A COMPARISON OF ESTROUS SYNCHRONIZATION MANAGEMENT SYSTEMS IN BEEF CATTLE

by

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LITERATURE REVIEW

Estrous synchronization can be a valuable tool to the beef cattle industry. A major advantage of estrous synchronization is that it allows the use of artificial insemination under conditions where heat detection and/or individual insemination of cows is difficult or impractical. Major disadvantages include the fact that it can be more labor intensive and that at present, it may be cost prohibitive. For these reasons, more labor efficient and inexpensive methods of synchronizing estrus in cattle have been investigated.

The first commercially successful approach to bovine estrous synchronization involved the use of prostaglandin $F_{2\alpha}$. Prostaglandins are 20 carbon unsaturated fatty acids with a cyclopentane ring and two adjacent side chains. There are four major categories of prostaglandins deliniated by differences in the cyclopentane ring. These are A, B, E, and F. Further differentiation is achieved by indicating the unsaturation or number of double bonds present with a subscript number in the name. In the F series, the configuration of the C9 hydroxyl group is indicated as α or β. Only the α forms occur naturally. The free forms of prostaglandins are fat soluble, however the sodium or tromethamine (THAM) salts are water soluble (Hansel, 1975; Walpole, 1975). All subsequent references to $PGF_{2\alpha}$ in the tromethamine salt form ($PGF_{2\alpha}$-THAM) will be shown as $PGF_{2\alpha}$.

The fact that exogenously administered $PGF_{2\alpha}$ causes premature luteolysis in the bovine when given between d 5 and 16 of the estrous cycle (onset of estrus=d 0) has been known for several years. Liehr et al. (1972) successfully caused luteolysis in beef heifers with an intrauterine infusion of of 6 mg of $PGF_{2\alpha}$ placed in the uterine horn ipsilateral to the corpus luteum on d 8 of the estrous cycle. The same treatment given in the contralateral uterine horn was ineffective. One-half mg of $PGF_{2\alpha}$ was ineffective when placed in either uterine horn or in the uterine body at day 4. However, Louis et al. (1972) found that a single contralateral infusion of 5 mg $PGF_{2\alpha}$ on d 11 did cause luteolysis. Luteolysis also resulted from an intravaginal infusion of 30 mg of $PGF_{2\alpha}$, however this response was delayed 1 to 2 d in respect to the intrauterine treatment response. Rowson et al. (1972) showed that two doses of .5 mg of $PGF_{2\alpha}$ infused into the uterine horn ipsilateral to the corpus luteum on consecutive days was effective in causing luteolysis in 20 of 21 heifers. Seventeen of those heifers displayed estrus on the third d after the initial treatment. All of the heifers were between d 5 and 16 of their estrous cycle. It was noted that the treatment was ineffective on d 1 through 4 of the cycle. Hill et al. (1973) found that 2 mg of $PGF_{2\alpha}$ placed in the body of the uterus was luteolytic after d 4 of the estrous cycle in cows. Inskeep (1973) reported that 1.0 mg of $PGF_{2\alpha}$ placed in the anterior part of the uterine horn ipsilateral to the corpus luteum resulted in estrus at 60 to 80 h post treatment in 17 of 28 cows.

Other forms of parenteral administration of exogenous $PGF_{2\alpha}$ have also proven effective in causing luteolysis and synchronization of estrus in the bovine. A much higher (4-5x) dosage is required. Lauderdale (1972) found that 30 mg of $PGF_{2\alpha}$ injected sc caused luteal regression when beef heifers were treated after d 5 of their estrous cycles. Interval to estrus was 2 to 4 d after treatment in 0 of 6, 17 of 17, and 12 of 12 heifers treated on d 2 to 4, 6 to 9 and 13 to 16 of their estrous cycle, respectively. Stellflug et al. (1973) found that higher dosages of $PGF_{2\alpha}$ administered im did not hasten luteolysis in Holstein heifers. The heifers were allotted to three treatment groups and received 1) 30 mg $PGF_{2\alpha}$, 2) two 15 mg. injections of $PGF_{2\alpha}$ at 6 h intervals, or 3) 60 mg $PGF_{2\alpha}$. Declines in serum progesterone, a reliable indicator of luteolysis, did not differ significantly between treatment groups after injection.

Beal et al. (1980) were successful in causing luteolysis in cattle before d 5 of the estrous cycle by giving a 25 mg im injection of $PGF_{2\alpha}$ on both d 3 and 4. Two injections earlier in the cycle or two injections given only on d 4 did not cause luteolysis.

Conception rates after a $PGF_{2\alpha}$ induced estrus appears to be equal to those in non-synchronized cattle. Lauderdale et al. (1973, 1974) found no conception rate difference between non-treated control cows which were inseminated by estrus (Group I) and two $PGF_{2\alpha}$ induced groups. Both treatment groups were injected with 30 mg of $PGF_{2\alpha}$, one being inseminated by estrus (Group II) and the other inseminated by appointment at 72 and 90 h after injection (Group III). Only cows with a palpable corpus luteum were treated. Conception rates were 53.3%, 52.2%, and 55.8% respectively, for groups I, II and III.

