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Developments in artificial insemination and controlled breeding in dairy cattle and deer in New Zealand

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ABSTRACT

Artificial insemination (AI) is widely used throughout New Zealand dairy herds because it is convenient and allows herd owners to utilise semen from intensively selected genetically superior sires. The future focus of AI use will be to synchronise oestrus in maiden heifers and cows to further concentrate seasonal calving patterns. There will also be continued use of progesterone-based treatments to stimulate ovarian activity in anoestrous cows and to increase pregnancy rates in inseminated cows.

Aspects of behaviour and marked seasonality in red deer and fallow deer currently present challenges to increasing the use of AI and controlled breeding in these species. It would be preferable to have fawning/calving in spring instead of summer, with or without the use of AI. However, the semen production of stags is best from 4 weeks after the onset of the induced or normal rut. This potentially increases the dependence on deep frozen semen and increases the need for the uterine deposition of sperm to increase sire coverage and achieve satisfactory pregnancy rates. Controlled use of hormones will produce altered calving/fawning dates and developing semen collection/processing techniques will increase the use of AI in deer.

Keywords Dairy cattle, red deer, fallow deer, artificial breeding, seasonality, anoestrus, controlled breeding.

INTRODUCTION

The separate development of artificial insemination (AI) in New Zealand in dairy cattle and in deer presents some interesting comparisons in relation to the future use of reproductive technologies in these species. The practical application of artificial insemination in both species has involved extensive original research to develop or to adapt reproductive technology to meet requirements applicable to the management of the two species. Deer are highly seasonal breeders; but there is no seasonal constraint to oestrous cyclicity in dairy cattle. They are however only inseminated for a single 4 to 8 week period in most herds so as to maintain a seasonally concentrated calving pattern.

While the use of AI in deer is a relatively recent development, a commercial AI service has been available to dairy herd owners since 1952. The use of this service has increased from less than 5% of herds in 1952 to almost 90% of herd owners who used AI with approximately 73% of all dairy cows in 1989. This service is primarily based on a liquid semen system which requires only 2 million total sperm per insemi-

nation and allows herd owners a choice of breed of sire rather than selecting a specific sire within breed.

The use of AI in dairy cows is accepted as a relatively uncomplicated and routine procedure. This acceptance has been an evolutionary process facilitated by unique developments in semen processing, inseminator training, oestrous detection and breeding management to allow herd owners to effectively utilise progeny tested genetically superior sires and to maintain genetic improvement in their herds. The increase in average herd size from 52 cows in 1950/55 to 157 cows in 1988/89 has made the use of AI a convenient necessity.

The increased use of reproductive technology in deer farming will also undergo an evolutionary development. This will be substantially influenced by the advantages of early season breeding and by the demand for new genetic material. In considering the likely developments in the future application of reproductive technology in deer and dairy cattle it is appropriate to compare several aspects of breeding management in the two species (Table 1).

TABLE 1 Comparative differences in reproductive physiology and AI use in deer and dairy cattle.

	Dairy cattle	Red deer	Fallow deer
MALE			
Semen collection	aseasonal	seasonal (March-July)	seasonal (April-Aug)
Semen collection	a/v	elect.ejac	elect.ejac
Semen processing	+18C or -196C	-196C	-196C
Sire coverage (ins/year)	>150,000	<300	<300
Progeny selection	intensive	limited	limited
FEMALE			
Cycle length (days)	18-24	17-19	20-22
Cyclicity	aseasonal	seasonal	seasonal
Oestrus length (h)	14	15-20 min (oestrus terminated at copulation)	15-20 min
Oestrus behaviour	female-female	male detected	male detected
Handling	frequent	limited	limited
Insemination	non-surgical	laparoscopic	laparoscopic
Semen placement	uterine	uterine	uterine
Pregnancy rate (natural)	65%	85%	60-85%
Pregnancy rate (AI)	60%	40-60%	70%
AI use (females/year in NZ)	1.7x10 ⁶	5000-10000	1000-1500

The need for specialised handling facilities and aspects of seasonality make the current application of reproductive technology less convenient with deer. However, recent and expected developments in semen collection, semen processing and oestrous cycle control in farmed deer will make the use of AI a more practical procedure.

