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Managing fertility in the New Zealand dairy herd

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ABSTRACT

Effective mating management remains crucially important to pastoral milk production systems in New Zealand (spring calving or autumn calving). The incidence of most diseases has decreased since the 1940s, but infertility, especially the 'anoestrous problem', has increased despite increased use of hormonal treatments and in association with genetic selection for increased yields of milk. The regular need to treat a high proportion of cows with hormones because they are not cycling at the start of mating should be seen as a sign of mismanagement in the system (genetics, health or feeding). 'Good herd management' should be used to achieve good fertility with minimal use of hormone treatments; this will include: - good prevention and control of all diseases; all heifers must reach target live weights and puberty at 12 months; all cows must be at BCS 5 at calving, and be fed generously in early lactation; excellent heat detection must be maintained for the entire AI mating period; infertile cows must be culled, and fertility included in the Breeding Worth. These aspects of 'good management' must be seen as essential factors in the maintenance of good herd welfare, and in the sustainable production of the high quality, clean and green dairy products required by the world markets. A number of commercial herds are showing that good fertility and good productivity can be achieved with minimum use of hormone treatments, with present-day cows. However, for some strains of cows, good feeding management may be impossible on a diet of grazed pasture.

Keywords: dairy; reproduction; milk yield; management.

INTRODUCTION

The seasonal calving systems used in New Zealand can not be successful unless the cows are fertile. The 'anoestrous cow' (not cycling at the start of the mating period) is now a bigger problem than 60 years ago (Macmillan, 1997). This has developed in association with higher yielding cows of higher genetic merit (for yield) stocked at higher rates per hectare, and with more emphasis on the need for compact calving. The use of hormonal treatments for anoestrous cows, and for late calving cows has also been developed over the past 40 years.

This paper will: - 1. Review the importance of fertility in seasonal calving systems. 2. Outline changes in mating, fertility and health since 1940. 3. Explain the consequences of genetic selection for increased milk yields. 4. Describe the effects of good feeding management of fertility. 5. Suggest that a change in attitude to the 'anoestrous cow problem' is required.

THE SEASONAL, PASTURE-BASED SYSTEM AND HERD FERTILITY

The seasonal pasture based system (Figure 1) is designed to make the herd's feed demand be as similar as possible to the pasture growth rate in each month of the year. This is achieved by: -

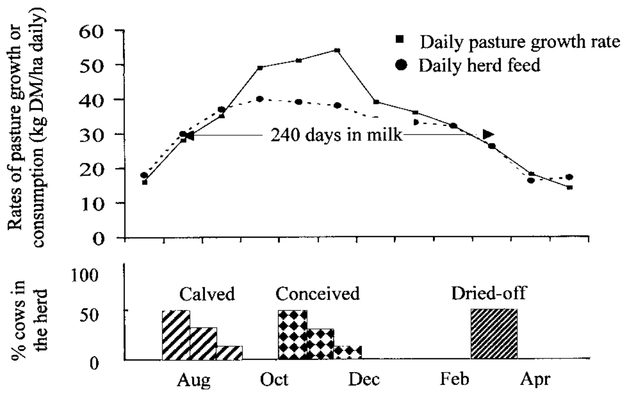
Using the appropriate stocking rate, to set the overall feed demand/ha throughout the year.

Calving and drying-off the herd at the appropriate times, to synchronise the increase in feed demand (calving) with the increase in pasture growth (spring), and the decrease in feed demand (dry-off) with the decrease in pasture growth (winter). (For farms on which pasture growth is slower in summer than in winter, calving in autumn rather than in spring, may achieve the best fit between feed demand and pasture growth).

The seasonal system also simplifies work and mating management on the farm: -

- The period of calving and calf rearing lasts only 10 - 12 weeks each year.
- The period of mating lasts only 10 - 12 weeks each year.
- Heat must be detected for only 3 - 6 weeks each year.
- Heat detection is facilitated by the large numbers of cows on heat simultaneously, with vigorous, visible activity.