Edqvist et al. (1975) found no difference in fertility between heifers injected with 25 mg $PGF_{2\alpha}$ im or sc on d 8 to 14 of their estrous cycle and non-treated controls. All heifers were bred by estrus. Prostaglandin $F_{2\alpha}$ appears not to be detrimental to subsequent normal ovarian activity. Lauderdale et al. (1981) injected beef heifers im with 25 mg $PGF_{2\alpha}$ seven times at intervals of 10 to 12 d. After the last injection the heifers were artificial inseminated by estrus. No difference in either ovarian activity, e.g. cystic follicles, or in fertility was detected compared to non-injected controls which were artificially inseminated by estrus.

Roche in 1974 found that neither dosage (20 mg or 30 mg of $PGF_{2\alpha}$ im) or the stage of the estrous cycle at injection affected estrous response or fertility of heifers. Only heifers from d 5 to 20 of the estrous cycle were used in this experiment. All heifers were bred by estrus. However, more recent research has indicated that stage of cycle does affect interval to estrus after prostaglandin $F_{2\alpha}$ or a prostaglandin $F_{2\alpha}$ analog treatment. King et al. (1982) found that interval to estrus was not different for heifers at d 6 through 9 of their estrous cycle at the time of $PGF_{2\alpha}$ treatment, but the interval increased by 9 h on d 10, and by 14 h on d 11 through 15. Similar results have been reported by other researchers (Ellicott et al., 1974; Dobson et al., 1975; Jackson et al., 1979). This variability of injection to estrus interval becomes important when timed insemination procedures are employed as opposed to breeding according to signs of estrus.

Several prostaglandin $F_{2\alpha}$ analogs have been developed and tested in recent years. These analogs appear to be very similar to $PGF_{2\alpha}$ in luteolytic activity with the exception of being more potent. $PGF_{2\alpha}$ analogs tested as estrous synchronization agents in cattle include ICI 79939 (Tervit et al., 1973; Dobson et al.,

1975) and ICI 80996 also called cloprostenol (Cooper, 1974; Cooper et al., 1975; Nancarrow et al., 1974; Thimonier et al., 1975; Leaver et al., 1975). Alfaprostol (K11941) or 18,19,20-trinor-17-cyclohexyl-13,14-didehydroprostaglandin $F_{2\alpha}$ methylester is a more recently developed $PGF_{2\alpha}$ analog. Schams and Karg (1982) compared the luteolytic capability of alfaprostol to other $PGF_{2\alpha}$ analogs, including cloprostenol, in heifers. Alphaprostol dosages of 5 mg or 6 mg im were used and no differences were noted either between dosages or analogs.

As previously stated, $PGF_{2\alpha}$ and its analogs are ineffective in causing luteolysis in the first 4 to 5 d of the bovine estrous cycle. In order to successfully synchronize estrus on a group basis, it becomes necessary to prevent cows from being in this ineffective period at the time of the synchronizing $PGF_{2\alpha}$ treatment. One method of accomplishing this involves the use of two injections of $PGF_{2\alpha}$ given 10 to 12 d apart. King and Robertson (1974) used a synchronization program whereby Holstein heifers received two sc injections of 30 mg $PGF_{2\alpha}$ ten d apart. All heifers were inseminated by estrus and no differences were found in either percentages of heifers displaying estrus or conception rates as compared to untreated controls.

Because estrous detection is time consuming, and often impractical, programs of estrous synchronization utilizing appointment insemination of cows have been investigated. Burfening et al. (1978) compared the efficacy of appointment breeding of cows which had received two injections of 25 mg of $PGF_{2\alpha}$ im to untreated controls bred 12 h post-estrus. Treatment cows were bred either at 72 and 96 h or only once at 80 h. No differences in conception rates were found. Wilson et al. (1978) compared untreated controls bred 12 h after estrus with cows and heifers treated with two doses of $PGF_{2\alpha}$ im 11 d apart and inseminated either 80 h after the second injection or 12 h after being detected in estrus. No differences were found between the three groups in first service pregnancy rate. Similar results have been been obtained in studies by Hafs et al. (1975); Louis et al. (1975); and Chipepa et al (1977) using $PGF_{2\alpha}$, and by Cooper (1974) and Refsal and Seguin (1980) using cloprostenol (ICI 80996).

More than 35 years ago, it was reported that progesterone could inhibit estrus and ovulation in the bovine (Christian and Casida, 1948). Later other workers used various forms of parenterally administered progestagens to synchronize estrus by administration for 14 to 18 d, however first service conception rates were generally lowered (Willet, 1950; Ulberg et al., 1951; Trimberger and Hansel, 1955; Curl et al., 1968; Wiltbank et al., 1971; Whitham et al., 1972; Woody and Pierce, 1974).

There are a number of orally active progestagens which have been used to synchronize estrus: 1) 6-methyl-17-acetoxy-progesterone (MAP) by Collins et al., 1961; Nelms and Combs, 1961; Hansel et al., 1961; Anderson et al., 1962; and Dhindsa et al., 1967; 2) 6-chloro-6-dehydro-17-acetoxyprogesterone (CAP) by Van Blake et al., 1963; Hansel et al., 1966; Wagner et al., 1968; and Grunert, 1975; 3) 16-17-dihyrdoxyprogesterone acetophenonide (DHAP) by Wiltbank et al., 1967; and 4) 17-acetoxy-6-methyl-16-methylenepregna-4,6-diene-3,20-dione (MGA®) by Zimbelman and Smith, 1966; Roussel and Beatly, 1969; Wilson et al., 1969; Chakaborty et al., 1971; Hill et al., 1971; and Hendricks et al., 1973. First service conception rates after prolonged oral progestagen treatment (14 to 18 d) has generally been lowered to the point of impracticality. It appears however, that short term treatment with progestagens does not significantly lower first service fertility. Chupin et al. (1975) found that fertility rates were 62%, 57.5%, 45.6%, and 26% for treatments with subcutaneous implants of norgestamet (SC 21009) for durations of 7, 9, 11, and 13-15 days in lactating cows, respectively. Percentages indicated are of the cows which displayed estrus after implant removal.

