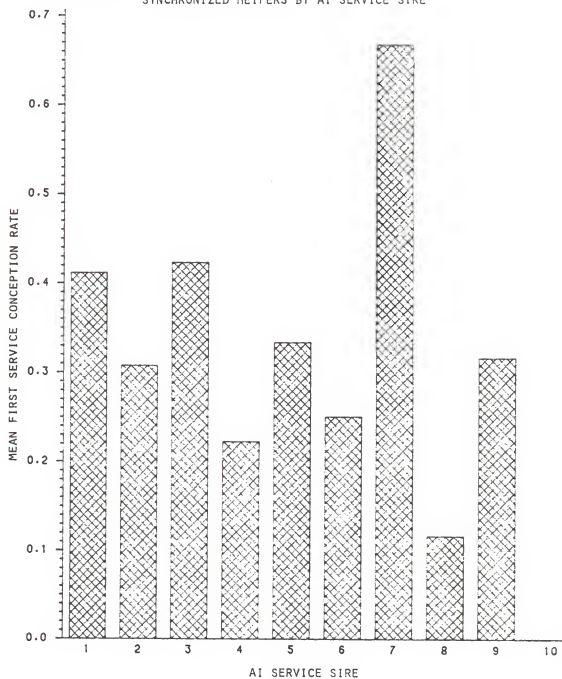
Several researchers (Grass et al., 1982; Hansen et al., 1983; Petitclerc et al., 1983; Schillo et al., 1983) have shown that season of birth and(or) photoperiod can significantly affect the onset of puberty. In this trial, season of birth significantly affected first service and overall pregnancy rate to AI. Spring born heifers had higher pregnancy rates to AI ($P < .01$) than fall born heifers. This effect might be due, however, to the fact that a large proportion of the fall born heifers were not cycling prior to treatment.

TABLE 11. CORRELATION COEFFICIENTS OF VARIOUS MEASUREMENTS OBTAINED AT BREEDING.

	Weight	Hip height	Ratio
Hip height	.256*		
Weight:height ratio	.967*	.006	
Age	-.182	.362*	-.304*

* Values different than zero ($P < .01$).

FIGURE 1. FIRST SERVICE CONCEPTION RATE OF SMB
SYNCHRONIZED HEIFERS BY AI SERVICE SIRE



Another factor which may have influenced pregnancy rates in this trial was stress. Previous studies, as reported by Hardin and Randel (1983), for beef heifers, and Martin et al. (1981), for ewes, have shown that stress reduces pregnancy rates.

Conception rates in this trial were lower than normally expected. The incidence of heifers which did not conceive to AI service and remained open after exposure to bulls through the end of the breeding season was 10.43% and 28.57% for first and second service, respectively. There may have been some unknown physiologic reason why these heifers did not conceive.

A location effect on first service conception rate and overall pregnancy rate to AI was observed ($P < .01$), possibly due to the low conception rate at one ranch where the level of cyclicity before treatment was determined, with 58.25% of the heifers not cycling. At that location, cycling heifers had higher first service conception ($P < .01$) and higher overall pregnancy rate ($P < .01$) than those heifers found to be noncycling (table 12), in agreement with results reported by Hixon et al. (1981).

Inadequate nutritional level may be one explanation for some heifers being noncyclic, as has been shown by Crichton et al. (1959). Another factor shown to affect age at puberty in heifers has been breed or heterosis (Wiltbank et al., 1966; Stewart et al., 1980; Dow et al., 1982; Ferrell, 1982; Nelsen et al., 1982).

Of the noncycling heifers, 47.79% showed a behavioral estrus (table 13), suggesting that ovarian activity in those heifers

TABLE 12. PREGNANCY RATES (%) AS AFFECTED BY LEVEL OF CYCLICITY.

	Cycling	Noncycling
First service conception rate	17.28 ^a	3.54 ^b
No. heifers	14/81	4/113
Second service conception rate	23.08	0.00
No. heifers	3/13	0/6
Total	20.99 ^a	3.54 ^b

^{a,b} Values on the same line with different superscripts differ ($P < .01$).

TABLE 13. EFFECT OF CYCLICITY^a ON INCIDENCE OF ESTRUS WITHIN TREATMENT GROUPS.

	GnRH		Control	
	Cycling	Noncycling	Cycling	Noncycling
No. heifers	18/45	27/56	18/36	27/57
% Showing estrus	40.00	48.21	50.00	47.37

^a Cycling = having greater than 1 ng/ml serum progesterone and/or an activated heat detector prior to SMB treatment.

may have been induced by treatment. These results are in agreement with others (Gonzalez-Padilla et al., 1975a,b; Short et al., 1976; Miksch et al., 1978; Spitzer, 1982; Brink et al., 1985) whose results have shown similar responses to progestin treatment in prepuberal heifers or anestrous cows. In this trial, fertility of the induced estrus is questionable, however, as only 1.85% of the noncycling heifers showing heat conceived to first service (table 13). These results are in agreement with those reported by Spitzer (1982) which show a large percentage of prepuberal heifers can be induced into estrus with the SMB treatment but pregnancy rates are low. They recommended that heifers be of sufficient age and weight to reach puberty prior to SMB treatment to achieve acceptable pregnancy rates.