DAIRY CATTLE REPRODUCTIVE EFFICIENCY

The reproductive performance of cows in well managed New Zealand herds produces average pregnancy rates to first insemination of 60% to 65%, and calving to conception intervals of 88 days (Macmillan *et al.*, 1987c).

Results from a recent international trial conducted in five countries (5 selected herds/country) with from 200 to 630 normally calving cows per country demonstrated some interesting features of the comparative reproductive performance of the cows in the New Zealand herds (Table 2).

The participating countries were England, the Netherlands, Belgium, Germany and New Zealand. The exigencies of maintaining a seasonally concentrated calving pattern in New Zealand herds contributed to the longest interval from calving to first insemination (77 days). However the highest pregnancy rate to first insemination (62%) combined with high oestrous detection rates produced the shortest interval from first insemination to conception (11 days) resulting in a calving to conception interval of 88 days. Only 5.1% of the 631 cows in the five New Zealand herds in this study did not conceive during the breeding season (Macmillan *et al.*, 1987). The cows included in this trial calved in the first 6 weeks of each herd's seasonal calving programme. None was induced, or received any other treatment during the breeding programme.

Improving the reproductive performance of cows in well managed herds should first focus on increased submission rates through treating anoestrous cows, as well as concentrating the submission period for first insemination. Treatments which increase pregnancy rates may have less effect on conception/calving patterns in herds which already achieve over 60% pregnancy to first insemination. Recent research has focussed on these three aspects; namely, concentrating the sub-

mission pattern in maiden heifers with oestrous synchrony, treating anoestrous lactating cows and increasing the pregnancy rate of inseminated cows.

OESTROUS SYNCHRONY IN DAIRY HEIFERS

The CIDR-B (Carter-Holt Harvey Agricultural Division, Hamilton, New Zealand) is a high temperature silicon moulded intravaginal device which contains 1.9 g progesterone. There is a rapid elevation in plasma progesterone concentration within 6 h of device insertion which gradually declines over the ensuing 7 weeks (Macmillan *et al.*, 1987a,b; Munro, 1987, Peterson and Henderson 1990;). This pattern of hormone release allows the device to be used as an exogenous source of progesterone to control the inter-oestrous interval and produce a synchronised oestrus from 2 to 5 days after device withdrawal. The concurrent use of oestradiol benzoate (OB) at device insertion or prostaglandin $F_{2\alpha}$ (PGF) at or from 2 days before device removal is necessary with treatment periods of less than 14 days to produce satisfactory synchrony (Macmillan *et al.*, 1987d).

Consistently producing a precision in synchrony which has over 90% of animals in oestrus within a single predictable 12 h period while still achieving pregnancy rates equal to those with natural mating is a challenge which has yet to be achieved. The interactions between treatment length, synchrony precision and pregnancy rate are demonstrated in Table 3.

TABLE 2 Comparative aspects of reproductive efficiency among dairy cows in well managed dairy herds in five countries^a.

Country	Calving to 1st insemination (days)	Average interval from: 1st insemination to conception (days)	Calving to conception (days)	% Pregnant to 1st insemination
A	77	22	99	46
B	68	16	85	51
C	71	19	90	54
D	68	19	87	55
E ^b	77	11	88	62

^a J.R. Chenault, the Upjohn Co., Kalamazoo, USA (unpublished)

^b New Zealand herds (631 cows)

TABLE 3 Precision of synchrony and first insemination fertility in dairy heifers treated with a CIDR-B intravaginal device for 7 to 21 days.

Trial	Treatment (days) ^a	No. heifers	% Inseminated:		% Pregnant or calving ^c
			at 48 h ^b	by 96 h	
1	7 ^d	105	60	97	64
	14	119	81	98	49
	21	122	97	100	37
2	7 ^d	137	-	93	56
	14	133	-	96	40
	21	133	-	99	41

^a days of CIDR treatment;

^b time after CIDR removal;

^c pregnant (Trial 1) or calving (Trial 2) to first insemination;

^d 5 ml of Lutalyse (Upjohn NZ) at CIDR removal.

