201

USE OF PROSTAGLANDIN $F_{2\alpha}$ IN LACTATING DAIRY COWS WITH A PALPABLE CORPUS LUTEUM BUT UNOBSERVED ESTRUS

by

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BIOGRAPHY

Shawn S. Plunkett, daughter of John and Carolyn Frey, was born Shawn Suzanne Frey, February 10, 1959 in Garden City, Kansas. She attended elementary and secondary schools at Satanta, Kansas, graduating from Satanta High School in 1977.

She received her associate degree at Garden City Community College in May, 1979. She enrolled at Kansas State University and completed requirements for Bachelor of Science degree in Agriculture in May, 1981. While a student at Kansas State University, she married Harmon Plunkett in May, 1980.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

REVIEW OF LITERATURE

Luteolytic Effects of Prostaglandin $F_{2\alpha}$ in Cattle

After prostaglandin $F_{2\alpha}$(PGF) was discovered to be luteolytic in rats by Pharriss and Wyngarden (1969), further studies were conducted to determine the effect of PGF on luteal function in other species. Administration of PGF was shown to induce luteolysis in various species including cattle (Lauderdale, 1972; Louis et al., 1974; Edqvist et al., 1975). PGF first was demonstrated to be luteolytic when administered to the bovine by intrauterine (Louis et al., 1974), intravenous (Lauderdale, 1972), subcutaneous (Lauderdale, 1972; Edqvist et al., 1975) and intramuscular (Roche, 1974; Hafs et al., 1974; Edqvist et al., 1975) routes if a functional corpus luteum (CL) was present. Various analogues of PGF also were found to be luteolytic in cattle (Cooper, 1974; Roche, 1976; Seguin et al., 1978).

Efficacy During the Estrous Cycle

Rowson et al. (1972) reported that the CL in cattle is insensitive to the luteolytic action of PGF before the fifth day of the cycle (estrus=day 0). The response of a group of cattle receiving PGF will vary according to the stage of the estrous cycle at the time of PGF administration. A normal 21-day estrous cycle can be divided into three phases based on the effectiveness of PGF during each phase: 1) from day 0 to 5 PGF is not luteolytic; 2) from day 5 to 16 PGF will regress the CL and induce normal estrus; 3) from day 17 to 21 the CL will have regressed normally and exogenous PGF will have no effect (Cooper, 1974).

Macmillan (1978) found that lactating dairy cows treated with an analogue of PGF during various stages of the estrous cycle resulted in varied intervals from treatment to first observed estrus. The response rate of cows exhibiting estrus within 6 days following treatment was 31% of cows treated during metestrus (days 0 to 5), 76% during early diestrus (days 6 to 9), 88% during mid-diestrus (day 10 to 13), 87% during late diestrus (days 14 to 17) and only 45% of the cows exhibited estrus when treated during proestrus (days 18 to 24). The distribution of response-intervals less than 6 days during diestrus was influenced by the stage of diestrus. In that study, synchronization was most precise among cows treated during early diestrus (days 6 to 9) and least precise during mid diestrus (days 10 to 13). Similar effects of stage of the estrous cycle on the interval to estrus after PGF have been reported (Johnson, 1978; Jackson et al., 1979; Refsal and Seguin, 1980; King et al., 1982). Those studies indicated that the stage of the estrous cyle at PGF treatment affected the precision of estrous synchronization.

PGF Dose Response Effects

PGF induces luteal regression when it is administered between days 5 and 16 of the cycle. The ability of PGF to induce luteolysis varies with the dosage used and route of administration. Many studies have been conducted to determine the optimum dose level in relation to the route of administration.

Louis et al. (1972) showed that 5 mg infusion of PGF into the uterine horn ipsilateral to the CL resulted in luteolysis. In 1974, they also demonstrated that 5 mg PGF infused into either the ipsilateral or contralateral horn induced luteal regression. PGF infusion was followed by increased estrogen secretion and an ovulatory surge of luteinizing hormone (LH) coincidental with the onset of estrus. After intrauterine administration of PGF, progesterone concentration declined within 12 h due to rapid decrease in CL diameter. Estrus began at 72 h and ovulation occurred at 95 h after PGF. Those results were similar to that observed previously (Louis et al., 1972). Donaldson (1977) infused the uterus of beef cows and heifers with 5 or 6 mg of PGF.

Seventy percent of the cattle treated with 5 mg and 74% treated with 6 mg were in estrus between 1 and 7 days after PGF infusion. The greatest proportion of the cattle were in estrus on day 3 following treatment.

Much work has been done with varying dosage levels of PGF given systemically. Renegar et al. (1978) reported that incidence of luteolysis was greater in cows given 15, 25, or 35 mg PGF (im) than in cows given 0 or 5 mg. No difference in response was detected among cows given 15, 25, or 35 mg PGF. Average incidence of luteolysis was 88%. Hafs and Manns (1975) reported no difference in the interval to estrus among heifers given 20, 30, or 40 mg PGF or in beef cows given 30 or 60 mg PGF. Eighty-eight and 69% of the heifers and cows were in estrus 3 to 6 days after PGF, respectively. Roche (1974) reported similar results in heifers.

PGF causes abortion in pregnant cattle (Lauderdale, 1972) because of its ability to regress the CL. The abortifacient action of PGF is related to stage of gestation and dosage. Dose of PGF required to cause abortion increases as pregnancy advances and the interval from PGF to abortion lengthens (Refsal et al., 1976; McAllister and Lauderdale, 1979). They reported that 3 mg or less was ineffective in causing abortion. Doses of 5 to 11 mg PGF were 30 to 80% effective, and doses of 20 mg or more were 67 to 100% effective when injected (im) into cattle at about 150 days or less of gestation.

Hormone Changes After PGF

Changes in concentration of serum LH, progesterone, and estradiol associated with PGF-induced CL regression have been described. Changes in hormone concentrations for PGF treated cows were similar to that of untreated cows during spontaneous luteal regression (Swanson et al., 1972; Louis et al., 1974).

Serum progesterone decreased to less than 50% of pretreatment concentrations within 12 h after PGF in dairy cows (Louis et al., 1974). In an earlier study with diestrous heifers, progesterone declined about 60% within 12 h (Louis et al., 1972). Serum progesterone concentration in treated cattle declined to nondetectable levels from 48 to 72 h after PGF administration. This is consistent with that observed in untreated cattle after spontaneous luteal regression (Swanson et al., 1972; Schams et al., 1977). Profiles of serum progesterone during subsequent estrous cycles following PGF treatment were similar to those in control estrous cycles (Louis et al., 1972; Edqvist et al., 1975).

Estradiol concentrations more than doubled 24 h after PGF and continued to increase until 72 h post-treatment (Louis et al., 1974). Estradiol concentrations during the estrous cycle after PGF were similar to that observed during untreated estrous cycles in control cows.

Serum LH after PGF remained unchanged until the preovulatory LH surge occurred (Louis et al., 1974). This is consistent with that of untreated cattle (Schams et al., 1977). Therefore, the increase in LH concentrations appears to be a result of decreasing progesterone concentrations rather than a direct response to PGF. Duration of the LH surge was similar for PGF-treated and control cows.

In overview, changes in LH, progesterone and estradiol after PGF administration resembled changes in untreated cattle after spontaneous CL regression. Schams and Karg (1982) reported similar results after examining the effect of PGF and its analogues on the secretion of LH, progesterone, FSH, prolactin and oxytocin. Only plasma prolactin and oxytocin concentrations increased within 20 min after administration of the analogue. Increase in plasma prolactin concentration agrees with the finding of Renegar et al. (1978), although it is not clear how PGF causes prolactin and oxytocin release. Schams and Karg (1982) suggested that PGF may influence hypothalamic neurohormone release.

In addition, Renegar et al. (1978) reported an increase in growth hormone and glucocorticoids after PGF. Growth hormone was unaltered for 4 h after injection of 5, 15, or 25 mg PGF. However, growth hormone increased 74% within 30 min in cows given 35 mg PGF and then returned to pretreatment concentration by 2 h. Glucocorticoids increased rapidly following injections of 15, 25, and 35 mg PGF. Glucocorticoids remained above pretreatment values until 4 h after injection.