A second approach to overcoming the problem of the inherient inactive period of $PGF_{2\alpha}$ has employed the use of a progestagen prior to the $PGF_{2\alpha}$ treatment. Several modes of administration and several different progestagens have been investigated for use in this manner. Thimonier et al. (1975) used a 10 d sc implant of 12 mg of norgestamet followed by a 500 μg im injection of cloprostenol at implant removal. A similar degree of synchronization was found when compared to a similar group of cows given two injections of 500 μg of cloprostenol 10 d apart. A separate trial was then performed whereby a 9 d norgestamet implant was used followed by the cloprostenol injection at either time of implant removal or 48 h before implant removal. Synchonization was improved by giving the injection earlier. Heersche et al. (1979) reported that treatment with a 7 d 6 mg norgestamet implant followed by an im injection of $PGF_{2\alpha}$, given at either the time of implant removal or 24 h before, were both effective methods of synchronizing estrus in beef heifers. There was no effect on first service conception rate compared to untreated controls. Similar results have been obtained by Wishart (1974) and Deletang (1975).

Because of the labor required in implanting, a more practical approach to the combination progestagen plus prostaglandin $F_{2\alpha}$ treatment has been the utilization of an orally active progestin. Lauderdale (1975) fed beef cows 1.0 mg MGA per head daily for 5 d. These cows then received im injections of 3 mg of 17ϕ-$PGF_{2\alpha}$ on the last day of feeding. Comparison was made to cows which received two injections of 3 mg of 17ϕ-$PGF_{2\alpha}$ 11 d apart and to another group of cows which received no treatment. No difference was found in fertility between groups. It was further noted that both treatments appeared to be equal in synchronizing ability. Moody et al. (1978) compared first service conception of untreated controls to cows which were fed 1.0 mg of MGA daily for 5 d followed by 25 mg of $PGF_{2\alpha}$ administered on day of withdrawl. No significant difference was detected.

A third method by which the ineffective period of $PGF_{2\alpha}$ can be circumvented involves two management systems using estrous detection in combination with administration of $PGF_{2\alpha}$. In the first system, estrus is detected for 4 to 5 d prior to the injection of $PGF_{2\alpha}$. In this way, all cows which would have been in days 1 to 4 of their estrous cycle are inseminated early and not injected. Those cows not showing estrus after the first 4 d of the breeding season receive $PGF_{2\alpha}$ and are either inseminated according to estrus or are inseminated by appointment at approximately 80 h post-injection. Lauderdale et al. (1980) used this system and found that first service conception rates did not differ between treated females, cows receiving two injections of $PGF_{2\alpha}$ 11 d apart, and untreated controls when all cows were bred by estrus. Wilson et al. (1981) examined a nearly identical system. Of all treated cows, 29.3% exhibited estrus in the pre-injection period and were inseminated 12 h after being observed. All cows receiving $PGF_{2\alpha}$ were inseminated at 80 h post-injection regardless of whether or not they were observed in estrus. A total of 45 cows received $PGF_{2\alpha}$ and 19 were inseminated without exhibiting estrus. The untreated control cows were bred 12 h after being observed in estrus. The control group had a slightly higher first service conception rate, but the difference was not significant.

The second management system of this type uses a procedure of injecting all females with $PGF_{2\alpha}$, observing for estrus, and then inseminating all individuals responding to the treatment. All females not responding are reinjected 10 to 12 d later and inseminated by estrus. Jochle et al. (1982) compared the above two management systems and the classical two injections at 11 d intervals to untreated controls using the prostaglandin $F_{2\alpha}$ analog alfaprostol. Treatment dosage was 5 mg per head. The first service conception rate was 49.5% for the alfaprostol treated groups and 48.3% for the control group. All three treatments were similar in effectiveness of synchronizing estrus.

Lauderdale et al. (1981) reported on a study whereby 5400 cows in 38 herds and 2761 heifers in 19 herds were assigned randomly to one of the five following treatments: 1) two 25 mg injections of $PGF_{2\alpha}$ 10 to 12 d apart followed by insemination at 77 to 80 h after the second injection; 2) the same $PGF_{2\alpha}$ treatment followed by detection of estrus and insemination by estrus; 3) estrus detection and insemination for 4 d. Females not observed in estrus and bred over the 4 d period received one injection on $PGF_{2\alpha}$ and were inseminated by estrus; 4) one injection of $PGF_{2\alpha}$ followed by estrous detection and insemination by estrus; or 5) uninjected controls which were inseminated by estrus. No significant difference were found in first service conception rate between $PGF_{2\alpha}$ treated cattle. Cattle in group 4 had a treatment pregnancy rate 74% as high as cattle in group 2. This approximates the theoretical difference of 75 to 80%. No significant effect was seen between treatments on subsequent fertility in the 28 d breeding season.