The two trials involved CIDR insertion periods of 7, 14 or 21 days, with a PGF injection (5 ml Lutalyse, Upjohn NZ) at CIDR removal with the 7-day treatment. Each treatment was used with dairy heifers in each of 6 to 8 selected herds per trial. Heifers were inseminated at 48, 72 and/or 96 h after device removal and after first being detected in oestrus using a tailpaint and raddle system (Macmillan *et al.*, 1988). The 21-day treatment produced the most precise synchrony (97% inseminated at 48 h), but the lowest pregnancy rate. The slightly less precise synchrony with the 7-day treatment

meant most animals were inseminated, but over a 3-day period.

A 2 or 3-day spread in the post-treatment interval to oestrus must be expected if the normal ovarian follicular wave patterns (Ginther, *et al.*, 1989) are maintained throughout the treatment period. Longer treatment periods produce more precise synchrony because the follicle wave pattern is not maintained, and a large follicle persists once the *corpus luteum* has ceased functioning following spontaneous luteolysis (Sirois and Fortune, 1990). Follicle lifespan is also extended if

TABLE 4 Precision of synchrony and pregnancy rates to first insemination in dairy heifers treated with a CIDR-B intravaginal device for 10 days and an injection of prostaglandin F_{2α} (PGF) at 8 or 10 days after device insertion.

Day	PGF Regime ^a	No. Dose	% Heifers inseminated:			Pregnancy rate (%)
			heifers	at 48 h ^b	by 96 h	
8		2.5	96	80	96	56
8		5.0	90	84	100	63
8		2.5 & 5.0	186	82	98	60
10		2.5	93	64	96	64
10		5.0	91	65	98	66
10		2.5 & 5.0	184	65	97	65
		Average	370	74	98	63

^a injected 8 or 10 days after device insertion with 2.5 or 5.0 ml Lutalyse (Upjohn, NZ).

^b time after CIDR removal

luteolysis is produced with an injection of PGF at CIDR insertion (Swanson *et al.*, 1990). These aged follicles may ovulate and then the ova be fertilised, but the increased incidence of abnormal embryo development produces lower pregnancy rates (Wishart, 1977).

The precision of synchrony can be increased when PGF is injected up to 2 days before CIDR removal, instead of at CIDR removal and still produce high pregnancy rates with a 10-day CIDR-treatment period (Table 4).

The earlier injection of PGF significantly increased the percentage inseminated at 48 h after device removal from 65% to 82%, but was still not sufficiently precise to justify using a single insemination time for all treated animals. However, 8 to 10 days of progesterone treatment was sufficient to allow the PGF dose to be halved and still produce synchrony (Table 4).

Achieving precise synchrony and normal fertility will involve a treatment sequence which produces a synchronised luteolysis and a synchronised pro-oestrus in which a dominant follicle from a recently formed follicular wave matures and then ovulates. Recent results suggest that this sequence may be achieved by inducing follicle atresia at treatment initiation and then producing a synchronised luteolysis at treatment termination to coincide with maturation of the ensuing follicular wave. Follicle atresia can be produced currently with several treatments including an injection of GnRH to release endogenous LH (Macmillan *et al.*, 1989b) or with oestradiol by intramuscular injection (Whittier *et al.*, 1986; Engelhardt *et al.*, 1989) or by vaginal capsule.

The use of oestrous synchrony in dairy heifers is most commonly regarded as a technique of convenience to facilitate the use of AI with a class of animals normally bred by bulls and to consequently reduce the generation interval and increase the rate of genetic improvement. While this is a definite long term advantage of the technique, the short term advantages are a concentrated calving pattern, earlier mean calving date and longer lactation length. The earlier, concentrated calving date can be advantageous to that group of animals in the herd which normally have the longest interval from calving to first oestrus (Macmillan and Clayton 1980) and the highest incidence of post-partum anoestrus (Fielden and Macmillan, 1973).