Characteristics of Estrus and Fertility After PGF in Cattle

The luteolytic properties of PGF and its analoges for controlling the onset of estrus in diestrous cattle is well established. The following will review the reproductive performance (interval from treatment to estrus and fertility at the induced estrus or after timed insemination) after administration of PGF.

Interval to Estrus

The majority of diestrous cattle treated with PGF exhibit estrus about 72 h after treatment (Cooper, 1974; Hafs et al., 1975; Roche, 1976). However, a distribution in the interval from treatment to detection of estrus has been reported (Hafs et al., 1975; Eddy, 1977; Britt et al., 1978; Macmillan et al., 1980).

Macmillan et al. (1980) found that only 31% of 437 dairy cows were detected in estrus in 3 days after treatment with a PGF analog (Cloprostenol). However, the response increased to 82% by 6 days. Hafs and Manns (1975) reported that 68% of suckled cows showed estrus on days 3 to 6 after PGF. In an earlier experiment, 50% of the cattle observed in estrus within 7 days after PGF were detected on day 3, but 88% were detected on days 2, 3 and 4 (Lauderdale et al., 1974). Similar results in dairy cows have been reported (Louis et al., 1972; Hafs and Manns, 1975; Roche and Prendiville, 1979).

Most heifers show estrus within 2 to 4 days after PGF (Tervit et al., 1973; Hafs et al., 1975; Britt et al., 1978; Baishya et al., 1980). Heifers treated in early luteal phase (days 5 to 9) had shorter intervals to estrus than heifers in later luteal phase of the estrous cycle (days 10 to 15) (Refsal and Seguin, 1980; King et al., 1982).

Fertility After PGF

It has been reported that PGF and its analogues can be used successfully without adverse effects on conception rates. Studies have shown that breeding cattle at PGF-induced estrus will yield conception rates comparable with those of control cattle.

Higher pregnancy rates have been reported in PGF-treated dairy (Macmillan et al., 1980) and beef cows (Lambert et al., 1976) when compared with untreated cows inseminated at estrus. Additional work has shown that fertility after inseminations at PGF-synchronized estrous periods were similar to that of control cows (Lauderdale et al., 1974; Seguin et al., 1978; Roche and Prendiville, 1979) and heifers (Roche, 1974; Hafs et al., 1975; Donaldson, 1977).

Inseminations at a predetermined time after PGF can eliminate problems associated with detection of estrus, particularly those associated with cattle not observed in estrus after treatment. However, research results on conception rates at a predefined time after PGF have not been consistent. Fertility has been reported to be normal in heifers and in cows in some studies, while in others, fertility was lower in cows after appointment inseminations compared with control cows inseminated after estrous detection.

Leaver et al. (1976) reported that fertility in heifers at a single insemination 72 h after PGF was normal. Hafs et al. (1975) also reported that fertility in heifers was normal compared with controls after two inseminations (70 and 88 h). Similar results also were reported (Hafs et al., 1978; Young and Henderson, 1981).

Seguin et al. (1978) reported higher conception rates in dairy cows inseminated twice by appointment (72 and 96 h after treatment) than in those inseminated based on signs of estrus. Additional studies in milked and suckled cows indicated that inseminations at predefined times after PGF administration achieved conception rates comparable with control cows inseminated at estrus (Lauderdale et al., 1974; Hafs and Manns, 1975; Roche, 1976; Lambert et al., 1976; Hafs et al., 1978; Roche and Prendiville, 1979).

In contrast, lower pregnancy rates after PGF were reported for appointment inseminated cattle compared with cattle inseminated at estrus (Donaldson, 1977; Macmillan et al., 1980). These data suggest that the interval to estrus after PGF is too variable for cows to be inseminated at predetermined times.

Reproductive Management Systems Using PGF

Numerous management systems utilizing PGF as a synchronizer of estrus have been studied. Most of those methods have attempted to circumvent the problem caused by the unresponsiveness of cattle to PGF during the early phases of their estrous cycles (days 1 to 5). The following will be a brief description of those systems.

Synchronization of Estrus in Cattle

Most management systems used to synchronize estrus in cattle can be categorized in one of the following systems presented in Table I.

In those studies comparing different estrous synchronization systems using PGF, fertility was similar to that for untreated control cattle. However, differences in fertility after insemination at a predefined time after PGF have been reported. The reasons for these differences are not clear but might reflect the number of anestrous cows present, stage of the estrous cycle, or a delay in onset of estrus following treatment.

Table I: Prostaglandin $F_{2\alpha}$ Management Systems

Method	Interval Between Injections	Estrous Detection	Insemination Protocol	References
I. Double Injection	10-12 days	Observe for estrus after second injection	AI according to estrus following second injection	Macmillan et al., 1977 Roche and Prendiville, 1979 Donaldson, 1977; Moody, 1979
II. Double injection	10-12 days	No estrus detection	AI at a predetermined time (80 h or 72 + 96 h)	Macmillan et al., 1977 Roche and Prendiville, 1979 Moody, 1979
III. Single Injection	___	Observe for estrus	AI for 5 days following injection	Macmillan et al., 1977 Roche and Prendiville, 1979 Moody, 1979 Doornbos and Anderson, 1979
IV. Single injection	___	Observe for estrus from 4 days before through 5 days after PGF. Inject those cows not yet inseminated	AI 4 days prior to injection. AI cattle not previously in-seminated according to estrus or at a predetermined time	Macmillan et al., 1977 Roche and Prendiville, 1979 Donaldson, 1977; Moody, 1979 Doornbos and Anderson, 1979 Han and Moody, 1979

Uses of PGF in Lactating Dairy Cows

Detection of estrus is extremely important in dairy herds utilizing artificial insemination. However, failure to detect cows in heat is responsible for considerable overall production losses (Christie, 1976; Pelissier, 1972). Dairymen appear to be extending calving intervals more because of days lost due to missed heat periods than due to failure of cows to conceive after insemination (Barr, 1975). Lauderdale (1974) reported that failure to detect estrus is related, at least partially, to failure of observation. Zemjanis et al. (1969) reported that 90% of reported cases of anestrus were due to failure of close observation for estrus. To aid in the detection of estrus, PGF has been used to induce estrus by regressing the CL.

Because PGF is ineffective in cattle between days 0 and 5 of the estrous cycle, management systems involving two injections of PGF 10 to 12 days apart followed by fixed time insemination or inseminations at estrus are effective. Researchers reported no difference in calving rates of cows inseminated at either 72 and 96 h after PGF or in those inseminated according to estrus after PGF or in control cows inseminated at estrus (Roche and Prendiville, 1979; Young and Henderson, 1981).

Cows can be selected for PGF treatment based on ovarian palpation (Lauderdale et al., 1974). Success of ovarian palpation is related to the accuracy of detecting a functional CL. Only cows with a CL would be candidates for PGF treatment. Fertility was reported to be normal in cows inseminated at estrus following PGF and in cows inseminated at predefined times (Lauderdale et al., 1974).

Dairy herds utilizing routine herd health programs in conjunction with regularly scheduled veterinary visits could incorporate effectively PGF for helping reproductive management of problem cows. In cows where estrus is not observed or where weak signs of estrus may preclude its detection, PGF appears to be a tool to aid dairymen in inseminating those cows after CL regression is induced by PGF (Seguin et al., 1978).

References

Baishya, N., P.J.H. Ball, J.D. Leaver and G.S. Pope. 1980. Fertility of lactating dairy cows inseminated after treatment with cloprostenol. Brit. Vet. J. 136:227.

Barr, H.L. 1975. Influence of estrus detection on days open in dairy herds. J. Dairy Sci. 58:246.

Britt, J.H., H.D. Hafs and J.S. Stevenson. 1978. Estrus in relation to time of administration of prostaglandin $F_{2\alpha}$ to heifers. J. Dairy Sci. 61:513.

Christie, E.H.L. 1976. Observations on the use of cloprostenol in a large dairy herd in Cheshire. Vet. Rec. 99:272.

Cooper, M.J. 1974. Control of oestrous cycles of heifers with a synthetic prostaglandin analogue. Vet. Rec. 95:200.

Donaldson, L.E. 1977. Synchronisation of oestrus in beef cattle artificial breeding programs using prostaglandin $F_{2\alpha}$. Australian Vet. J. 53:72.