It should be noted that the above four management systems using $PGF_{2\alpha}$ are F.D.A. approved and are commercially available to producers using Lutalyse® (Upjohn Co.) for estrous synchronization in cattle.

A COMPARISON OF ESTROUS SYNCHRONIZATION MANAGEMENT SYSTEMS IN BEEF CATTLE

SUMMARY

A total of 57 heifers and 483 cows at six locations were divided into six estrous synchronization treatment groups: 1) two injections of $PGF_{2\alpha}$ given 11 d apart, 2) one injection of $PGF_{2\alpha}$ followed by a second injection 11 or 12 d later for those not in estrus after the first injection, 3) two injections of alfaprostol given 11 d apart, 4) one injection of alfaprostol followed by a second injection 11 or 12 d later for those not in estrus after the injection, 5) MGA orally for 5 d followed by a $PGF_{2\alpha}$ injection 40 h after final feeding, and 6) MGA orally for 5 d followed by $PGF_{2\alpha}$ 48 h after the final feeding. All cattle were artificially inseminated by appointment at approximately 74 h post-injection for heifers and 78 h post-injection for cows.

Least squares means for conception rate (%) in treatments 1 through 6 were 1) 23.2, 2) 27.2, 3) 19.9, 4) 31.3, 5) 17.5, and 6) 25.1, respectively. No significant differences (P=.72) were found among those means. The percent of cows exhibiting estrus after treatment was similar in all treatments tested (treatments 2 through 5).

Under the conditions of this experiment, those estrous synchronization management systems tested were equally efficient in synchronizing estrus and resulted in a similar percentage of cows conceiving after treatment.

INTRODUCTION

Synchronization of estrus has proven to be a valuable tool to the beef cattle industry in that it allows the use of artificial insemination under conditions where estrous detection and/or individual insemination of cattle is difficult or impractical. However, at present estrous synchronization can be labor intensive and cost prohibitive.

It has been known for several years that exogenously administered $PGF_{2\alpha}$ causes premature luteolysis and synchronization of estrus in the bovine when given between d 5 and 16 (d of estrus=d 0) of the estrous cycle (Lauderdale, 1972; Liehr et al., 1972; Louis et al., 1972; Rowson et al., 1972; Hill et al., 1973; Inskeep et al., 1973).

More recently, management systems which circumvent the ineffective period of $PGF_{2\alpha}$ (d 1 to 4) on a group basis have been developed.

One method uses two injections of $PGF_{2\alpha}$ given 11 to 12 d apart (King and Robertson, 1974). A major drawback to this procedure is that hormone costs are doubled. Since estrous detection is costly in terms of labor and is often impractical, insemination by appointment after treatment has been used instead of insemination by estrus. Comparisons of insemination by estrus and by appointment have been made by Burfening et al., 1978; Wilson et al., 1978; Hafs et al., 1977; Louis et al., 1975; and Chipepa et al., 1977. Variable results have been obtained, but generally conception has been similar with the two methods.

A second system utilizes a parenterally administered progestagen in combination with $PGF_{2\alpha}$ (Wishart, 1974; Deletang, 1975; Heersche, 1979). Because orally active progestagens are often more convenient to administer, these have also been investigated for possible use with $PGF_{2\alpha}$ (Lauderdale, 1975; Moody et al., 1978).

A third method of circumventing the inactive period of $PGF_{2\alpha}$ involves the use of estrous detection with $PGF_{2\alpha}$ injection (Lauderdale et al., 1981). In this system, hormone costs are reduced, but labor requirement is higher and the breeding period lengthened to about 10 days.

Several $PGF_{2\alpha}$ analogs have been investigated, including alfaprostol, which has been shown to be an effective estrous synchronization agent (Jochle et al., 1982; Keay et al., 1983).

The objective of this study was to investigate the efficacy of several estrous synchronization management systems that could be more labor efficient and/or less expensive. Systems were evaluated in terms of estrous response and fertility at the synchronized period.

MATERIALS AND METHODS

<u>Trial 1</u>. In the spring of 1981, 114 crossbred cows and 25 crossbred heifers at the Kansas State University Experiment Station at Hays, Kansas (location 1) and 76 Hereford and Angus cows at the Kansas State University Purebred Beef Unit at Manhattan, Kansas (location 2) were allotted to the following groups.

Group 1. Fifty-seven cows and 12 heifers at location 1 and 37 cows at location 2 were injected with 25 mg $PGF_{2\alpha}$[1] im twice at 11 d intervals. Cows and heifers at location 1 were inseminated by

appointment an avg of 78.3 ± 1.9 h and 73.0 ± 0.4 h, respectively after the second injection. Cows at location 2 were inseminated an avg of 77.6 ± 0.6 after the second injection.

Group 2. Fifty-seven cows and 13 heifers at location 1 and 39 cows at location 2 were injected once with 25 mg $PGF_{2\alpha}$ im. Those females exhibiting estrus within 80 h after the $PGF_{2\alpha}$ injection were inseminated. Those not responding were reinjected 11 d later at location 1 and 12 d later at location 2. Cows and heifers at location 1 were inseminated by appointment an avg of 78.4 ± 1.3 h and 74.4 ± 1.1 h, respectively. Cows at location 2 were inseminated an avg of 77.0 ± 0.8 h after the 2nd injection. Cattle were allotted using a stratified random procedure by age (heifers versus cows) and calving date at location 1 and by breed and calving date at location 2. At time of insemination, groups were additionally balanced at each location for inseminator and service bull.