FIGURE 1: To illustrate the seasonal pattern of calving and drying-off, and their effects on the synchrony between feed requirements and pasture growth



The aims and objectives of mating and fertility in these seasonal systems are simple but rigorous: -

- All cows (including 2 years olds) must calve in a 10 week period, at the 'time' of year which is 'right' for that farm and system.
- All replacement heifers must reach puberty at least 2 months before the start of their mating period (or at 12 to 13 months of age), so that they can conceive at 14 to 15 months.
- Obviously, to achieve the first point above, all cows (including replacement heifers) must conceive in a 10 week period at the 'right' time of year (see Macmillan, 1998; Burke, 1999).
- Good fertility is obviously essential to these systems, but these systems also facilitate good heat detection.

Dates and patterns of calving, and milk production

Cows are able to conceive, calve and lactate in any season of the year, provided that feed can be made available to meet their requirements. For example, autumn-calved cows can produce more milk, in longer lactations, than spring-calved cows, and autumn-calved herds can achieve the same milk production as spring-calved herds, but require more supplementary feeds in the winter (Garcia & Holmes, 1999).

However, within spring-calved herds, late-calving cows usually produce less milk than earlier-calving herd mates, mainly because of shorter lactations (MacMillan *et al*, 1984; Garcia & Holmes, 1999). For example, cows which calved in week 10 produced 25% less milk than those which calved in weeks 1 to 3 (Stevens *et al.*, 2000). Of course, these later-calving cows could have been dried-off later than their herd-mates, if feed had been made available, but this would have complicated the herd's management and feeding. Winter-milk is being produced from 'late-spring-calvers' in this way on some farms.

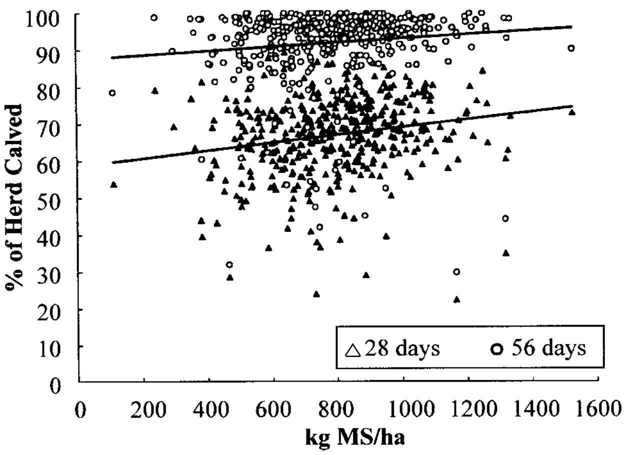
The keys to simple, successful seasonal pasture-based systems are therefore: -

Compacting mating and calving periods (calving either in spring or in autumn).

Good feed management to ensure that all cows can be fed to their requirements throughout a long lactation.

Although the relationship between compactness of calving and milksolids production per hectare is not strong (Figure 2), the data show that the herds which produce higher yields of milksolids/ha generally also achieve more compact calving patterns. The most likely explanation of these results is that good herd management causes both compact calving **and** high milksolids per hectare. Consequently compact calving and high milksolids per hectare are associated with each other (McKay, 2000).

FIGURE 2: Association between milksolids produced per hectare and the percentage of the herd calved in 4 or 8 weeks; using 1997 data from L. Burton (Burke, 1999).



CHANGES IN MATING AND FERTILITY SINCE 1940

Major changes and developments have taken place in the last 60 years (Table 1), and a brief review of some main points provides a useful perspective from which to examine the present and the future.

TABLE 1: Data for mating, cows and fertility in 1940 to 1996 (NZBD Reports, 1941, 1951, 1952; Macmillan, 1972 and 1976; Hayes, 1998).

	1940-1950	1971	1996
Methods of mating	Bulls (and venereal diseases)	AI	AI plus CIDRs and inductions
Breeds	Mainly Jersey	Mainly Jersey	Mainly HF
Average milksolids (kgMS/cow):	180 kg	210 kg	290 kg
Average stocking rate (cows/ha):	1.2	1.9	2.6
Non return rate to 1st service	62%	60 to 64% smaller herds 52 - 57% larger herds	65 to 69%
% calved in 4 weeks	45%	63%	63%
% empty after 100 day mating	8%	5%	8%

The main issues and recommendations for the three periods are shown below.