POST-PARTUM ANOESTRUM

The average interval from calving to first oestrus of around 45 days is influenced by age, breed, calving date and season (Macmillan and Clayton, 1980) and varies between herds (Macmillan and Day, 1987). Post-partum anoestrus is the major form of infertility in New Zealand dairy herds. Its effects include reduced submission rates (Macmillan *et al.*, 1975), lower conception rates to first insemination (Macmillan and Clayton, 1980) and an increased incidence of short oestrous cycles and return to service intervals of 8 to 12 days (Macmillan and Watson, 1971). The condition differs from that seen in suckling beef cattle and is associated with a lack of dietary energy in early lactation. Increasing dry matter intake and body condition at calving both reduce the interval from calving to first oestrus (McGowan, 1981).

The use of CIDR's to provide progesterone priming before injecting pregnant mare serum gonadotrophin (PMSG) has been widely adopted throughout New Zealand since the results of this form of treatment for post-partum anoestrus were first reported (Macmillan and Day, 1987). The effectiveness of the treatment varies between herds, age groups, stage of season (Day and Taufa, 1988) and form or individual batch of PMSG (Jubb *et al.*, 1989; Macmillan *et al.*, 1989a). A recently identified form of variation in treatment response is ovulation without oestrus (Macmillan *et al.*, 1989a). The average post-treatment incidence of ovulation among 850 anoestrous cows injected with either 400 or 600 IU of PMSG from two sources after a 7-day CIDR treatment was 85% (Table 5) but 22% of these ovulatory responses (ie. 19 out of 85) were not associated with sufficiently obvious symptoms of behavioural oestrus for the herd owners to present these animals for insemination.

The ovarian changes which occur during the period of progesterone treatment and after the PMSG injection have not been monitored and described. Consequently, the factors associated with the range of ovarian responses have not been identified. Although treatment regimes may be modified to improve their efficacy, hormonal stimulation of ovarian activity may not always be effective when the anoestrus is the consequence of malnutrition.

TABLE 5 Post-treatment response patterns among anoestrous cows treated with a CIDR-B intravaginal device for 7 days and either 400 IU of PMSG from three batches of "Pregnecol" (Batch A, B or C), or 400 or 600 IU of "Folligon".

PMSG Treatment	No. cows	% of cows which ovulated with		Total ^a
		Oestrus	No oestrus	
A ^b	221	66	21	87
B	191	66	16	82
C	139	68	20	88
400 ^c	164	65	27	92
600	164	69	14	83
Total/average	879	67	20	87

^a ovulation or no ovulation within 14 days post-treatment.

^b "Pregnecol" (NZ Pastoral Consultants, Waipukurau).

^c "Folligon" (Intervet International B.V.; Chemavet Distributors Ltd., Auckland).

INCREASING PREGNANCY RATES

Most "fertility" treatments have been applied at or about the time of insemination. Their effect is largely limited to increasing fertilisation rate. This is more likely to be influenced by aspects of sperm survival than by variations in final follicle maturation and ovulation. A significant female contribution to the efficiency of reproductive performance in cattle occurs during the periods of early embryonic development and the maternal recognition of pregnancy. If pregnancy rates are to be increased in well managed dairy herds in New Zealand, the insemination treatments will have to be applied. An original concept involving the use of GnRH showed that a single injection of 10 mg of the potent analogue Buserelin (Receptal, Hoechst NZ) on days 11, 12 or 13 after first insemination increased pregnancy rate by 11%, and significantly altered the distribution of return-to-service intervals (Macmillan *et al.*, 1986). Subsequent studies showed that this form of GnRH treatment produced premature follicle atresia and altered the production of oestrogen around the time of pregnancy recognition and the initiation of luteolysis (Macmillan *et al.*, 1989b; Thatcher *et al.*, 1989). However, the effects of the injected GnRH appear to vary within different populations of cattle and do not produce consistently beneficial effects on pregnancy rate (Jubb *et al.*, 1990; W.W. Thatcher, unpublished).

