Increasing pregnancy rates in New Zealand dairy cattle

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ABSTRACT

In a series of 10 trials involving over 5000 lactating dairy cows, animals inseminated when detected in oestrus from 3 days after an injection of a prostaglandin $F_2\alpha$ (PGF) had an average pregnancy rate of 68% compared to 59% in untreated herdmates. The variation in the post injection interval to oestrus necessitated detecting oestrus before the PGF-related fertility effect could be repeatedly demonstrated. When a synthetic analogue of gonadotrophin releasing hormone (GnRH) was injected before PGF in an attempt to reduce the variation in this injection-to-oestrus interval, the opposite effect occurred, the average interval was increased by 3 days (4.13 *v* 7.03) and the PGF-related fertility effect was eliminated. A second trial with GnRH confirmed that an injection of this hormone had an effect on the corpus luteum which prevented complete luteolysis by PGF. This interaction between GnRH and the corpus luteum was studied in 3 further trials in which GnRH was injected once at from 1 to 13 days post insemination. Positive fertility effects were observed in each trial, but they were not consistent. Nonetheless, the strategic use of these 2 types of hormones offer prospects for significantly increasing pregnancy rates to first insemination in lactating dairy cows.

INTRODUCTION

Hormonal therapy has been routinely used with varied success to treat cattle with reproductive disorders such as cystic ovarian structures, endometritis or pyometra, and post partum anoestrum. Normal reproductive processes can be modified also by the use of hormones which may alter the length of the oestrous cycle and consequently synchronise oestrus, increase the number of follicles which ovulate at an oestrus, abort an early pregnancy, or prematurely induce parturition in late pregnancy. These modifications may increase a herd's reproductive efficiency by reducing the effect of factors such as poor oestrus detection or a short post partum interval to first insemination.

The 'natural' fertility of cows in seasonal dairy herds in New Zealand is relatively high (Macmillan, 1979). Well managed, intensively stocked herds can maintain an average pregnancy rate to first insemination of over 65% (Macmillan and Clayton, 1980). Since this level of fertility is close to the physiologically 'normal' limit (Macmillan, 1973), future increases most likely will require the appropriate use of hormonal therapy which reduces the substantial losses of developing embryos occurring around 2 weeks after insemination and fertilisation (Bartol *et al.*, 1981).

Numerous hormonal procedures have been tested in many countries in attempting to increase pregnancy rates above physiologically 'normal' levels. None has been sufficiently successful to have become widely adopted in commercial herds. However, a series of trials in New Zealand with 2 types of hormone which have been synthesised only recently, produced results which unexpectedly showed that this elusive objective of increasing pregnancy rates in lactating dairy cows was possible.

MATERIALS AND METHODS

Friesian, Jersey or Friesian-Jersey crossbred animals in herds in the Waikato or Manawatu in which cows calved from mid July to mid September were used in a series of trials conducted in October and November of each year to study the effects of either prostaglandin $F_2\alpha$ (PGF) or gonadotrophin releasing hormone (GnRH) on pregnancy rates to first insemination. In most trials the experimental cows were treated at selected stages of the oestrous cycle, and were inseminated only after being detected in oestrus rather than at predetermined post treatment intervals. Oestrus detection procedures involving the use of tailpaint, insemination details and pregnancy testing routines have been described previously (Macmillan *et al.*, 1980).

Two forms of PGF were used: 25 mg of the tham salt of PGF injected i.m. ('Lutalyse'; Upjohn, USA); and 0.5 mg of the PGF analogue cloprostenol ('Estrumate'; ICI, UK). The GnRH was a synthetic analogue buserelin ('Receptal'; Hoechst, Germany) injected i.m. at either 5 or 10 mcg. Whereas a PGF injection was made during dioestrus in the cycle preceding the first insemination, GnRH treatments were also applied at selected post insemination intervals. Some general details for the 15 trials included in the series are summarised in Table 1.

TABLE 1 Injection and insemination programmes used in trials with 2 prostaglandins and a gonadotrophin releasing hormone.

Trial No.	Treatment	Insemination procedure	Number of herds	Year
1a	P[1]E[2]	72 + 96[6]	17	1974
b	PE	de[7]		
2	PE	72 + 98	3	1975
3	PE	72 + 96	9	1975
4	PE	72 + de	6	1976
5	PE	72 + de	1	1976
6	PE	de	9	1977
7	PE	de	1	1978
8	PE	de	6	1978
9	PL[3]	de	8	1980
10	R[4] + PL	de	8	1980
11	R (pre)[5]	de	7	1980
12	PL	de	8	1981
13	R (post)[5]	de	7	1981
14	PL + R (post)	de	8	1981
15	R (post)	de	12	1982

[1] Prostaglandin $F_2\alpha$.
[2] Estrumate.
[3] Lutalyse.
[4] Gonadotrophin releasing hormone—Receptal.
[5] Injected during the cycle preceding (pre) insemination or post insemination (post).
[6] Inseminated at 72 h and/or h post injection.
[7] Detected in oestrus before insemination.