Doornbos, D.E. and D.C. Anderson. 1979. Bovine estrous synchronization systems and resulting fertility using $PGF_{2\alpha}$. J. Anim. Sci. 49 (Suppl. 1):292.

Eddy, R.G. 1977. Cloprostenol as a treatment for no visible oestrus and cystic ovarian disease in dairy cows. Vet. Rec. 100:62.

Edqvist, L.E., I. Settergren and G. Anstrom. 1975. Peripheral plasma levels of progesterone and fertility after prostaglandin $F_{2\alpha}$ induced oestrus in heifers. Cornell Vet. 65:120.

Hafs, H.D.,T.M. Louis, P.A. Noden and W.D. Oxender. 1974. Control of the estrous cyle with prostaglandin $F_{2\alpha}$ in cattle and horses. J. Anim. Sci. 38 (Suppl 1):10.

Hafs, H.D. and J.G. Manns. 1975. Onset of oestrus after prostaglandin $F_{2\alpha}$ in cattle. Vet. Rec. 96:134.

Hafs, H.D., J.G. Manns and B. Drew. 1975. Onset of oestrus and fertility of dairy heifers and suckled beef cows treated with prostaglandin $F_{2\alpha}$. Anim. Prod. 21:13.

Hafs, H.D., J.G. Manns and P.D.P. Wood. 1978. Fertility of heifers and suckled cows inseminated at predetermined intervals after treatment with prostaglandin $F_{2\alpha}$. J. Agric. Sci. 91:479.

Han, D.K. and E.L. Moody. 1979. Comparisons of estrous synchronization management systems using prostaglandin $F_{2\alpha}$. J. Anim. Sci. 49 (Suppl 1):190.

Jackson, P.S., C.T. Johnson, B.J. Furr and J.F. Beattie. 1979. Influence of stage of oestrous cycle on time of oestrus following cloprostenol treatment in the bovine. Theriogenology 12:153.

Johnson, C.T. 1978. Time to onset of oestrus after injection of heifers with cloprostenol. Vet. Rec. 103:204.

King, M.E., G.H. Kiracofe, J.S. Stevenson and R.R. Schalles. 1982. Effect of stage of the estrous cycle on interval to estrus after $PGF_{2\alpha}$ in beef cattle. Theriogenology 18:191.

Lambert, P.W., W.M. Greeene, J.D. Strickland, D.K. Han and E.L. Moody. 1976. $PGF_{2\alpha}$ controlled estrus in beef cattle. J. Anim. Sci. 42:1565.

Lauderdale, J.W. 1972. Effects of $PGF_{2\alpha}$ on pregnancy and estrous cycle of cattle. J. Anim. Sci. 35:246 (Abstr.).

Lauderdale, J.W. 1974. Estrus detection and synchronization of dairy cattle in large herds. J. Dairy Sci. 57:348.

Lauderdale, J.W., B.E. Seguin, J.N. Stellflug, J.R. Chenalt, W.W. Thatcher, C.K. Vincent and A.F. Loyancano. 1974. Fertility of cattle following $PGF_{2\alpha}$ injection. J. Anim. Sci. 38:964.

Leaver, J.D., P.M. Mulvany, R.G. Glencross and G.S. Pope. 1976. Synchronization of oestrus in dairy cattle with a prostaglandin analogue (ICI 80996). Anim. Prod. 22:145 (Abstr.).

Louis, T.M., H.D. Hafs and D.A. Morrow. 1972. Estrus and ovulation after $PGF_{2\alpha}$ in cows. J. Anim. Sci. 35:1121 (Abstr.).

Louis T.M., H.D. Hafs and D.A. Morrow. 1974. Intrauterine administration of prostaglandin $F_{2\alpha}$ in cows: progesterone, estrogen, LH, estrus and ovulation. J. Anim. Sci. 38:347.

Macmillan, K.L., R.J. Curnow and G.R. Morris. 1977. Oestrus synchronisation with prostaglandin analogue: I. Systems in lactating dairy cattle. New Zealand Vet. J. 25:366.

Macmillan, K.L. 1978. Oestrus synchronsation with a prostaglandin analogue: II. Special aspects of synchronisation. New Zealand Vet. J. 26:104.

Macmillan, K.L., A.M. Day and J.F. Smith. 1980. Onset of oestrus and fertility in lactating dairy cows injected with an analogue of prostaglandin $F_{2\alpha}$, cloprostenol. Anim. Reprod. Sci. 3:171.

McAllister, J.F. and J.W. Lauderdale. 1979. Lutalyse in pregnancy termination. Proceedings of the lutalyse symposium. Brook Lodge, Augusta, Michigan, August 6-7.

Moody, E.L. 1979. Studies on lutalyse use programs for estrus control. Proceedings of the lutalyse symposium. Brook Lodge, Augusta, Michigan, August 6-7.

Pelissier, C.L. 1972. Herd Breeding problems and their consequences. J. Dairy Sci. 55:385.

Pharriss, B.B. and L.J. Wyngarden. 1969. The effect of prostaglandin $F_{2\alpha}$ on the progestogen content of ovaries from pseudopregnant rats. Soc. Exp. Biol. Med. 130:92.

Refsal, K.R., B.E. Seguin, E.C. Mather, B.K. Gustafsson, J.C. Meiske and R.D. Goodrich. 1976. Use of estradiol and prostaglandin $F_{2\alpha}$ to induce abortion in feedlot heifers. Minnesota Cattle Feeder's Report, p.91.

Refsal, K.R. and B.E. Seguin. 1980. Effect of stage of diestrus and number of cloprostenol injections on intervals to estrus, LH peak and ovulation in heifers. Theriogenology 14:37.

Renegar, R.H., H.D. Hafs, J.H. Britt and T.D. Carruthers. 1978. Luteolysis, growth hormone, glucocorticoids, prolactin and milk production in lactating dairy cows given $PGF_{2\alpha}$. J. Anim. Sci. 47:532.

Roche, J.F. 1974. Synchronization of oestrus and fertility following artifical insemination in heifers given prostaglandin $F_{2\alpha}$. J. Reprod. Fert. 37:135.

Roche, J.F. 1976. Fertility of cows after treatment with a prostaglandin analogue with or without progesterone. J. Reprod. Fert. 46:341.

Roche, J.F. and D.J. Prendiville. 1979. Control of estrus in dairy cows with a synthetic analogue of prostaglandin F_2 alpha. Theriogenology 11:153.

Rowson, L.E.A., R.Tervit and A. Brand. 1972. The use of prostaglandins for synchronization of oestrus in cattle. J. Reprod. Fert. 29:145 (Abstr.).

Schams, D., E. Schallenberger, B. Hoffman and H. Karg. 1977. The oestous cycle of the cow: hormonal parameters and time relationships concerning oestrus, ovulation, and electrical resistance of the vaginal mucus. Acta Endocrinologica 86:180.

Schams, D. and H. Karg. 1982. Hormonal responses following treatment with different prostaglandin analogues for estrous cycle regulation in cattle. Theriogenology 17:499.

Seguin, B.L., B.K. Gustafsson, J.P. Hurtgen, E.C. Mather, K.R. Refsal, R.A. Wescott and H.L. Whitmore. 1978. Use of the prostaglandin $F_{2\alpha}$ analog cloprostenol (ICI 80, 996) in dairy cattle with unobserved estrus. Theriogenology 10:55.

Swanson, L.V., H.D. Hafs and D.A. Morrow. 1972. Ovarian characteristics and serum LH, prolactin, progesterone and glucocorticoids from first estrus to breeding size in hostein heifers. J. Anim. Sci. 34:284.

Tervit, H.R., L.E.A. Rowson and A. Brand. 1973. Synchronization of oestrus in cattle using a prostaglandin $F_{2\alpha}$ analogue (ICI 79939). J. Reprod. Fert. 34:179.

Young, I.M. and D.C. Henderson. 1981. Evaluation of single and double artificial insemination regimes as methods of shortening calving intervals in dairy cows treated with dinoprost. Vet. Rec. 109:446.

Zemjanis, R., M.L. Fahning and R.H. Schultz. 1969. Anestrus the practitioner's dilemma. Vet. Scope 14:15.