The effect of the GnRH treatment is most likely an indirect one, acting on ovarian follicles to delay the initiation of luteolysis and to extend the period when pregnancy recognition may occur.

An alternative approach is to stimulate embryo development and consequently increase the production or concentration of the bovine trophoblastic protein bTTP1; (Thatcher *et al.*, 1989). Attempts at using exogenous progesterone to stimulate embryo growth and increase pregnancy rates have produced variable results, possibly because of a wide range of differences in form, time and dose of administration.

A series of trials was recently completed in which CIDR's were inserted into dairy cows from 4 to 17 days after first insemination for 4 to 12 days (Table 6).

The results of these trials showed that progesterone supplementation using a CIDR-B intravaginal device only increased pregnancy rates when the device was inserted from 6 to 8 days after first insemination. Further trials are necessary to more precisely define the effects of varying time from to insertion, duration of treatment and form of treatment. Resolving these issues could see widespread use of the technology in dairy herds in New Zealand and elsewhere to increase pregnancy rates in inseminated animals and with embryo transfer.

TABLE 6 Effects of a 4 to 12-day CIDR treatment from 4 to 17 days after insemination on pregnancy rates in lactating dairy cows.

Trial No.	No. cows		Day of insertion	Days to removal	Pregnancy rate (%)		Probability C vs T	
	C ^a	T ^a			C	T		
1	472	514	14 to 17	4 to 7	63.6	64.0	>0.20	
2	628	493	10 to 16	6	66.6	64.3	>0.20	
3	466	461	4 to 9	6 or 12	66.1	74.6	0.02	
3	}	69	75	4	6 or 12		72.0	0.20
		71	70	5	6 or 12		68.6	>0.20
		77	78	6	6 or 12	66.1	74.3	0.14
		87	87	7	6 or 12		85.1	0.001
		81	75	8	6 or 12		77.3	0.01
		81	76	9	6 or 12		68.4	>0.20

a Contemporary herd mate control (C) or treated (T) cows.

REPRODUCTIVE SEASONALITY AND EFFICIENCY OF FARMED DEER

Two species of deer, the red deer (*Cervus elaphus*) and the fallow deer (*Dama dama*), together account for 95% of farmed deer in New Zealand. Both species exhibit highly seasonal patterns of reproduction mediated by photoperiod, with oestrus/conception occurring during autumn and calving/fawning occurring in summer following a 234-day gestation (Guinness *et al.*, 1978; Asher and Adam, 1985; Asher 1987). In the case of fallow deer, the period of first oestrus of the breeding season is synchronized naturally to within a 12 to 14-day period that coincides with the rut (Asher, 1985). Up to 85% of does conceive to first oestrus matings even though copulation generally occurs only once per oestrous period (Asher, 1986, 1987). This results in a very concise pattern of births, with 66% of fawns born within a 10-day period in December (Asher and Adam, 1985). While late-term abortions have been observed on some fallow deer farms (mainly arising from *Leptospira* infection; Asher, 1989), it would appear that early embryonic wastage is not a significant phenomenon in farmed deer, and conception rates are closely aligned with parturition rates. In the absence of conception to first oestrus, hinds/does will exhibit return oestrus at

intervals of 18 days (red deer; Guinness *et al.*, 1971) or 21 days (fallow deer; Asher, 1985). Due to high conception rates to the first and second oestrus, it is uncommon for hinds/does to exhibit more than one oestrous cycle.