In some trials, the control group of cows comprised randomly selected animals which were similar to the experimental group but were injected with sterile saline solution as a placebo. In other trials, the control group comprised untreated cows inseminated either on the same days as their treated herdmates or during the first 3 weeks of a herd's seasonal inseminating programme.

RESULTS AND DISCUSSION

The objectives of the initial PGF trials were:
(i) to assess the feasibility of using these hormones to substantially reduce or even eliminate the need for oestrus detection in comparatively large seasonal dairy herds; and
(ii) to study the consequences of further condensing a seasonally concentrated calving pattern in these herds.

While substantial changes in calving pattern were achieved (Macmillan and Curnow, 1976), the need for oestrus detection was not eliminated because of the variation in the post injection interval to oestrus (Macmillan, 1978). Oestrus detection was often more difficult when larger numbers of cows were in oestrus simultaneously. These detection problems were mostly overcome with the associated development of tail-painting (Macmillan and Curnow, 1977). These conclusions were derived from the first 5 trials (Table 1).

The later PGF trials were designed:
(i) to identify factors which were contributing to the observed variation in the post injection interval to oestrus; and
(ii) to evaluate alternative systems based on single PGF injection programmes.

Since all these trials involved detection of oestrus before insemination, fertility effects associated with the oestrus occurring after the PGF-induced luteolysis could be identifed. Data from the initial trials were also re-analysed but only included cows diagnosed in oestrus during a 24 h period preceding a set time insemination.

The results in Table 2 clearly demonstrate a beneficial fertility effect associated with the use of PGF. The only trial in which this advantage was not obtained (Trial 4) was one in which semen processed using an experimental technique was used to inseminate cows in the PGF group (Macmillan *et al.*, 1977). In most of the trials the 'untreated' cows had pregnancy rates to first insemination of around 60%. This is a comparatively high level of fertility and supports previous conclusions about the high reproductive rates of New Zealand dairy cows (Macmillan, 1979). Under these conditions, the strategic use of PGF in conjunction with effective oestrus detection can increase pregnancy rates to first insemination by around 10%.

TABLE 2 Pregnancy rates to first insemination among cows treated with prostaglandin $F_2\alpha$ (PGF) and detected in oestrus before insemination compared with untreated herdmates.

Trial No.	PGF treated n	PGF treated % pregnant	Untreated n	Untreated % pregnant	Difference %
1a	74	74	182	53	+ 14
b	67	60			
2	156	73	239	62	+ 11
3	149	74	572	62	+ 12
4	468	56	329	65	− 9
5	135	69	141	62	+ 7
6	297	73	167	63	+ 10
7	279	62	84	44	+ 18
8	343	75	375	67	+ 8
9	233	72	824	60	+ 12
12	416	62	299	52	+ 10
Total or Average	2338	68	3212	59	+ 9

The reason for the PGF fertility effect has not been elucidated but may be associated with the rapidity of the induced luteolysis and consequent decline in plasma progesterone (Macmillan *et al.*, 1980). This effect could be more conveniently exploited if the precision of synchrony in oestrus after PGF treatment

TABLE 3 Pregnancy rates to first insemination among cows treated with gonadotrophin releasing hormone (GnRH) and/or prostaglandin $F_2\alpha$ (PGF) during the cycle preceding insemination.

Trial No.	Treatment sequence: Saline + PGF n	% pregnant	GnRH + PGF n	% pregnant	Untreated n	% pregnant
10	233	71.7	251	61.4	824	60.3

	GnRH n	% pregnant	Untreated n	% pregnant
11	260	66.9	896	65.0

could be improved. One attempt to achieve greater precision was tested in Trial 10 when cows in dioestrus were injected with GnRH (5 mcg Receptal) or saline at 0.25, 24 or 72 h before PGF. The GnRH was expected to release a single surge of LH and FSH from the anterior pituitary gland. The gonatrophins would stimulate ovarian follicle development and consequently improve the synchrony in oestrus after a PGF injection when follicle maturation was most rapid. The results in Fig. 1 show that the opposite effect occurred, and the average interval from a PGF injection to oestrus was increased from 4.13 to 7.03 days ($P < 0.01$) in the cows pre treated with

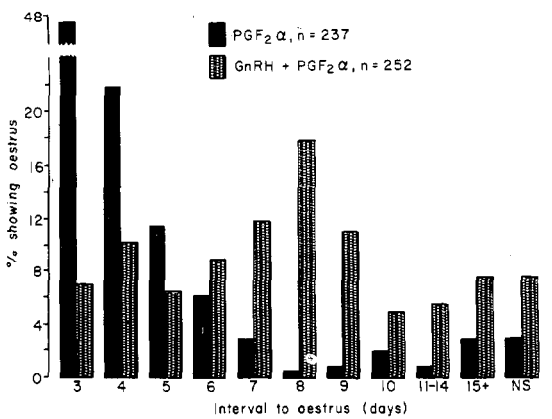

FIG. 1 Post injection intervals to oestrus among cows injected with prostaglandin $F_2\alpha$ (PGF) or gonadotrophin releasing hormone (GnRH) and PGF.