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INTRODUCTION

Calving-to-conception intervals longer than 120 days are an economical liability to dairymen. As calving intervals increase, maximum milk yield per day of calving interval decreases (Speicher and Meadows, 1967). Maximum milk production per day of calving interval is achieved when calving intervals are about 365 days (Call, 1978). Failure to detect estrus is the primary cause for those prolonged intervals to conception (Lauderdale, 1974; Barr, 1975). Dairymen lose 40.3 days of calving interval per cow per year because 53% of estrous periods go undetected (Barr, 1975). Missed estrous periods often occur in cows with delayed intervals to first service and after inseminations of cows that fail to conceive.

Prostaglandin $F_{2\alpha}$ (PGF) and its analogues have proven useful as luteolytic agents (Schams and Karg, 1982). PGF could be a potential solution for dealing with cows with unobserved estrus. Inducing luteolysis with PGF for inseminations by appointment or at estrus should help reduce days open and thereby shorten calving intervals to increase milk production per day of calving interval. The objective of our study was to determine the effectiveness of using PGF to induce estrus and to reduce days open in cycling lactating dairy cows with unobserved estrus.

MATERIALS AND METHODS

Two experiments were conducted in 16 Kansas dairy herds and in the Kansas

State University (KSU) herd ranging in size from 40 to 200 cows. Criteria for selecting dairy herds required: 1) enrollment in the Dairy Herd Improvement Association (DHIA), and 2) a herd health program which included a cooperating relationship with a veterinarian who made regular postpartum uterine and pregnancy examinations at biweekly or monthly intervals. The distribution of cows utilized in both experiments is shown in Table 1.

Experiment A (Expt. A)

Dairy cows not inseminated by approximately 60 days postpartum because of unobserved estrus were presented for veterinary examination at a routine herd visit. Those cows with a palpable corpus luteum (CL) were assigned randomly to either a non-treated control group (n=85) or to a treatment group (n=138) that received (im) 25 mg prostaglandin $F_{2\alpha}$ (Lutalyse^{R}; dinoprost tromethamine). Blood was collected from all cows at treatment (0 h) by coccygeal venipuncture and mailed to KSU. In the KSU herd, additional blood was collected from 41 treated cows at 24 and 72 h after PGF to determine the proportion of cows with luteolysis. Blood was stored for 24 h at 5° C until serum was harvested by centrifugation. Serum was stored at -20° C until assayed by radioimmunoassay for progesterone (Stevenson et al., 1981). Serum progesterone at 0 h ($\geq$ 1 ng/ml) was the criterion for verifying a functional CL by ovarian palpation.

Treatment cows were artificially inseminated (AI) at estrus or by appointment at 72 and 96 h after PGF in the absence of estrus. Inseminations at 72 and 96 h were counted as one service. If estrus occurred after 96 h in cows inseminated by appointment, cows were re-inseminated according to routine procedures on that dairy for cows detected in estrus. Control cows were observed for estrus and inseminated accordingly. Control cows not observed in estrus during 4 wk after initial examination were reevaluated and eligible for PGF treatment at the discretion of the veterinarian and dairymen. Cows returning to estrus after

TABLE 1. Distribution of dairy cows assigned to Experiments A and B.

	Expt. A [a]		Expt. B [b]	
Herds	Control [c]	PGF	Control	PGF
KSU herd	40	92	23	26
Field herds [d]	45	46	16	20
Total	85	138	39	46

[a] Dairy cows with unobserved estrus ($\geq$ 60 days postpartum).

[b] Dairy cows diagnosed open at pregnancy examination (40 to 60 days post-AI).

[c] Ten control cows subsequently were treated with PGF about 4 wk after assignment to the control group.

[d] Sixteen cooperating Kansas dairy herds.

insemination were re-inseminated. Cows not returning to estrus were examined for pregnancy between 40 and 60 days post-AI.

Experiment B (Expt. B)

Cows with unobserved estrus after insemination and diagnosed open at pregnancy examination were assigned randomly to a control (n=39) or treatment group (n=46) if a palpable CL was present. Cows assigned for treatment received (im) 25 mg PGF. Blood was collected and inseminations were performed as described in Expt. A.

Data were analyzed in both experiments by least squares procedures using the General Linear Model procedure (Barr et al., 1979). Herd, treatment and herd x treatment effects were examined. Percentage data were tested by chi-square.

RESULTS

Expt. A

Intervals from parturition to treatment, estrus, first service and conception are shown in Table 2. In no case were there significant (P>.05) interaction effects between herd and treatment. Postpartum interval to treatment was 21 days shorter (P<.01) in the control group. Reduced calving to treatment intervals in controls probably resulted from some bias introduced by the dairymen who opted for placing most recently calved cows in the control rather than in the treatment group. In addition, 10 cows initially assigned to the control group failed to show estrus during 4 wk and subsequently were assigned to PGF treatment at a later postpartum period. However, the difference in the postpartum interval to treatment was still evident when those 10 cows were excluded from the analysis. Despite this apparent bias, interval from calving to conception was similar for PGF-treated cows compared with controls (Table 2).

Intervals from treatment to estrus, first service, and conception were shorter

TABLE 2. Intervals (days) from parturition to treatment, estrus, first service and conception (Expt. A).

Item	Control	PGF[a]
Calving to treatment	73.1 ± 3.4	94.5 ± 2.6[b]
Calving to post-treatment estrus	94.5 ± 3.7	100.1 ± 3.3
Calving to first service	94.9 ± 4.0	97.8 ± 2.9
Calving to conception	130.8 ± 6.5	126.4 ± 4.8

[a] Prostaglandin $F_{2\alpha}$ (25 mg).

[b] $\underline{P} < .01$

($\underline{P}$<.01) for PGF than for control cows (Table 3). Estrous detection in the KSU herd indicated that estrus occurred 65.7 $\pm$ 2.1 h ($\bar{X}$ $\pm$ SE) after PGF. In all herds, PGF-treated cows exhibited estrus approximately 3 days after treatment. PGF-treated cows that showed estrus (54%) were observed in estrus on or before 3 days after PGF (n=75) while 8, 3 and 1 cows exhibited estrus by 4, 6 and 7 days post-PGF, respectively. PGF cows were inseminated sooner after treatment than control cows (2.9 $\pm$ .9 vs 23.4 $\pm$ 1.2 days). Although PGF cows were further postpartum than were controls at treatment, conception occurred 22 days earlier ($\underline{P}$<.01) for PGF-treated cows than for controls. In this experiment, 75 cows were inseminated at estrus and 58 cows were inseminated by appointment. Six cows were not re-inseminated again at 96 h according to the protocol.

A higher proportion (97%, $\underline{P}$<.001) of treated cows were inseminated at estrus 2 to 5 days after treatment compared with control cows (10%, Figure 1). More ($\underline{P}$<.001) PGF-treated cows (99%) showing estrus were inseminated within 2 to 25 days while only 52% of control cows were inseminated within 25 days post-treatment. Because more treated cows were inseminated earlier than control cows, there was a tendency ($\underline{P}$=.12) for more treated cows than control cows to conceive 2 to 5 days after treatment (45 vs 14%; Figure 1). When the period was extended to 25 days, 49% PGF cows conceived compared with 28% control cows ($\underline{P}$<.05). An additional 21 cows inseminated at 72 and 96 h after PGF in the absence of estrus conceived 2 to 5 days after treatment (Figure 1).

First service conception was similar in control and PGF cows (Table 4). Conception rate of cows inseminated at estrus was not different between treatment groups. However, PGF-treated cows tended to have higher conception rates (45 vs 39%) when inseminated at estrus. Cows inseminated by appointment had similar conception rates (40%) when compared with control cows inseminated according to estrus (39%). Total services per conception or per cow and total pregnancy rate

TABLE 3. Reproductive performance of dairy cows treated with PGF for unobserved estrus (Expt. A)[a].

Item	Control	PGF[b]
Treatment to post-treatment estrus	23.1 $\pm$ 1.4	3.1 $\pm$ 1.2[c]
Treatment to first service	23.4 $\pm$ 1.2	2.9 $\pm$ .9[c]
Treatment to conception	59.3 $\pm$ 5.8	37.2 $\pm$ 4.3[c]

[a] Least square means $\pm$ standard error (days).

[b] Prostaglandin $F_{2\alpha}$ (25 mg).