SEASONAL CONSTRAINTS ON DEER PRODUCTION

Summer calving/fawning patterns are of adaptive significance to red and fallow deer within their original environments of continental Europe, consequently producing problems within the traditional pastoral farming systems in New Zealand. There is often a poor alignment with peak pasture quality and quantity in spring and the high energy demands of early lactation in summer. Summer/autumn drought conditions during the lactation period compromise calf/fawn growth rates. Considerable research effort has been applied to advancing the calving/fawning season by manipulation of the season of conceptions (rut), either by direct control of ovarian function (CIDR + PMSG or GnRH; Asher and Smith, 1987; Asher and Macmillan, 1986; Fennessy and Fisher, 1988), by melatonin treatment of both males and females (Asher *et al.*, 1988a; Fisher *et al.*, 1988; Wilson, 1989) or by hybridization with other "species"

that exhibit different seasonality (e.g. red deer x Pere David's deer; fallow deer x Mesopotamian fallow deer; Asher *et al.*, 1988b). The most practical short-term approach appears to be the strategic administration of melatonin implants to either or both sexes (Asher, 1990).

SEMEN COLLECTION FROM DEER AND ITS LIMITATIONS ON THE WIDESPREAD APPLICATION OF AI

Semen collection from bucks/stags is highly seasonal due to the circannual pattern of spermatogenesis in these species (Lincoln, 1971; Haigh *et al.*, 1984; Asher *et al.*, 1987). Furthermore, semen from deer has been collected primarily by electroejaculation of heavily sedated animals. These two factors have limited considerably the widespread application of AI in farmed deer. The seasonal constraints on semen collection almost negate the potential usage of fresh semen for AI. Farmers prefer to conduct most inseminations early in the breeding season. However, stags/bucks attain full seasonal fertility only a few weeks before the onset of the rut, and semen collection "on demand" at this time is often difficult to achieve. Most deer semen is collected post-rut; necessitating frozen storage for subsequent use. Using melatonin implants to advance the spermatogenic cycle of male deer may reduce some of these problems. Strategic treatment with melatonin over summer and autumn can considerably advance the potential season of semen collection and have stags/bucks producing processable semen at the start of the rut. This has already been successfully applied to commercial semen collection from elite fallow bucks on the Ruakura Deer Artificial Breeding Centre.

An alternative method of semen collection is presently being investigated because of the disadvantages of electroejaculation. H.N. Jabbour and others (unpublished) have developed a prototype internal artificial vagina (AV; NZ patent 230466). For semen collection with the AV, ovariectomised fallow does are treated with CIDR devices for 6 days and 0.05 mg oestradiol benzoate 24 hours after CIDR device removal. The does are fitted with the internal AV at the mean time to onset of oestrus, generally 18-24 hours after the oestradiol injection, and exposed to the bucks. Following mating, the AV is removed and the semen is

aspirated and assessed for quality. This technology may dramatically alter the availability of semen from stags/bucks.

OESTROUS DETECTION IN DEER:

The detection of oestrus in red and fallow deer is difficult in on-farm situations. Firstly, deer are handled very infrequently, especially during the rut when stags/bucks are often aggressive towards other deer and humans. This limits the opportunity to closely observe females for signs of overt oestrus. Secondly, recent data suggest that overt oestrus in deer is exhibited only until copulation; an average period of only 15-20 minutes from its onset (Asher, 1986). This necessitates the use of remote detection methods, such as sire-sign harnesses. This technique has been usefully applied in research trials, but has a high labour input, which limits the on-farm application. The wallowing behaviour of red deer stags may make harness techniques ineffective.

Nearly all AI programmes for farmed deer have relied upon fixed-time inseminations following oestrous synchronisation treatments; with very little attempt to detect oestrus (whether natural or induced).

OESTROUS SYNCHRONISATION IN DEER

Synchronisation in red and fallow deer utilises similar methods to those used with other livestock species (Fennessy *et al.*, 1989). The proportion of hinds/does exhibiting induced oestrus and the degree of synchrony of oestrus are dependant on the time of year when treatments are administered. Generally, results are most consistent after the onset of the natural breeding season in autumn.