Observations for estrus were made early morning, noon, and late evening. KaMar[2] heat mount detectors were applied to all females. Estrous response to the first $PGF_{2\alpha}$ injection in group 2 was determined by observed estrous behavior and KaMar activation.

Pregnancy was diagnosed by rectal palpation 55 to 66 d after insemination at location 1 and from 100 to 130 d at location 2. Those data were combined with subsequent calving data to determine conception date. All females were on native grass pasture during the experiment.

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[1]Prostaglandin $F_{2\alpha}$ (dinoprost tromethamine)- Lutalyse®, The Upjohn Company, Kalamazoo, MI 49001.

[2]KaMar Heatmount Detectors®, KaMar, Inc., Box 773838, Steamboat Springs, CO 86477.

Trial 2. This trial was conducted in the spring of 1982, with 112 crossbred cows and 18 crossbred heifers at location 1 and 60 Hereford, Angus and Simmental cows at location 2. Cattle were allotted to the following groups.

Group 1. Twenty-eight cows and six heifers at location 1 and 17 cows at location 2 were injected with 25 mg $PGF_{2\alpha}$ im twice 11 d apart. Cows and heifers at location 1 were inseminated by appointment after the second injection an avg of 78.9 ± 0.5 h and 74.1 ± 0.5 h, respectively. Cows at location 2 were inseminated an avg of 77.7 ± 1.0 h after second injection.

Group 2. Twenty-eight cows and four heifers at location 1 and 15 cows at location 2 were injected once with 25 mg $PGF_{2\alpha}$ im. Those females exhibiting estrus within 80 h after the $PGF_{2\alpha}$ injection were inseminated. Those not responding were reinjected at an 11 or 12 d interval at location 1 and 2, respectively. Cows and heifers at location 1 were inseminated by appointment an avg of 76.4 ± 1.6 h and 74.6 ± 0.5 h after injection, respectively. Cows at location 2 were inseminated an avg of 78.0 ± 0.8 h after injection.

Group 3. Twenty-nine cows and five heifers at location 1 and 15 cows at location 2 were injected with 6 mg alfaprostol[3] im twice 11 d apart. Cows and heifers at location 1 were inseminated by appointment an avg of 78.8 ± 1.0 h and 74.3 ± 0.5 h after the second injection, respectively. At location 2, insemination of cows occurred an avg of 77.9 ± 1.1 after the second injection.

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[3]Alfaprostol (18,19,20-trinor-19-cyclohexyl-13,14-didehydro-$PGF_{2\alpha}$-methylester), Hoffman-LaRoche, Inc., Nutley, NJ 07110.

Group 4. Twenty-five cows and five heifers at location 1 and 13 cows at location 2 were injected once with 6 mg alfaprostol im. Those females exhibiting estrus within 80 h after the alfaprostol injection were inseminated as in group 2. Those not responding were reinjected at an 11 d interval at location 1 and a 12 d interval at location 2. Cows and heifers at location 1 were inseminated by appointment an avg of 77.1 ± 1.9 h and 75.1 ± 0.4 h after injection, respectively. Cows at location 2 were inseminated 77.8 ± 0.9 h after injection.

Cattle were allotted using a stratified random procedure by age and calving date at location 1 and by breed and calving date at location 2. At the time of insemination, groups were also balanced at each location for inseminator and service bull.

Observations for estrus were made at early morning, noon, and late evening. KaMar and Tel-tail[4] estrous detection aids were applied to all females. Estrous response to the first $PGF_{2\alpha}$ or alfaprostol injection in groups 2 and 4 was determined by a combination of observed estrus and KaMar plus Tel-tail status.

Pregnancy was diagnosed by rectal palpation at 55 to 66 d after insemination at location 1 and from 71 to 83 d at location 2. Those data were combined with subsequent calving data to determine conception date. All females were on native grass pasture during the experiment.

<u>Trial 3</u>. In the fall of 1981, 88 crossbred cows and 27 crossbred heifers at location 1 were allotted to the following groups.

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[4]Tel-Tail®, Imperial Chemical Industries, Ltd., Macclesfield, Cheshire, England.

Group 1. Forty-three cows and 12 heifers were injected with 25 mg $PGF_{2\alpha}$ im twice 11 d apart. Cows and heifers were inseminated by appointment an avg of 78.6 $\pm$ 0.7 h and 75.4 $\pm$ 0.3 h after the second injection, respectively.

Group 2. Forty-five cows and 15 heifers were fed 1.0 mg MGA female daily for 5 d. Approximately 40 h after the final feeding of MGA cows and heifers received one 25 mg im injection of $PGF_{2\alpha}$ and were inseminated by appointment an avg of 79.9 $\pm$ 0.6 h and 75.2 $\pm$ 0.3 h after injection, respectively.

MGA was administered in range cubes. Cubes contained 95.5% ground grain sorghum, 2% wet molasses, 1.5% sodium bentonite, and 1% MGA-100 premix[5]. The mix was steam conditioned to 65-75°C as the cubes were being formed. A 25 hp Master Model California Pellet Mill was used.

The range cubes were fed at the rate of .22 kg per head per day. Group 1 females received similar cubes with no MGA during the same period. Cattle were allotted using a stratified random procedure by age (heifers versus cows) and postpartum interval. At time of insemination, groups were also balanced for inseminator and service bull.