[c] $\underline{P} < .01$

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

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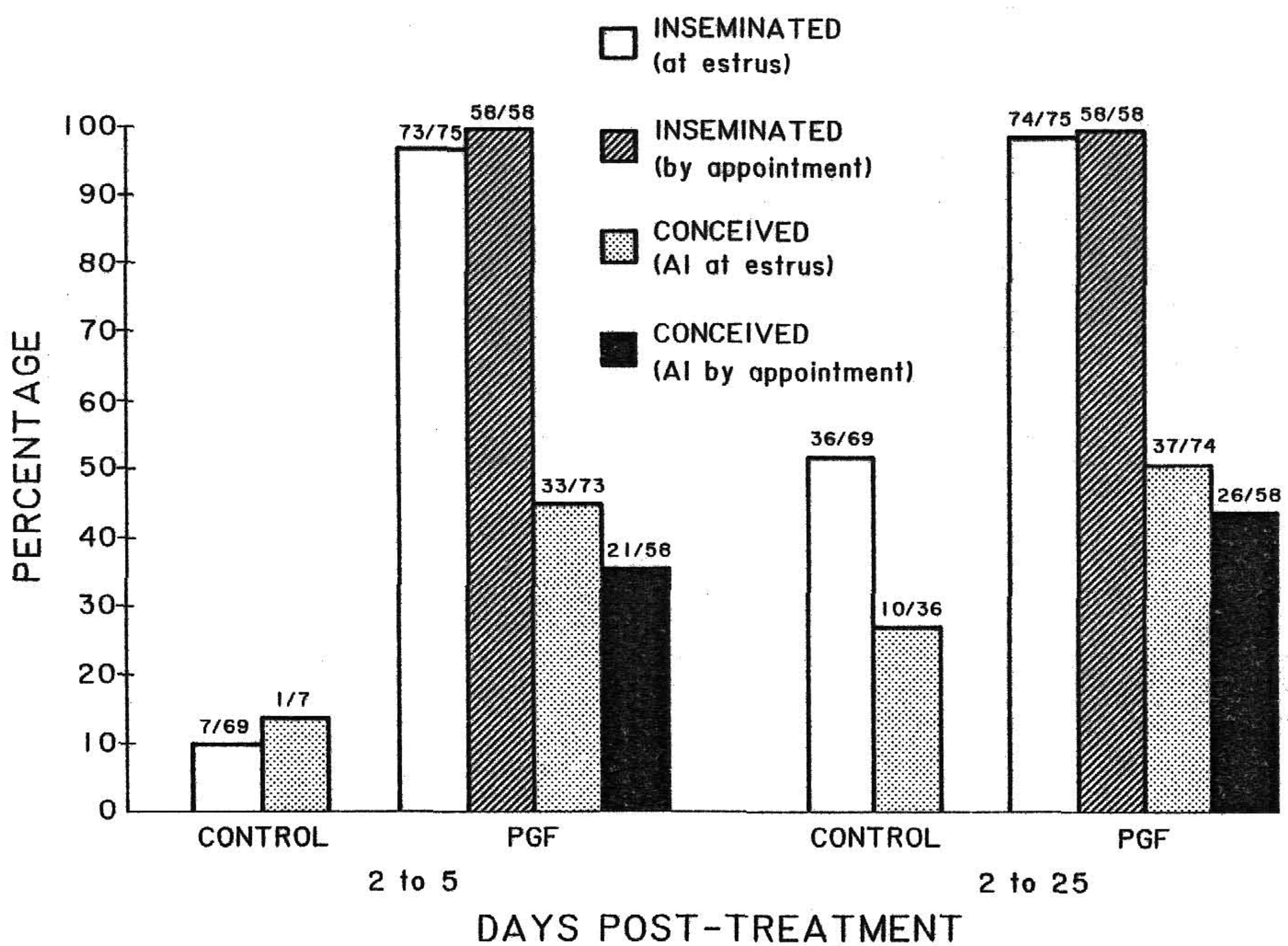

Figure 1. Percentage of control and PGF-treated cows inseminated at estrus or by appointment and pregnant from 2 to 5 and 2 to 25 days post-treatment (Expt. A).

TABLE 4. Fertility in dairy cows after PGF treatment for unobserved estrus (Expt. A).

Item	Control	PGF
First service conception, %	39 (27/69)	43 (57/133)
By estrus, %	39 (27/69)	45 (34/75)
By appointment (72 and 96 h), %	- -	40 (23/58)
Total services/conception[a]	1.91 $\pm$ .1	1.88 $\pm$ .1
Total services/cow[a]	1.98 $\pm$ .1	1.95 $\pm$ .1
Total pregnancy rate[b], %	88.4 (61/69)	85.7 (114/133)

[a] Appointment inseminations (72 and 96 h) were counted as one service.

[b] Total pregnancy rate = Number of cows conceived/number of cows inseminated.

were similar in control and treated cows (Table 4). Status of cows assigned to this experiment that failed to conceive is shown in Table 5. Similar proportions of control (11/85, 13%) and PGF-treated (22/138, 16%) cows were removed from herds for various reasons.

Expt. B

In no case were there any significant ($\underline{P}\geq.05$) herd X treatment interactions for Expt. B. Intervals from parturition to treatment, estrus, first service and conception were similar for PGF cows compared with controls (Table 6). Although no difference was observed in the interval from calving to post-treatment estrus, interval from treatment to post-treatment estrus was shorter ($\underline{P}<.01$) for PGF cows compared with controls (Table 7). More importantly, time from treatment to conception was 16.5 days shorter ($\underline{P}<.15$) for PGF cows than for control cows. Five cows were in estrus from days 4 to 7 post-treatment while the remainder was in estrus by 3 days (41%). In the KSU herd, cows were in estrus 65.8 $\pm$ 4 h after PGF. Nineteen cows and 23 cows were inseminated at estrus and by appointment, respectively. Three cows failed to be re-inseminated at 96 h. One cow inseminated at 96 h was not inseminated at 72 h.

A greater proportion ($\underline{P}<.001$) of treated cows (90%) were inseminated at estrus from 2 to 5 days after PGF compared with control cows (16%, Figure 2). An additional 6% PGF cows and 49% control cows were inseminated by 25 days. Pregnancy rate was similar in PGF and control cows inseminated from 2 to 5 days after treatment (Figure 2). However, pregnancy rate from 2 to 25 days after treatment tended to be higher ($\underline{P}<.20$) in control than in PGF cows (60 vs 39%) inseminated at estrus. However, 48% of treated cows had conceived (estrus and appointment) by 25 days post-treatment compared with 60% of control cows. By inseminating cows that did not show estrus at 72 and 96 h after treatment, an additional 12 cows conceived by 5 days (Figure 2).

TABLE 5. Status of assigned dairy cows that failed to conceive (Expt. A).

Item	Control	PGF
Retained in herd	3	2
Removed from herd	11	22
Low production	2	7
Reproductive failure	2	10
Mastitis or udder problems	3	3
Injury or death	4	2
Proportion of cows removed (%)	11/85 (13)	22/138 (16)

TABLE 6. Intervals (days) from parturition to treatment, estrus, first service and conception (Expt. B).

Item	Control	PGF[a]
Calving to treatment	152.4 $\pm$ 10.1	158.3 $\pm$ 9.3
Calving to post-treatment estrus	169.6 $\pm$ 11.2	168.3 $\pm$ 12.7
Calving to first service	168.2 $\pm$ 12.1	165.0 $\pm$ 10.4
Calving to conception	188.9 $\pm$ 14.8	195.8 $\pm$ 12.8

[a] Prostaglandin $F_{2\alpha}$ (25 mg).

TABLE 7. Reproductive performance of dairy cows treated for unobserved estrus (Expt. B)[a].

Item	Control	PGF[b]
Treatment to post-treatment estrus	19.6 $\pm$ 2.3	3.3 $\pm$ 2.6[c]
Treatment to first service	20.5 $\pm$ 1.9	3.0 $\pm$ 1.7[c]
Treatment to conception	45.6 $\pm$ 8.5	29.1 $\pm$ 7.3

[a] Least square means $\pm$ standard error (days).