1940 - 1950

- Natural mating; infectious diseases (brucellosis and vibriosis) are main problems.
- Never mate a cow until 40 days after she calved.
- Feed for production; no problems with reproduction

(James, 1955).

1970s

- Artificial insemination: accurate heat detection essential.
- High submission rate essential (for compact calving).
- Mate all cycling cows (even if within 40 days of calving).
- Problems: post-partum anoestrus in young cows and silent heats in older cows.

(Macmillan, 1972 & 1976).

1990s

- Patterns of matings and calving after start dates are crucial.
- Heat detection.
- Prolonged post-partum anoestrus, major problem
- Must grow heifers to reach targets.
- Use of hormone treatments to overcome anoestrus, and to induce premature calving.

(Macmillan, 1998).

The increasing importance of heat detection, prolonged post partum anoestrous and hormone treatments is clear. Non-return rate has shown little change for the past 60 years, but compactness of calving increased between 1950 to 1970, but not thereafter. In fact submission rates have probably decreased slightly in recent years (Burton & Harris, 1998). Infectious diseases have largely been controlled (e.g., brucellosis, vibriosis and mastitis), but infertility (mainly late calving or non-pregnancy has increased over the same period (Table 2).

TABLE 2: Trends in diseases, culling and wastage (%), 1938 - 1998. (NZDB Report 1978; Xu & Burton, 2000).

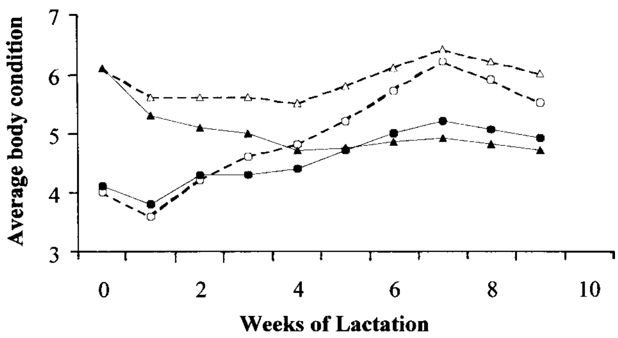
	1938/43	1969/74	1998
Total removed	**16.8**	**19.7**	**19.6**
Died	1.4	0.8	1.9
Sold for dairying	0.9	1.2	4.1
Reproductive	2.6	4.6	6.3
Low yield	5.6	6.4	2.1
Mastitis; SCC	3.7	0.8	1.1
Feet; lame		0.1	0.4
Type; udder; behaviour	1.5?	0.6	0.7
FE		0.7	0.2
Bloat; metabolics	0.3	0.2	

GENETIC SELECTION FOR INCREASED MILK YIELDS

The modern dairy cow is the result of many years of intensive selection for increased yields of milk or milksolids, but without the inclusion of a fertility trait in the selection indices. Many experiments in the past 20 years have shown that these modern cows are characterised by a large increase in their capacity to produce milk and a smaller increase in their capacity to eat food. Consequently they experience longer periods of negative energy balance, and greater loss of body condition, especially in early lactation (Holmes, 1988; Buckley *et al.*, 2000). This is illustrated by the data in Figure 3, which shows that for cows which calved in condition score 4 or 6, the high merit cows either lost more or gained less body condition during lactation, to finish 1 condition score thinner than the lower merit cows.

European concerns about the resultant 'metabolic stress' stimulated a whole conference devoted to this one topic (Oldham *et al.*, 1999).

FIGURE 3: Changes in body condition during lactation for Friesian cows of high (●,—) or low (O,△) genetic merit, which calved in either fat (6) or thin (4) body condition (Holmes, 1988).