Arije and Wiltbank (1971), Short and Bellows (1971) and Laster et al. (1972) showed that weight was an important factor in puberty attainment, with heavier heifers reaching puberty earlier than lighter weight heifers in each study. The means and ranges of the various measurements taken at breeding for the noncycling heifers in this trial are shown in table 14. The group of noncycling heifers in this trial had a lighter mean breeding weight ($P < .01$) than cycling heifers at the same location. This light weight may be one explanation for the apparent infertile heat shown by the noncycling heifers. Smith et al. (1979) reported that SMB treatment was effective in inducing a fertile estrus in heifers weighing over 250 kg,

TABLE 14. WEIGHT, HIP HEIGHT AND WEIGHT:HEIGHT RATIO OF CYCLING AND NONCYCLING HEIFERS AT BREEDING.

	n	Cycling			N	Noncycling		
		Mean	SE	Range		Mean	SE	Range
Weight, kg	81	268 ^a	3.0	197 - 354	112	252 ^b	2.6	202 - 331
Hip height, cm	81	115	.48	106 - 132	113	116	.40	106 - 127
Weight:height ratio, kg/cm	81	2.3 ^a	.20	1.8 - 3.0	112	2.1 ^b	.20	1.7 - 2.7

^{a,b}Mean values on the same line with different superscripts differ ($P<.01$).

yet did not induce a fertile estrus in many lighter weight heifers.

Effect of GnRH - trial with $\text{PGF}_{2\alpha}$. In this trial, all heifers were bred approximately 12 h after observed estrus. The administration of GnRH at breeding had no significant effect on first service conception rate (table 15). This is in agreement with the results of Burfening et al. (1978) who synchronized estrus with two injections of $\text{PGF}_{2\alpha}$ 11 d apart. Second service conception rate in this trial, however, tended ($P < .10$) to be lower in heifers receiving GnRH than in the control group (table 15). Spitzer (1982) hypothesized that a decrease in conception after GnRH may be due to an inaccurate timing of LH release relative to estrus. Repeated GnRH treatment of the same heifers at consecutive services had no significant effect on second service conception rate (table 16).

Of heifers receiving one $\text{PGF}_{2\alpha}$ injection, 77.7% responded by showing estrus within 5 d following injection. Of heifers receiving the second $\text{PGF}_{2\alpha}$ injection, 76.5% showed heat within 5 d after the injection (table 17). This is slightly higher than the response observed by Burfening et al. (1978) when two injections of $\text{PGF}_{2\alpha}$ were given 11 d apart. In the study by Burfening et al. (1978), conception rates did not significantly differ between synchronized females bred by estrus compared to untreated controls; however, in this trial, heifers not receiving $\text{PGF}_{2\alpha}$ tended ($P < .10$) to have higher conception to first service than heifers which received $\text{PGF}_{2\alpha}$, one or two injections

TABLE 15. EFFECT OF GnRH ON FIRST AND SECOND SERVICE CONCEPTION RATES (%) FOLLOWING PGF₂ α SYNCHRONIZATION.

	GnRH	Control
First service conception rate	47.67	51.02
No. heifers	41/86	50/98
Second service conception rate	45.16 ^a	65.38 ^b
No. heifers	14/31	34/52

^{a,b}Values on the same line with different superscripts differ ($P < .10$).

TABLE 16. EFFECT OF GnRH TREATMENT AT CONSECUTIVE SERVICES ON SECOND SERVICE CONCEPTION RATE (%) FOLLOWING PGF₂ α .

	GnRH at first service only	GnRH at first and second services	Control
No. heifers	7/12	14/30	27/40
Second service conception rate	58.33	46.67	67.50

TABLE 17. ESTRUS RESPONSE TO PGF₂ α .

	Showed estrus	No response
1 injection	77.70	22.30
No. heifers	108/139	31/139
2 injections	76.47	23.53
No. heifers	13/17	4/17

(table 18). Stage of the estrous cycle at which $\text{PGF}_{2\alpha}$ was administered may have also affected pregnancy rates, as shown by King et al. (1982). There were, however, no significant differences in conception rates between the group receiving GnRH and the control group due to $\text{PGF}_{2\alpha}$ administration (table 19).