[b] Prostaglandin $F_{2\alpha}$ (25 mg)

[c] $\underline{P} < .01$

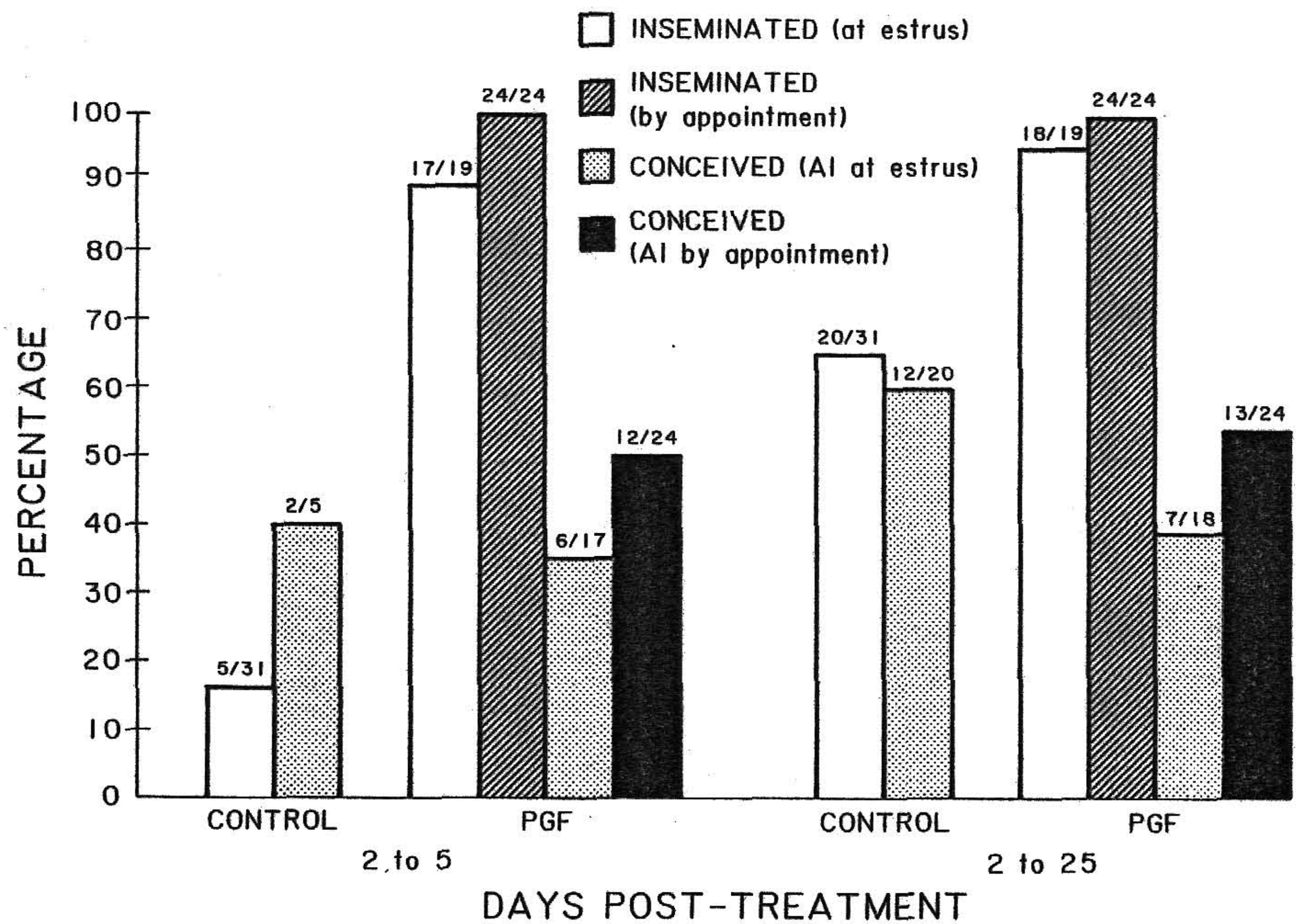

Figure 2. Percentage of control and PGF-treated cows inseminated at estrus or by appointment and pregnant from 2 to 5 and 2 to 25 days post-treatment (Expt. B).

First service conception was similar in both groups (Table 8). Cows inseminated by appointment tended to have higher ($\underline{P}$<.16) conception rates than cows inseminated at estrus after PGF (54 vs 32%). Total services per conception or per cow and total pregnancey rate were similar in both treatment groups (Table 8). Status of cows that failed to conceive throughout Expt. B is shown in Table 9. In all herds combined, a higher proportion ($\underline{P}$<.05) of cows eventually were removed from the control (12/39, 31%) than from the PGF group (5/46, 11%).

Serum progesterone concentrations at PGF treatment for KSU cows from both experiments are illustrated in Figure 3. Changes in the pattern of progesterone concentrations at 0, 24 and 72 h after treatment for cows responding to PGF and for cows that failed to undergo luteolysis were different. Serum progesterone was lower ($\underline{P}$<.05) at 24 and 72 h than at 0 h in cows that underwent luteolysis, but progesterone initially declined ($\underline{P}$<.05) from 0 to 24 h and then increased to pretreatment concentrations by 72 h in cows that failed to respond to PGF. Niney-one percent of the KSU cows responded to PGF while 9% failed to respond as determined by serum progesterone concentrations at 0, 24 and 72 h. Palpation error (cows with progesterone concentrations less than 1 ng/ml at 0 h) occurred in 4.5% of the cows. First service conception rate was 43% in cows responding to PGF, 0% in cows failing to respond and 33% in cows where palpation error occurred. Mean progesterone concentrations at 0, 24 or 72 h after PGF were not different for cows conceiving and not conceiving at first service.

Milk yield had no effect on the interval to estrus after PGF (r=.06), although milk yield tended to be greater ($\underline{P}$=.32) on day of PGF treatment in cows inseminated by appointment in absence of detected estrus than in cows inseminated at estrus. Therefore, possible stress due to high milk yield did not appear to influence the expression of estrus for those cows not detected in estrus after PGF.

TABLE 8. Fertility in dairy cows with unobserved estrus (Expt. B).

Item	Control	PGF
First service conception, %	52 (16/31)	44 (19/43)
By estrus, %	52 (16/31)	32 (6/19)
By appointment (72 and 96 h), %	—	54 (13/24)
Total services/conception[a]	1.73 $\pm$ .19	1.63 $\pm$ .17
Total services/cow[a]	1.74 $\pm$ .18	1.65 $\pm$ .16
Total pregnancy rate[b], %	83.9 (26/31)	81.4 (35/43)

[a] Appointment inseminations were counted as one service.

[b] Total pregnancy rate = Number of cows conceived/number of cows inseminated.

TABLE 9. Status of assigned dairy cows that failed to conceive (Expt. B).

Item	Control	PGF
Retained in herd	1	6
Removed from herd	12	5
Low Production	5	3
Reproductive failure	5	1
Mastitis or udder problems	1	1
Injury or death	1	0
Proportion of cows removed (%)	12/39 (31)	5/46 (11)[a]