For fallow deer, the three main methods of oestrous synchronisation are: (a) 14-day treatment with a CIDR device (type S or G); (b) injection with a PGF between days 12 and 15 of the oestrous cycle; and (c) natural return to oestrus 21 days after a previous synchronisation (Asher and Thompson, 1989). For red deer, oestrous synchronisation is achieved almost exclusively by 12-14 days of CIDR device insertion combined with an injection of 200-250 i.u. PMSG at or near CIDR device withdrawal (Fennessy *et al.*, 1989). PMSG is contra-indicated for use in fallow deer due to

an unacceptably high incidence of multiple ovulations (even at 100-200 iu per doe) and low conception rates (Asher *et al.*, 1990b). Its routine use in red deer may overcome stress-related ovulation suppression. Recent work at Ruakura indicates that suitable synchrony of red deer hinds can be achieved without additional PMSG support if CIDR device removal is left until after the natural rut (e.g. mid April). This indicates that PMSG may only be required if inseminations are to be performed early in the breeding season. The use of prostaglandins has not been extensively investigated for red deer, but their use is quite efficacious in inducing oestrous synchrony in fallow does if administered at the correct stage of the oestrous cycle (Asher and Thompson, 1989).

While a wide range of progestagen-releasing devices has yet to be tested for efficacy of oestrous synchronisation in deer, a large number of studies have been conducted on the use of the intravaginal CIDR device. The retention rate of CIDR devices is very high (98-100%). They release sufficient progesterone during the period of insertion to elevate blood concentrations to a level comparable to natural endogenous concentrations observed during dioestrus. The mean interval from CIDR device withdrawal to the onset of oestrus appears to be between 36 and 50 hours depending on season and additional gonadotrophin support. For both red and fallow deer, ovulation occurs about 24 hours after the onset of oestrus (Asher *et al.*, 1990a; G.W. Asher, unpublished).

INSEMINATION TECHNIQUES FOR DEER

The two methods of artificial insemination practiced on deer in New Zealand are intravaginal/intracervical (per vaginum) and laparoscopic intrauterine insemination. Intravaginal insemination is the simplest method, but requires large numbers of viable spermatozoa (in excess of 100 million) for reasonable success rates. As this form of insemination is analogous to natural mating, semen placement is timed to coincide with the mean time to onset of oestrus, being approximately 48 hours after CIDR device withdrawal/prostaglandin injection for fallow deer (Asher and Thompson, 1989) and 36-40 hours after CIDR device withdrawal/PMSG administration for red deer (G.W. Asher, unpublished data).

Intracervical insemination is likely to be less

wasteful of spermatozoa than intravaginal insemination. Present studies indicate that at least 50-100 million live spermatozoa are required. Success rates with such inseminations performed 48 hours after CIDR device withdrawal may range from 40-65% for fallow deer (Jabbour and Asher, 1990). Success rates for red deer inseminated 40-60 hours after CIDR/PMSG treatment have been highly variable (30-60%; Fennessy *et al.*, 1990).

Laparoscopic intrauterine insemination allows precise placement of relatively small quantities of semen close to the site of fertilization. For fallow deer, inseminations of 30-40 million live spermatozoa at 65-70 hours after CIDR device withdrawal have resulted in 60-70% conception rates (Asher *et al.*, 1990c). Rates of 40-80% have been observed for fixed-time inseminations in red deer 56-60 hours after CIDR withdrawal and PMSG injection (Fennessy *et al.*, 1990).

SEASONALITY PROBLEMS WITH AI

Optimization of oestrous/ovulation synchronisation is achieved towards the end or after the natural rut. Inseminations performed during this period will obviously result in calves/fawns born slightly later than those conceived to natural matings. Furthermore, poor success to AI will result in a high return rate 18 (red deer) or 21 (fallow deer) days after AI. This again results in late calving/fawning. Some farmers are attempting to perform inseminations before the natural rut to circumvent the pitfalls of late fawning. This in itself could contribute to poor conception rates to AI.

The use of PMSG at or near CIDR device withdrawal will clearly aid in inducing oestrus/ovulation in red deer before the natural rut. However, its use in fallow deer is questionable. The answer may lie with the strategic use of melatonin implants to advance the natural rut period. This may alleviate the need to use PMSG.

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