Effect of breeding weight, frame, condition and age - trial with $\text{PGF}_{2\alpha}$. The means and ranges for measurements taken at breeding in this trial are shown in table 20. Heifers heavier than the mean weight tended ($P < .10$) to have a higher first service conception rate than the lighter weight heifers (table 21). Similarly, heifers with a higher weight:height ratio had a higher second service conception rate ($P < .05$) than did those heifers in the low group (table 21). Second service and overall pregnancy rate to AI was higher ($P < .01$) in the group of heifers older than the mean age compared to the younger group (table 21).

Correlation coefficients for the various measurements taken at breeding can be found in table 22. There was a correlation of .35 between age and condition (weight:height ratio) ($P < .05$). Furthermore, a correlation of .45 existed for breeding weight and hip height ($P < .01$), and a correlation of .94 between weight and condition at breeding ($P < .01$).

TABLE 18. EFFECT OF PGF₂^α ON FIRST SERVICE CONCEPTION RATE (%).

	PGF ₂ ^α	Control
No. heifers	61/134	30/50
First service conception rate	45.52 ^a	60.00 ^b

^{a,b}Values with different superscripts differ (P<.10).

TABLE 19. FIRST SERVICE CONCEPTION RATE (%) AS AFFECTED BY PGF₂^α AND GnRH.

	GnRH	Control
PGF ₂ ^α		
First service conception rate	43.08	47.83
No. heifers	28/65	33/69
Control		
First service conception rate	61.90	58.62
No. heifers	13/21	17/29

TABLE 20. WEIGHT, HIP HEIGHT, WEIGHT:HEIGHT RATIO AND AGE AT BREEDING OF HEIFERS IN PGF₂^α SYNCHRONIZATION PROGRAM.

	n	Mean	SE	Range
Weight, kg	116	410	2.4	341 - 477
Hip height, cm	75	117	.29	111 - 123
Weight:height ratio, kg:cm	50	3.5	.02	2.9 - 3.9
Age, d	116	431	1.5	380 - 455

TABLE 21. EFFECT OF BREEDING WEIGHT, HIP HEIGHT, WEIGHT:HEIGHT RATIO AND AGE ON PREGNANCY RATE (%).

	Weight, kg		Height, cm		Ratio, kg:cm		Age, d	
	>Mean	<Mean	>Mean	<Mean	>Mean	<Mean	>Mean	<Mean
Group average	429	389	119.5	115.4	3.64	3.3	443	415
First service conception rate	42.37	49.12	48.57	45.00	32.14 ^a	59.09 ^a	46.97	44.00
No. heifers	25/59	28/57	17/35	18/40	9/28	13/22	31/66	22/50
Second service conception rate	56.67	52.17	53.33	57.89	68.75 ^c	0.00 ^d	67.74 ^c	36.36 ^d
No. heifers	17/30	12/23	8/15	11/19	11/16	0/6	21/31	8/22
Overall pregnancy rate to AI	76.27	75.44	77.14	80.00	78.57	68.18	84.85 ^c	64.00 ^d

a,b Values on the same line within a measurement with different superscripts differ ($P < .10$).

c,d Values on the same line within a measurement with different superscripts differ ($P < .05$).

TABLE 22. CORRELATION COEFFICIENTS OF VARIOUS MEASUREMENTS OBTAINED AT BREEDING.

	Weight	Hip height	Weight:height ratio
Hip height	.459 [*]		
Weight:height ratio	.948 [*]	.156	
Age	.338 [*]	.222	.357 ^{**}

^{*} Values different than zero ($P < .01$).

^{**} Values different than zero ($P < .05$).

Of those heifers which did not conceive to first or second service, 38.71% and 74.29%, respectively, were found to be open at the end of the breeding season.

There were no significant differences in first service conception rate due to AI sires used in this trial.

Conclusion

The administration of GnRH at the time of AI did not significantly affect first or second service conception rates in heifers estrus synchronized with SMB, all data combined. However, of heifers which were not observed in estrus prior to breeding and inseminated by appointment after SMB treatment, GnRH treatment did have a significant improvement on first service conception rate. In the group of heifers which had not shown heat prior to AI, GnRH probably induced endogenous LH release, hastening ovulation and, thus, bringing time of ovulation and insemination into a favorable correlation for increased conception to occur.

Of heifers receiving SMB treatment, 61.08% showed a response of estrus 24 to 48 h after norgestomet implant removal. Heifers which showed estrus in this trial had a significantly higher first service conception rate than those in which no estrus was observed. Conception to first service did not significantly differ, however, between heifers inseminated 12 h after observed estrus and those inseminated 48 h post implant removal.

At one location, where the level of cyclic activity was determined prior to SMB treatment, estrus was observed in 47.79% of the prepuberal heifers 24 to 48 h after implant removal, yet only

1.85% conceived to first service, suggesting that the observed heat was merely a behavioral estrus, probably induced by the progestin implant and was not, in most cases, a fertile estrus.