In the 1980s no measurable differences in reproduction and fertility were recorded over 6 years between two groups of Friesian cows which differed by 25% in genetic merit for milkfat yield (Holmes, 1988). Similarly, only small effects on fertility were reported in selection studies, at several United States research centres, which began in 1947 with the final matings in the late 1970s and early 1980s (Kelm *et al.*, 2000). However, evidence of reduced fertility in modern, selected cows has accumulated rapidly in the past 5 years, especially in Holstein-Friesians with overseas genetic backgrounds. For example, conception rate in the United States decreased from 51% to 40% between 1960 and 1995 (Royal *et al.*, 2000), and high merit Holstein-Friesian cows had conception rates to first service of 39 and 41% compared with 49 and 53% in lower merit cows in two studies in Scotland and Ireland (Pryce *et al.*, 1999; Buckley *et al.*, 2000). A similar difference was recorded between two strains of Holstein-Friesians which differed genetically in live weight and nationality of genetics (Holmes *et al.*, 1998). The heavier strain had a higher % of United States' genes and a lower conception rate (by 11% units). This latter finding is supported dramatically by Dr Eric Kolver's recent results (Penno & Kolver, 2000; Table 3).

TABLE 3: Non pregnant rates in Holstein-Friesian cows, of either New Zealand or overseas (OS) genetics, and fed on either pasture or a total mixed ration (Penno & Kolver, 2000).

	Generous pasture		Total mixed ration	
	NZ cows	OS cows	NZ cows	OS cows
kg MS/cow:	311	289	424	437
Percent non pregnant:	4	34	11	16

These results suggest that, on grazed pasture, despite generous allowances, the overseas cows could not eat enough to maintain normal fertility. The difference between the strains was much smaller when they were fed on the total mixed ration.

Given the increased energy deficit and loss of body condition experienced in early lactation by the modern high merit cow (and associated endocrine and metabolic changes; see Oldham *et al.*, 1999) and the fact that fertility has not been included in genetic selection indexes, it is not surprising that her fertility has decreased. Fortunately, any decreases in the fertility of Holstein-Friesian and Jerseys with mainly New Zealand genetics have been relatively small so far (Burton & Harris, 1999).

However, the high merit cow's greater capacities for milk production and for feed consumption (and her consequent greater feed conversion efficiencies, both gross and marginal) are vitally important components of modern dairy systems. Some of these advantages can be illustrated by data for the two stocking rates with 'optimum' milksolids/ha in a trial carried out in 1983 - 1986 by Dr Arnold Bryant (see Holmes, 1995), with cows of high or low merit.

TABLE 4: Results for Jersey cows of high or low genetic merit in 1983, at their 'optimum' stocking rates (see Holmes, 1995).

	High merit BI fat : 100	Low merit BI fat : 125
Cows/ha:	3.15	4.76
kg MS/cow:	301	195
Feed eaten (t DM/cow):	3.9	3.1
Calculated gross feed conversion efficiency (kg MS/t DM eaten):	77	66
kg MS/ha:	1127	928
Calculated for 100 hectares, and 12 t DM eaten/ha		
Cows required:	308	387
Total milksolids produced:	92,600	75,500

Fewer cows (-79 cows) would be required to eat the 1200 t DM on 100 ha, and they would produce more total milksolids (+17,100 kg MS). These represent decreased costs, and increased gross income. In addition, their higher marginal feed conversion efficiency enables high merit cows to produce larger responses to **extra** feed (e.g., 115 or 86 g extra milksolids per kg of concentrate by cows of high or low genetic merit respectively given an extra 0.5 t concentrate/cow; Fulkerson, (2000).) This capacity increases the range of feeding options, which can be used profitably with higher merit cows.

GOOD MANAGEMENT CAN INCREASE FERTILITY

Diseases and disorders

Cows which were affected by reproductive tract disorders after calving showed much lower rates of submission and pregnancy than healthy cows. Even cows which had mastitis, metabolic disorders or lameness after calving showed slightly reduced rates of submission and pregnancy (Table 5). Healthy cows had the highest fertility.

TABLE 5: Effects of ill-health on reproduction and fertility (Xu & Burton, 2000).