GnRH. This pre treatment had temporarily prevented the complete luteolysis of the corpus luteum by the exogenous PGF. One consequence of this action was that the PGF fertility effect observed in the cows which received a saline placebo instead of GnRH (Trial 9, Table 2) was eliminated (Table 3). The interactions between GnRH, the corpus luteum and endogenous PGF were demonstrated also in Trial 11 in which cows were injected once with GnRH when at days 12 to 16 of the oestrous cycle preceding insemination (Table 1). The GnRH injection altered the average length and the variation of these cycles (Macmillan and Taufa, 1981) because of the effect on the corpus luteum but this effect was not associated with any alteration in fertility (Table 3).

While this GnRH-induced effect on the corpus luteum was not beneficial when applied during the cycle preceding insemination (Table 3), post insemination treatment effects could differ. Moller and Fielden (1981) found that a GnRH injection from zero to 6 h before insemination increased pregnancy rates by over 9%. This effect was not simply due to a reduced incidence in delayed ovulations (Fielden and Moller, 1983). In Trials 13 and 14 cows in the experimental groups were injected once with GnRH (5 mcg Receptal) or saline from 1 to 10 days post insemination. PGF was used during the cycle preceding insemination in Trial 14. Both trials produced similar results (Table 4). Whereas a GnRH injection from 1 to 6 days post insemination reduced pregnancy rates, an increase resulted if the treatment was applied from 7 to 10 days post insemination.

Trial 15 was designed to confirm this latter effect, to extend the post insemination interval to injection to 13 days and to evaluate the usually recommended dose rate of 10 mcg of Receptal (twice the previously used experimental dose). The results in Table 5 show these objectives were only partly achieved as the lower dose rate did not alter pregnancy rates when injected at from 7 to 13 days post insemination (58.1% *v* 63.0%; $\chi^2_1 = 1.872$, $P > 0.10$). In contrast, the 10 mcg dose rate produced an interaction involving the post insemination interval ($\chi^2_1 = 4.89$; $P < 0.95$) largely due to a pregnancy rate of 75.4% among cows treated with GnRH from 11 to 13 days post insemination (Table 5).

These trials with GnRH have not produced effects on pregnancy rates which are as consistent as those with PGF (Tables 2, 3, 4 and 5). An extended series of trials similar to that completed with PGF may be necessary to identify beneficial effects on pregnancy rates from GnRH treatments.

TABLE 4 Pregnancy rates to first insemination among cows injected with gonadotrophin releasing hormone (GnRH) from 1 to 10 days post insemination.

Post-insemination interval (d)		Trial 13			Trial 14		
		GnRH	Saline	Difference	GnRH	Saline	Difference
1 to 3	%	54.5	71.0	− 16.5	68.4	73.1	− 4.7
	n	66	69		57	52	
4 to 6	%	61.2	69.7	− 8.5	64.7	75.5	− 10.8
	n	85	89		51	53	
7 to 10	%	77.1	63.9	+ 13.2	72.9	66.1	+ 6.8
	n	96	83		48	56	
1 to 10	%	65.6	68.0	− 2.4	68.6	71.4	− 2.8
	n	247	241		156	161	

It is possible that the pregnancy effects obtained from the strategic use of PGF (Table 2) and GnRH (Table 4; Fielden and Moller, 1983) may be additive. For example, the herds included in Trials 12 and 14 (Table 1) included cows injected with saline, PGF alone or PGF + GnRH. The pregnancy rates for cows which could be compared with those injected once with GnRH from 7 to 10 days post insemination were 56.8% (saline), 66.1% (PGF) and 72.9% (PGF + GnRH) respectively.

Until hormone treatments successfully produce precise synchrony in oestrus, the accurate detection of oestrus will remain an important requirement for the effective exploitation of other treatment programmes which may increase pregnancy rates above those normally obtained in well executed breeding programmes. Even if precise oestrus synchrony is achieved, the detection of oestrus may still be desirable in order to monitor expected responses. The extent to which fertility effects obtained from the strategic use of PGF and GnRH are exploited in commercial herds will depend on a variety of factors including the cost and inconvenience associated with the use of the therapy, the value of the cow or her production and the predicted value of the potential progeny.

TABLE 5 Pregnancy rates to first insemination among cows injected with 5 or 10 mcg of Receptal (GnRH) from 7 to 13 days post insemination (Trial 15).

Treatment	Days post insemination 7 to 10		11 to 13	
	n	% pregnant	n	% pregnant
5 mcg GnRH	219	60.3	18	
saline	232	62.9	195	63.1
10 mcg GnRH	196	60.7	142	75.4
saline	189	67.2	161	66.3

It is probable that the fertility effects of PGF and GnRH are the consequence of altered corpus luteum function which, in turn may enhance the chances of implantation. If this hypothesis is substantially correct, then similar fertility effects to those observed in dairy cattle in these and related trials could be obtained in other domesticated mammals.

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