Observations for estrus were made early morning, noon and late evening. KaMar heatmount detectors were applied to all females. Estrous response was determined by a combination of observed estrous behavior and KaMar status.

Pregnancy was diagnosed by rectal palpation 61 d after

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[5]MGA-100® (17-acetoxy-6-methyl-16-methylenepregna-4,6-diene-3,20-dione), The Upjohn Company, Kalamazoo, Mich. 49001.

insemination. Palpation data were combined with subsequent calving data to determine conception date.

All females were on native grass pasture during the experiment and were supplemented with native grass hay.

Trial 4. In the spring of 1982, 127 Hereford cows at the Kansas State University Casoday Research Herd at Casoday, Kansas (location 3) were allotted to the following groups.

Group 1. Forty-three cows were injected with 25 mg $PGF_{2\alpha}$ im twice 11 d apart. Cows were inseminated by appointment an avg of 75.4 ± 0.6 h after the second injection.

Group 2. Thirty-nine cows were fed 1.0 mg MGA/female daily for 5 d. Approximately 40 h after the final feeding of MGA, all cows were injected im with 25 mg $PGF_{2\alpha}$ and were inseminated by appointment an avg of 74.1 ± 0.5 h after injection.

Group 3. Forty-five cows were treated as in group 2 except the $PGF_{2\alpha}$ injection was given approximately 48 h after the last MGA feeding and they were inseminated an avg of 75.0 ± 0.6 h after injection.

MGA was fed in the same manner as in trial 3. Cattle were allotted randomly and at the time of insemination groups were balanced for inseminator.

Pregnancy was diagnosed by rectal palpation 61 d after insemination. Subsequent calving data were combined with pregnancy diagnosis data to determine conception date. All females were on native grass pasture during the experiment.

Data were analyzed using a General Linear Model (SAS Institue Inc, 1982) with a least squares analysis of variance (Snedecor and Cochran, 1980). The data reported in table 3 was analyzed using Chi-Square analysis (Zar, 1974).

RESULTS AND DISCUSSION

Data from the three trials were pooled for statistical analysis since there was a common treatment (2 injections of $PGF_{2\alpha}$ 11 d apart) in all trials and at all locations. Least squares means of first service conception for the management systems investigated are summarized in table 1. No significant differences in first service conception rates were found between treatments ($p=.72$). These data are in agreement with reports by Lauderdale et al., 1975; Moody et al., 1978; Lauderdale et al., 1981; and Jochle et al., 1982.

Table 2 shows the influence of various factors on first service conception rate. Conception rate was significantly affected by location of experiment ($p=.0013$). Least squares means of conception rate show values that are generally considered low in the beef cattle industry. This probably reflects the nutritional program and general fertility of the herds. First service conception rates (LSM) by trial and location were: <u>trial 1</u>-location 1 (28.0), location 2 (41.3); <u>trial 2</u>-location 1 (1.5), location 2 (5.6); <u>trial 3</u> (14.2); and <u>trial 4</u> (53.6).

Age of female significantly influenced conception rate ($p=.0093$). Least squares means of conception rate for virgin heifers, first calf heifers, and aged cows were 28.56%, 10.77%, and 32.71%, respectively. Postpartum interval also had a significant influence on conception rate ($p=.0001$). These data were not available for analysis in trial 4. In the other trials, LSM conception rate was increased by .66% for each day of additional postpartum interval at time of insemination.

The effectiveness of alfaprostol in inducing estrus appears to be equal to $PGF_{2\alpha}$. Alfaprostol is not approved for marketing ,but as indicated here appears to be effective. Table 3 summarizes this comparison. Alfaprostol when given twice 11 d apart induced estrus in 65.3% of all females. This is similar to the 70.7% which were induced by $PGF_{2\alpha}$ used in an identical procedure ($p=.43$). When one injection of alfaprostol (trial 2 - group 4) was given, 41.9% of the treated females displayed estrus and were subsequently inseminated. This compares to the 38.9% of females which displayed estrus and were inseminated after one injection of $PGF_{2\alpha}$ in trials 1 and 2 - group 2 ($p=.74$). In these groups, 81.4% of all females eventually responded to either the first or to the second alfaprostol injection. This is similar ($p=.45$) to the 76.3% response when $PGF_{2\alpha}$ was used. Keay et al. (1983) reported a 90% response to one injection of alfaprostol in cycling beef heifers. This surpasses the theoretical value of 75 to 80% when $PGF_{2\alpha}$ is used. Data in the present experiment tends to refute the theory that alfaprostol may be effective earlier in the bovine estrous cycle than $PGF_{2\alpha}$ as no difference was seen between the compounds in percentage of cattle reponding to 1 injection ($p=.74$).

Table 3 also compares the estrous response after the treatment of 2 injections 11 d apart with the treatment involving 1 injection plus another 11 or 12 d later for those cattle not responding to the first injection; the percentage of cattle that responded with $PGF_{2\alpha}$ was 70.7 and 76.3 and with alfaprostol was 65.3 and 81.4, respectively. While the treatments of one injection plus another injection to unresponsive females treatments did tend to be higher in estrous response, these differences were not significant ($PGF_{2\alpha}$ $p>.1$, alfaprostol $p=.15$). A portion of this increased response may have been due to the increased postpartum interval (calving date to treatment date) of 11 or 12 d which occurred in any female which did not respond to the first injection given. One could expect more cattle to be cycling with an increase of postpartum interval.