In the trial with $\text{PGF}_2\alpha$, the administration of GnRH had no significant effect on first service conception rate. Second service conception rate in this trial, however, tended to be lower in heifers receiving GnRH, possibly due to the induced ovulation of premature ova, decreasing fertility, in the GnRH treatment group.

Of heifers receiving one $\text{PGF}_2\alpha$ injection, 77.7% responded by showing estrus within 5 d following injection. Of those heifers receiving two $\text{PGF}_2\alpha$ injections, 76.47% were observed in heat within 5 d after the second injection. Heifers not receiving $\text{PGF}_2\alpha$, bred during the first 5 d of the breeding season, tended to have higher conception to first service than those heifers which received $\text{PGF}_2\alpha$, either one or two injections. Thus, $\text{PGF}_2\alpha$ was effective in inducing estrus in a high proportion of the heifers, yet fertility was lessened with $\text{PGF}_2\alpha$ administration.

No significant difference in second service conception rate between groups receiving GnRH at first service only, both first and second service and the control group were observed in either trial. Repeated GnRH treatment of the same heifers at consecutive services did not appear to affect conception at second service.

Breeding weight and condition significantly influenced first service conception rate in both trials, with heavier heifers and heifers with higher weight:height ratios having significantly higher conception rates. In the $\text{PGF}_2\alpha$ trial, second service conception and

overall pregnancy rate was significantly higher in the group of heifers older than the mean age compared to the younger group. It can be concluded that yearling heifers should be of sufficient weight, age and condition prior to the start of the breeding season if high pregnancy rates are to be achieved.

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EFFECT OF GnRH, BREEDING WEIGHT,
FRAME, CONDITION AND AGE ON PREGNANCY RATES
IN ESTRUS SYNCHRONIZED BEEF HEIFERS

by

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Trials were conducted with 621 yearling beef heifers utilizing two methods of estrus synchronization. In one trial, all heifers received a 6 mg norgestomet ear implant for 9 d and an intramuscular injection of 5 mg estradiol valerate and 3 mg norgestomet at the time of implant insertion (SMB) and were bred either by appointment, 48 h following implant removal, or by estrus, approximately 12 h after heat was first detected. All heifers were allotted at breeding to either an untreated control group or a treated group which received 100 µg gonadotropin releasing hormone (GnRH) subcutaneously at the time of artificial insemination (AI). When possible, heifers returning to estrus were treated similarly at second service. At one location, the level of cyclicity was determined based on blood progesterone levels and heat detection aids. In a second trial, heifers were bred by heat for 5 d, and any heifers not showing heat within the initial 5 d period were injected with 25 mg prostaglandin- $F_{2\alpha}$ ($PGF_{2\alpha}$) on d 6 of the breeding season. Twelve days following $PGF_{2\alpha}$ injection, any heifers which still had not shown heat were given a second injection of $PGF_{2\alpha}$. All heifers were bred approximately 12 h after heat was first detected, for a 65 d breeding season. As in the trial with SMB, each heifer was allotted at breeding to either the control group or the GnRH treatment group. Where possible, heifers in each trial were weighed and hip height measurements taken at breeding. A weight:height ratio was used to estimate heifer condition. Additionally, when available, birth date and birth weight data on the heifers was recorded. Gonadotropin releasing hormone, administered at breeding, did not significantly affect first or second service conception rates when all data was combined in the SMB treated

heifers. First service conception rate was, however, improved with GnRH treatment ($P<.05$) in those SMB treated heifers which did not exhibit estrus prior to breeding and were bred by appointment. Overall conception to first service did not significantly differ between SMB treated heifers inseminated by appointment and those inseminated by estrus. At the one location, where the level of cyclic activity was determined prior to SMB treatment, a large proportion of prepuberal or noncycling heifers exhibited estrus; however, conception rate in this group was extremely low. In the trial with $\text{PGF}_2\alpha$, GnRH had no significant effect on first service conception, although second service conception tended ($P<.10$) to be lower in heifers receiving GnRH. Heifers not receiving $\text{PGF}_2\alpha$, bred during the first 5 d of the breeding season, tended ($P<.10$) to have higher conception to first service than heifers receiving $\text{PGF}_2\alpha$, either one or two injections. Repeated GnRH treatment of the same heifers at consecutive services did not significantly affect second service conception rate in either trial. In both trials, breeding weight and condition significantly influenced first service conception rate, with heavier heifers and heifers with high weight:height ratios having higher conception rates ($P<.05$). Additionally, in the trial with $\text{PGF}_2\alpha$, second service and overall pregnancy rate to AI was higher ($P<.05$) in the heifers older than the mean age. In conclusion, GnRH was effective in improving conception in SMB treated heifers which did not show heat prior to breeding but not in heifers under other breeding systems.