	3 week submission rate (%)	Conception rate to 1st service (%)	Pregnancy rate (%) 3 weeks	Pregnancy rate (%) Total
No diseases:	80	53	42	93
All diseases:	77	49	38	87
Mastitis:	79	51	40	89
Metabolics:	74	49	36	86
Retained placenta:	71	39	28	76
Uterine infection:	61	34	21	75

Feeding and body condition score (BCS) in heifers and cows

The effects of feeding and BCS on fertility have been recognised for many years; some examples will be given to illustrate the main points.

Growth rate and live weight in heifers Holstein-Friesian heifers were reared under different feeding levels, and in those which weighed more than 300 kg at 15 months, only 7 to 9% were anoestrous, whereas for those that weighed less than 270 kg, 17 to 19% were anoestrous at 15 months. The corresponding values for Jersey heifers were: - more than 225 kg, 0 to 6% anoestrous and less than 190 kg, 20% anoestrous (Penno, 1997). Lighter weight at 15 months increased the incidence of anoestrus, and would have reduced the submission rate, if the anoestrous heifers had not been treated with CIDRs.

Feeding level and body condition in cows The effects of a range of BCS and levels of feeding were examined by Grainger *et al.* (1982) and modelled by McGowan (1981) (Table 6).

TABLE 6: To show the effects on body condition and feeding on fertility in Jersey and Friesian cows, producing 1.2 kg MS/day in early lactation (McGowan, 1981).

	BCS and feeding level in early lactation (kg DM/cow daily)			
	3 BCS		5 BCS	
	9 kg DM	12 kg DM	9 kg DM	12 kg DM
Post partum anoestrous interval (days):	52	46	41	34
3 week submission rate (%):	70	77	80	83
6 week pregnancy rate (%):	69	74	76	82

These earlier results have been supported by many recent studies (e.g., McDougal, 1993). The adverse effects of a high stocking rate, with no supplements fed, on feeding level, body condition and fertility are shown in Table 7.

TABLE 7: The effects of a high stocking rate without supplements on aspects of fertility in Holstein-Friesian cows (McDougal, 1994).

	Friesian cows/ha 3	Friesian cows/ha 4
Body condition score:		
at calving	5.0	4.6
at mating	4.5	3.8
Days calving to 1st heat:	35	52
Days calving until 100% cycled:	70	80
Percentage conceived:		
by day 25 of mating	63	55
by day 50 of mating	83	77

Similarly, a stocking rate of 4.4 cows/ha increased the incidence of anoestrous cows to 35% compared with 11% for herds at 3.3 cows/ha. However this adverse effect was overcome completely by feeding maize silage to the 4.4 cows/ha (MacDonald, 1999).

In all studies in New Zealand and Australia, cows which were in good condition and well fed had the highest fertility. However, 'over-fat' condition at calving can depress appetite after calving and will result in the rapid loss of condition after calving. This large negative energy balance can cause metabolic disorders and other types of ill-health (Oldham *et al.*, 1999). Fortunately obesity is not a major problem in New Zealand's dairy cows.

Heat detection and 'detection fatigue'

The crucial importance of reliable, accurate heat detection was discussed in detail by Macmillan (1998), together with the use of tail-paint as an aid. Although the period of heat detection is usually only 6 to 7 weeks in duration, 'heat detection fatigue' may cause reduced care and attention in the latter weeks, and therefore decreases in submission rates (Cavalieri *et al.,* 2000).

Data of this type show that it will be impossible to achieve good fertility without first achieving good herd health and good feeding management throughout the year, and good heat detection throughout the period of AI. With some strains of cows it may be impossible to achieve good feeding management on a diet of grazed pasture.

ATTITUDES TO THE ANOESTROUS PROBLEM: PREVENT OR TREAT?

Post-partum anoestrus is part of the normal, reproductive events in a healthy cow (Macmillan, 1997). It becomes a "problem" if it is prolonged beyond the normal 4 to 6 weeks, so that even cows which calved early are still not cycling at the start of the mating period.