[a] $\underline{P} < .05$

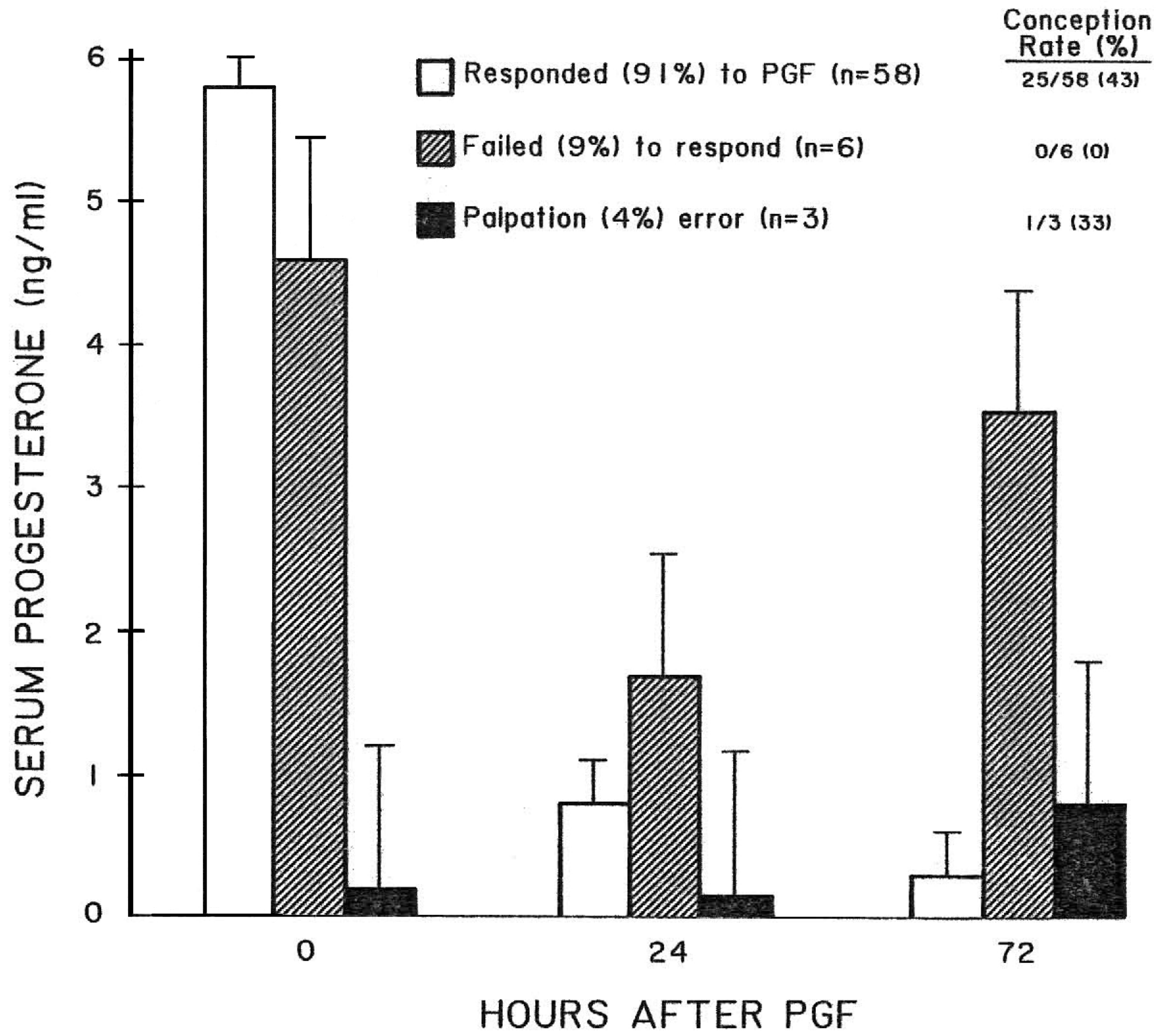

Figure 3. Mean serum progesterone concentrations in PGF-treated cows from the KSU herd (Expt. A and B`

DISCUSSION

These results indicate that conception intervals can be reduced when cycling dairy cows with previously unobserved estrus are treated with PGF. A reduction of 22 days in Expt. A and 16.5 days in Expt. B for PGF cows compared to non-treated cows on commercial dairy farms demonstrates that PGF treatment is effective for reducing lengthy calving intervals. Young and Henderson (1981) also observed shorter calving intervals in cows treated with PGF compared with controls.

Success of these two experiments was dependent upon accurate assessment of a functional CL as verified by serum progesterone ($\geq$1 ng/ml) at treatment. Accuracy of CL detection was 96% and similar to that reported by Seguin et al. (1978). Patterns of progesterone for cows responding to PGF were similar to those reported for diestrous heifers (Louis et al., 1973; Schams and Karg, 1982) and for lactating cows (Louis et al., 1974; Hafs et al., 1974; Lamming et al., 1975; Renegar et al., 1978). Progesterone concentrations in cows (n=6) that failed to respond indicated that PGF had a suppressing effect on CL secretion of progesterone but failed to be luteolytic. These cows could have been early diestrus and less prone to respond to PGF (King et al., 1982).

More than one-half (54%) of the treated cows in Expt. A exhibited estrus by 3 days after PGF. Those data confirm previous reports in dairy cows (Lauderdale, 1974; Chupin et al., 1977; Macmillan et al., 1980). By 7 days following treatment, 63% of cows in Expt. A had exhibited estrus and 52% in Expt. B. These data are similar to those of Hafs et al. (1975) for suckled beef cows. Cows exhibiting estrus 5 to 10 days after treatment appear to represent a delayed response to PGF and are preceded by PGF-induced luteolysis (Macmillan, 1978).

Proportion of treated cows in Expt. A that were inseminated at estrus and conceived from 2 to 5 days after treatment were greater than for controls. Those results are similar to previous observations (Seguin et al., 1978). Pregnancy rate from 2 to 25 days post-PGF for treated cows also was higher than for controls. However, Seguin et al. (1978) reported no difference in pregnancy rate from 2 to 21 days after treatment in treated and control cows. Treated cows were inseminated sooner than control cows in Expt. B but conception from 2 to 5 days after treatment was not different between the two groups. However, conception from 2 to 25 days after treatment tended to be higher in control cows compared with treated cows. The difference may be due to fewer observations in Expt. B than in Expt. A.

Fertility being similar in control and PGF-treated cows in both experiments was consistent with other studies (Lauderdale et al., 1974; Roche, 1976; Hafs et al., 1978; Seguin et al., 1978). Cows inseminated by appointment had similar conception to that of cows inseminated at estrus in Expt. A. However, the reverse tended to be true for cows in Expt. B. Fertility of other cattle inseminated at predetermined intervals after PGF was equivalent to that of controls (Hafs et al., 1975). In contrast, dairy and beef cows inseminated by appointment had higher conception rates than those inseminated after estrous detection (Lambert et al., 1976; Seguin et al., 1978). Results of Expt. A are comparable for beef (Donaldson, 1977) and dairy cows (Leaver et al., 1976) inseminated by appointment. Lower fertility in cows inseminated by appointment could be due to the variation in post-treatment interval to estrus (Roche and Prendiville, 1979; Macmillan et al., 1980). This could explain the difference in fertility for cows inseminated by appointment between experiments. However, differences in fertility for treated cows inseminated by appointment compared with treated cows inseminated at estrus cannot be explained. It is likely that cows inseminated by appointment are in true estrus but fail to express strong symptoms (standing and mounting) of estrus. Futhermore, it has been demonstrated that one of three cows conceived when inseminated following detection of weak estrous (mucus, bawling, or appearance) symptoms (Stevenson et al., 1983).

Fertility tended to be similar in PGF-treated cows when inseminated at estrus or by appointment in the absence of detected estrus. To increase pregnancy rates, it was important to inseminate all cows after PGF whether observed in estrus or not because only 54 and 41% of the cows were detected in heat in Expt. A and B, respectively. Appointment inseminations increased the number of cows pregnant by 21 (36%) in Expt. A and by 12 (50%) in Expt. B between 2 and 5 days post-PGF. These 33 cows would not have been inseminated or conceived as soon after treatment if not inseminated by appointment at 72 and 96 h post-PGF in the absence of detected estrus.

Dairy herds utilizing a routine herd health program with regular veterinary visits (biweekly or monthly) could incorporate PGF treatments into their management routine. These results indicate that PGF is an effective treatment for cycling cows with unobserved estrus, providing a functional CL is present at treatment. This treatment was effective for cows with unobserved estrus early postpartum (Expt. A) as well as for open cows with unobserved estrus after insemination (Expt. B). The treatment advantage includes an earlier conception postpartum and an increase in the pregnancy rate 2 to 5 days after PGF treatment.

Lengthy calving intervals result from problems associated with unobserved estrus as well as infertility. Barr (1975) demonstrated that missed estrous periods were correlated more highly with calving intervals (r=.92) than with the failure of cows to conceive (r=.38). Therefore, PGF treatment for unobserved estrus should be successful in not only reducing days open (or calving intervals) but also effective for reducing the range or variation in those intervals. Cows with unobserved estrus such as those used in these studies are the primary causes of lengthy calving intervals. Therefore, PGF treatment offers an alternative to handle those problem cows with long open periods.

REFERENCES

Barr, H.L. 1975. Influence of estrus detection on days open in dairy herds. J. Dairy Sci. 58:246.

Barr, A.J., J.H. Goodnight, J.P. Sau, W.H. Blair and D.M. Chilko. 1979. User's guide to SAS 1979. SAS Inst. Inc., Cary, NC.