Estrous response in the 5 d MGA plus $PGF_{2\alpha}$ treatment was compared to two injections of $PGF_{2\alpha}$ 11 d apart. This is summarized for cows in Table 4 and for heifers in table 5. Only data from trial 3 was used. No differences were seen in either percentage of treatment females responding or pattern of estrus between treatments. Lauderdale (1975) reported similar data. The combination of MGA feeding followed by one $PGF_{2\alpha}$ injection appears to be a viable alternative to the two injections of $PGF_{2\alpha}$ program. Inhibiting estrus with the orally active progestogen for 5 d insures that all corpora lutea present are mature enough that exogenous $PGF_{2\alpha}$ will induce luteolysis. MGA is not approved for marketing as an estrous synchronizing agent. However, under the conditions of these trials it appears that MGA in combination with $PGF_{2\alpha}$ could be a more economical and less labor intensive system for synchronization of estrus. A major advantage of this approach to estrous synchronization is that hormone costs are reduced while labor requiring procedures such as estrous detection and administration of a second injection of $PGF_{2\alpha}$ are eliminated. MGA becomes even more attractive when it is considered that at present it is widely available at a relatively low cost for use in inhibition of estrus in feedlot heifers.

The estrous synchronization management systems which were compared were equally effective in terms of subsequent fertility and degree of synchronization. Therefore, if all of these systems become commercially available, the beef producer could choose the management system that best fits his needs in terms of economics and labor requirement. Unfortunately, conception rates were lower than desired in all trials. This was apparently due to the low numbers of cattle which responded to treatment and displayed estrus. The likely explanation is that there were a large number of anestrus females at the time of experiment. There was no difference noted in estrous response between treatments. Further research is needed comparing these systems in cattle with higher fertility.

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

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TABLE 1. EFFECT OF ESTROUS SYNCHRONIZATION TREATMENTS ON FIRST SERVICE CONCEPTION RATES

Treatment	Number of Locations	n	LS Means of conception	p-value[a]
Two injections of $PGF_{2\alpha}$ 11 d apart	6	255	23.19%	---
One injection of $PGF_{2\alpha}$ plus another 11 or 12 d later for those not responding	4	156	27.16%	.47
Two injections of alfaprostol 11 d apart	2	49	19.88%	.70
One injection of alfaprostol plus another 11 or 12 d later for those not responding	2	43	31.25%	.36
1.0 mg MGA daily for 5 d followed by $PGF_{2\alpha}$ 40 h after final feeding	2	99	17.50%	.39
1.0 mg MGA daily for 5 d followed by $PGF_{2\alpha}$ 48 h after final feeding	1	45	25.10%	.83

[a] P-value compared to the least squares mean of two injections of $PGF_{2\alpha}$ 11 d apart.

TABLE 2. INFLUENCE OF VARIOUS FACTORS ON FIRST SERVICE CONCEPTION RATES

Factor	Probability of Having No Effect
Estrous synchronization treatment	.7175[a]
Location	.0013[a]
Age (heifer, 1st calf heifer, or cow)	.0093[a]
Treatment to insemination interval	.9396[b]
Postpartum interval[c]	.0001[d]
Cow breed	.6564[b]
Inseminator	.1081[a]

[a] Model included Treatment + Location + Age + Inseminator.

[b] Model included Treatment + Location + Age + Treatment to insemination interval + Postpartum interval + Cow breed + Inseminator.

[c] Postpartum intervals on cows at Casoday field trial (Trial 4) were not available.

[d] Model included Treatment + Location + Age + Postpartum interval + Inseminator.

TABLE 3. ESTROUS RESPONSE TO ONE VERSUS TWO INJECTIONS OF $PGF_{2\alpha}$ OR ALFAPROSTOL[a]

Treatment	n	No. in estrus (%) after 1st injection[b]	No. in estrus (%) after 2nd injection[c]	Total % displaying estrus after treatment
Two injections of $PGF_{2\alpha}$ 11 d apart	157	--[d]	111 (70.7)	70.7
One injection of $PGF_{2\alpha}$ plus another 11 or 12 d later for those not responding to first injection	156	61 (38.9)	58 (61.1)	76.3
Two injections of alfaprostol 11 d apart	49	--[d]	32 (65.3)	65.3
One injection of alfaprostol plus another 11 or 12 d later for those not responding to first injection	43	18 (41.9)	17 (68.0)	81.4

[a] Data from trial 1 and 2.

[b] Percentage indicated = no. of females in estrus after 1st injection / total no. of females in treatment.

[c] Percentage indicated = no. of females in estrus after 2nd injection / no. of females which received a 2nd injection.

[d] Cattle in treatment were not detected for estrus after one injection.

TABLE 4. ESTROUS RESPONSE OF COWS TO MGA PLUS $PGF_{2\alpha}$ INJECTION VERSUS TWO INJECTIONS OF $PGF_{2\alpha}$ [a]

Time of Estrous Response After $PGF_{2\alpha}$ Injection [b]		No. of cows in MGA + $PGF_{2\alpha}$ Group (%) [c]	No. of Cows in Two Injections of $PGF_{2\alpha}$ Group (%) [d]
48 - 56 h		7 (15.6)	7 (16.3)
56 - 64 h		2 (4.4)	5 (11.6)
64 - 72 h		6 (13.3)	5 (11.6)
72 - 96 h		-------[e]	-------[e]
96 - 104 h		4 (8.9)	0 (0)
104 - 112 h		4 (8.9)	8 (18.6)
	Total	23 (51.1)	25 (58.1)

[a] Data from trial 3.