The dilemma, to prevent or to treat, was identified with great clarity by Jacob Malmo, a veterinarian who has researched the topic for many years (Malmo, 2000). He stated "The use of CIDR devices and oestradiol benzoate injected 24 hours after CIDR removal, along with re-synchrony with used CIDR devices and oestradiol benzoate injection given at the time of CIDR reinsertion, and 24 hours after removal, is an efficacious treatment for anoestrous dairy cows. However, such treatment does involve farmers in additional work and cost. We need to address the causes of what we see as an alarming trend towards an increased incidence of anoestrus, and reduced 21 days submission rates, in our seasonal calving dairy herds".

The hormonal treatments have been discussed in detail by Macmillan (1998) and were shown to increase rates of submission and pregnancy in anoestrous cows, and to reduce the number of late calving cows in many studies. However, their increased use must inevitably have resulted in the retention of 'infertile' cows, which would otherwise have been culled for late conception or late calving. This may have allowed genetic merit for fertility to decrease slightly in the past 30 years, despite the increased use of the hormone treatments (Burton & Harris, 1999). Any such trends will be addressed by the inclusion of a fertility trait in the Breeding Worth, in 2001.

In addition, the knowledge that these treatments are available for treatment of infertile cows in an emergency may have reduced the importance attached by some farmers to good feeding management of heifers and cows. For example, small, anoestrous heifers can be mated after treatment with CIDRs (Penno, 1997), and thin, underfed cows can be mated after treatment with CIDRs (MacDonald, 1999). Therefore less urgency may be attached to the achievement of targeted live weights, body condition scores and feeding levels in these animals.

An 'anoestrous' problem should be regarded as a sign of mismanagement (genetic, health or feeding) in the herd.

Minimal use of hormonal treatments

Results are presented below from a study of herds which used no inductions for 2 years, when compared with average data from other herds (Stevens, 2000).

TABLE 8: Performance by herds that did not induce cows to calve prematurely (Stevens, 2000)

	Non-inducing herds	Profitwatch average herds
Number of herds:	49	415
Cows/herd:	212	227
kg MS/cow:	325	305
kg MS/ha:	837	787
Economic farm surplus (EFS $/ha):	914	666

TABLE 9: Reproductive performance by herds that did not induce cows to calve prematurely (Stevens, 2000)

	Non-inducing herds	Profitwatch average herds
Number of herds:	77	730
Percent of cows induced (%):	0.2	8.9
Length of mating period (days):	81	102
Percent cows empty (%):	8.1	7.0
Replacement rate (%):	22.4	22.5
Percent cows treated with CIDRs:	4.4	10.6

The non-inducing herds produced slightly more milk per cow and per hectare and had a higher EFS/ha. Results from a later postal survey provided additional data about the reproductive performance in a larger number of non-inducing herds (Table 9).

The non-inducing herds restricted their mating period to 81 days (the targeted duration of their calving period), had a slightly higher empty rate and used fewer CIDRs. Comments by the non-inducing farmers indicated a greater emphasis on body condition at calving and good feeding in early lactation. Management of anoestrous cows included separating them from the main herd for preferential feeding, or running them with a bull to detect weak heats, but the effectiveness of these methods is not known.

Outstanding results for both milk production and fertility were also achieved in a herd which feeds vegetable byproducts as supplements to grazed pasture (Reid, 1997); 425 kg MS/cow, and 1920 kg MS/ha, with no inductions and only 4 CIDRs in a total of 900 cows. The interpretation of the data in Figure 2 also probably applies to the Reids' herd.

CONCLUSION

Good health, good body condition at calving, and good feeding during lactation will all contribute to improved fertility. In addition, there is now clear evidence that the definition of 'good genetic merit' must include 'good fertility'.

The combination of 'good genetic merit for fertility' plus 'good herd management' will in future achieve good herd fertility, with minimal reliance on hormonal treatments as demonstrated by a number of commercial herds. This pathway is more appropriate for the sustainable production of high quality, clean, green dairy products from cows that are managed to satisfy all their welfare requirements. Indeed a high incidence of anoestrous cows at the start of mating should be interpreted as a sign of poor welfare in the herd.

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