Call, E.P. 1978. Economics associated with calving intervals. Page 190 in Large Herd Dairy Management, C.J. Wilcox, ed. Univ. Presses of Florida, Gainesville.

Chupin, D., J. Pelot and P. Mauleon. 1977. Control of estrus and ovulation in dairy cows. Theriogenology 7:339.

Donaldson, L.E. 1977. Synchronisation of oestrus in beef cattle artificial breeding program using prostaglandin $F_{2\alpha}$. Australian Vet. J. 53:72.

Hafs, H.D., T.M. Louis, P.A. Noden and W.D. Oxender. 1974. Control of the estrous cycle with prostaglandin $F_{2\alpha}$ in cattle and horses. J. Anim. Sci. 38(Suppl. I):10.

Hafs, H.D., J.G. Manns and B. Drew. 1975. Onset of oestrus and fertility in dairy heifers and suckled beef cows treated with prostaglandin $F_{2\alpha}$. Anim. Prod. 21:13.

Hafs, H.D., J.G. Manns and P.D.P. Wood. 1978. Fertility of heifers and suckled cows inseminated at predetermined intervals after treatment with prostaglandin $F_{2\alpha}$. J. Agric. Sci. 91:479.

King, M.E., G.H. Kiracofe, J.S. Stevenson and R.R. Schalles. 1982. Effect of stage of the estrous cycle on interval to estrus after $PGF_{2\alpha}$ in beef cattle. Theriogenology 18:191.

Lambert, P.W., W.M. Greene, J.D. Strickland, D.K. Han and E.L. Moody. 1976. $PGF_{2\alpha}$ controlled estrus in beef cattle. J. Anim. Sci. 42:1565 (Abstr.).

Lamming, G.E., H.D. Hafs and J.G. Manns. 1975. Hormonal control of reproduction in cattle. Anim. Prod. 4:71.

Lauderdale, J.W. 1974. Estrus detection and synchronization of dairy cattle in large herds. J. Dariy Sci. 57:348.

Lauderdale, J.W., B.E. Seguin, J.N. Stellflug, J.R. Chenault, W.W. Thatcher, C.K. Vincent and A.F. Loyancano. 1974. Fertility of cattle following $PGF_{2\alpha}$ injection. J. Anim. Sci. 38:964.

Leaver, J.D., P.M. Mulvany, R.G. Glencross and G.S. Pope. 1976. Synchronization of oestrus in dairy cattle with a prostaglandin analogue (ICI 80:996). Anim. Prod. 22:145 (Abstr.).

Louis, T.M., H.D. Hafs and B.E. Seguin. 1973. Progesterone, LH, estrus and ovulation after prostaglandin $F_{2\alpha}$ in heifers. Proc. Soc. Exp. Biol. Med. 143:152.

Louis, T.M., H.D. Hafs and D. A. Morrow. 1974. Intrauterine administration of prostaglandin $F_{2\alpha}$ in cows: progesterone, estrogen, LH, estrus and ovulation. J. Anim. Sci. 38:347.

Macmillan, K.L. 1978. Oestrus synchronisation with a prostaglandin analogue III. Special aspects of synchronisation. New Zealand Vet. J. 26:104.

Macmillan, K.L., A.M. Day and J.F. Smith. 1980. Onset of oestrus and fertility in lactating dairy cows injected with an analogue of prostaglandin $F_{2\alpha}$, cloprostenol. Anim. Reprod. Sci. 3:171.

Renegar, R.H., H.D. Hafs, J.H. Britt and T.D. Carruthers. 1978. Luteolysis, growth hormone, glucocorticoids, prolactin and milk production in lactating dairy cows given $PGF_{2\alpha}$. J. Anim. Sci. 47:532.

Roche, J.F. 1976. Fertility in cows after treatment with prostaglandin analogue with or without progesterone. J. Reprod. Fert. 46:341.

Roche, J.F. and D.J. Prendiville. 1979. Control of estrus in dairy cows with a synthetic analogue of prostaglandin F_2 alpha. Theriogenology 11:153.

Schams, D. and H. Karg. 1982. Hormonal responses following treatment with different prostaglandin analogues for estrous cycle regulation in cattle. Theriogenology 17:499.

Seguin, B.E., B.K. Gustafsson, J.P. Hurtgen, E.C. Mather, K.R. Refsal, R.A. Wescott and H.L. Whitmore. 1978. Use of the prostaglandin $F_{2\alpha}$ analogue cloprostenol (ICI 80, 996) in dairy cattle with unobserved estrus. Theriogenology 10:55.

Speicher, J.A. and C.E. Meadows. 1967. Milk production and costs associated with length of calving interval of holstein cows. J. Dairy Sci. 50:975 (Abstr.).

Stevenson, J.S., N.M. Cox and J.H. Britt. 1981. Role of ovary in controlling luteinizing hormone, follicle stimulating hormone and prolactin secretion during and after lactation in pigs. Biol. Reprod. 24:341.

Stevenson, J.S., M.K. Schmidt and E.P. Call. 1983. Estrous intensity and conception rates in holsteins. J. Dairy Sci. 66:275.

Young, I.M. and D.C. Henderson. 1981. Evaluation of single and double artificial insemination regimes as methods of shortening calving intervals in dairy cows treated with dinoprost. Vet. Rec. 109:446.

USE OF PROSTAGLANDIN $F_{2\alpha}$ IN LACTATING DAIRY COWS WITH A PALPABLE CORPUS LUTEUM BUT UNOBSERVED ESTRUS

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ABSTRACT

USE OF PROSTAGLANDIN $F_{2\alpha}$ IN LACTATING DAIRY COWS
WITH A PALPABLE CORPUS LUTEUM BUT UNOBSERVED ESTRUS

Two experiments were conducted in 17 dairy herds to determine the effectiveness of prostaglandin $F_{2\alpha}$ (treatment) for inducing estrus and reducing days open in cycling lactating dairy cows. Cows with unobserved estrus ($\geq$60 days postpartum) before first insemination (Experiment A) and cows with unobserved estrus after insemination and determined open by uterine palpation *per* rectum (Experiment B) were eligible for treatment if a corpus luteum was palpated. Cows in Experiment A were assigned randomly to either a non-treated control group (n=85) or to receive 25 mg prostaglandin $F_{2\alpha}$(n=138) after detection of a corpus luteum by ovarian palpation. Cows were inseminated either at estrus or at 72 and 96 h post-treatment in the absence of detected estrus. Intervals (mean $\pm$ SE) from treatment to estrus (23.1 $\pm$ 1.4 vs 3.1 $\pm$ 1.2 days), treatment to first service (23.4 $\pm$ 1.2 vs 2.9 $\pm$ .9 days) and treatment to conception (59.3 $\pm$ 5.8 vs 37.2 $\pm$ 4.3 days) were longer for controls than for treated cows, respectively. Although conception at first service was similar in controls (39%) and in treated (43%) cows, treated cows inseminated at estrus tended to have higher conception (45%) than did control cows (39%). Treated cows that showed estrus (54%) were observed in estrus on or before day 3 after prostaglandin $F_{2\alpha}$ (n=75). The remainder (n=58) did not show estrus and were inseminated at 72 and 96 h post-treatment. Similar procedures were followed for Experiment B. Intervals from treatment to estrus (19.6 $\pm$ 2.3 vs 3.3 $\pm$ 2.6 days) and treatment to first service (20.5 $\pm$ 1.9 vs 3.0 $\pm$ 1.7 days) were longer for control cows and treatment to conception (45.6 $\pm$ 8.5 vs 29.1 $\pm$ 7.3 days) tended to be

longer for controls (n=39) than for treated cows (n=46), respectively. Overall, conception at first service was similar in controls (52%) and treated (44%) cows. Treated cows (41%) exhibited estrus by day 3 following treatment (n=19). The remainder (n=24) did not show estrus before inseminations at 72 and 96 h after prostaglandin $F_{2\alpha}$. Results of these studies indicate that prostaglandin $F_{2\alpha}$ is an effective management tool for inducing corpus luteum regression and subsequent estrus. Successful treatment is dependent upon accurately diagnosing the presence of a functional corpus luteum. Days open are reduced in cows with previous unobserved estrus if treated cows are inseminated at estrus and by appointment in the absence of observed estrus.