[b] Interval indicates time from the post-MGA injection of $PGF_{2\alpha}$ in the MGA+$PGF_{2\alpha}$ treatment and time from the second injection of $PGF_{2\alpha}$ in the two injection treatment.

[c] Forty-five cows were fed 1.0 mg MGA/head/d for 5 d. Forty h after the last feeding they received 25 mg $PGF_{2\alpha}$.

[d] Forty-three cows were injected twice with 25 mg $PGF_{2\alpha}$ 11 d apart.

[e] Estrus was not observed during this period.

TABLE 5. ESTROUS RESPONSE OF HEIFERS TO MGA PLUS $PGF_{2\alpha}$ INJECTION VERSUS TWO INJECTIONS OF $PGF_{2\alpha}$ [a]

Time of Estrous Response After $PGF_{2\alpha}$ Injection [b]		No. of Heifers in MGA + $PGF_{2\alpha}$ Group (%) [c]	No. of Heifers in Two Injections of $PGF_{2\alpha}$ Group (%) [d]
48 - 56 h		4 (26.7)	4 (33.3)
56 - 64 h		0 (0)	1 (8.3)
64 - 72 h		1 (6.7)	0 (0)
72 - 96 h		-------[e]	-------[e]
96 - 104 h		0 (0)	1 (8.3)
104 - 112 h		0 (0)	0 (0)
	Total	5 (33.3)	6 (50.0)

[a] Data from trial 3.

[b] Interval indicates time from the post-MGA injection of $PGF_{2\alpha}$ in the MGA+$PGF_{2\alpha}$ treatment and time from the second injection of $PGF_{2\alpha}$ in the two injection treatment.

[c] Fifteen heifers were fed 1.0 mg MGA/head/d for 5 d. Forty h after the last feeding they received 25 mg $PGF_{2\alpha}$.

[d] Twelve heifers were injected twice with 25 mg $PGF_{2\alpha}$ 11 d apart.

[e] Estrus was not observed during this period.

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A COMPARISON OF ESTROUS SYNCHRONIZATION MANAGEMENT SYSTEMS IN BEEF CATTLE

by

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Synchronization of estrus has proven to be valuable in the beef cattle industry by allowing artificial insemination to be used under conditions where estrous detection and/or insemination of cows is difficult or impractical. However, at present synchronization of estrus can be cost prohibitive and labor intensive. Four trials were designed to investigate less expensive or more labor efficient methods of synchronizing estrus in beef females.

Injections were given im in all cases. Prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) dosage was 25 mg and alfaprostol dosage was 6 mg. Injections, in animals receiving two injections, were always 11 or 12 d apart. All inseminations were by appointment at approximately 74 h after injection for heifers and 78 h after injection for cows. Melengestrol acetate (MGA) was fed at the rate of 1.0 mg/head/day. Trials 1 and 2 were conducted at two locations while 3 and 4 were conducted at one location.

Trial 1. Twelve heifers and 96 cows were divided into two treatment groups. Group 1 received two injections of $PGF_{2\alpha}$ and were artificially inseminated (AI) by appointment. Group 2 was injected with $PGF_{2\alpha}$ and those females showing estrus by 80 h after injection were AI at approximately 80 h. Those cattle not found in estrus by 80 h were reinjected 11 or 12 d later and then AI by appointment.

Trial 2. A total of 18 heifers and 172 cows were assigned to one of four treatment groups. Groups 1 and 2 were the same as groups 1 and 2 in Trial 1. Procedures used in groups 3 and 4 were the same as in groups 1 and 2, respectively, except alfaprostal was injected instead of $PGF_{2\alpha}$.

Trial 3. Twenty-seven heifers and 88 cows were allotted to two groups. Group 1 received two injections of $PGF_{2\alpha}$ and were then AI by appointment. Group 2 was fed MGA for 5 d then injected with $PGF_{2\alpha}$ 40 h after the last MGA feeding.

Trial 4. Cows (127) were assigned to one of three groups. Group 1 received two injections of $PGF_{2\alpha}$ and was then AI by appointment. Group 2 was treated the same as group 2 in trial 3. Group 3 was the same as group 2 except $PGF_{2\alpha}$ was injected 48 h after the last MGA feeding.

Data was pooled across the six treatments and six locations and was analyzed using a General Linear Model and a least squares means analysis. No difference (p=.72) was found between treatments for the least squares means of first service conception rate. First service conception rates (%) were 23.2 for groups given two injections of $PGF_{2\alpha}$ then AI (19.9 for alfaprostol) and 27.2 for groups given $PGF_{2\alpha}$ then inseminated if in estrus and reinjected if not (31.3 for alfaprostol). The MGA group injected at 40 h had a conception rate of 17.5 and the rate for those injected at 48 h was 25.1. Conception rates appeared to be low due to the small number of cattle in estrus after treatment. This was apparently due to a high percentage of the females being anestrus during treatment since the percentage of females observed in estrus, or exhibiting signs of estrus, was not different between treatments.

The estrous synchronization management systems which were compared did not differ in degree of estrous synchronization or in percentage of females conceiving.