# The development of reproductive management practices in New Zealand: what will the future hold in a consumer-focused, environmentally-conscious, export-driven marketplace?

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The New Zealand (NZ) economy and its dairy industry are sensitive to global consumer perception of farming practices used to generate milk products because milk exports account for >25% of national export earnings and >90% of milk produced is exported as products. Astute management of product image and market risk is, therefore, important for the viability of the industry and country. More than 95% of milk produced in NZ comes from strictly seasonal, pasture-based systems, with associated constraints on reproductive performance. Increasing herd sizes, operational changes and genetic selection priorities have further challenged dairy farmers to achieve optimal levels of herd fertility. Reproductive management practices have developed to address the need to maintain a 365-day inter-calving interval, essentially through maximizing the number of cyclic cows during the breeding period and minimizing the duration of the seasonal calving period. Aspects of the hormonal interventions developed and routinely used to achieve these objectives have been the subject of product quality and market risk concerns forcing the industry to explore alternative ways of achieving reproductive performance goals. One approach has been to exploit the inherently high level of fertility in NZ dairy herds. This approach has seen the inclusion of fertility-related traits in the national genetic evaluation system to prevent further decline in genetic fertility. More recently, a nationally coordinated extension program has been adopted to support farmers and their advisors to identify, prioritize and improve on key management areas for incremental gains in herd reproductive performance. Advances in automation and bio-sensing are yet to make a significant impact, but remain potentially valuable additions in supporting the dairy farmer to manage the areas having the largest effects on reproductive performance.

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## Introduction

More than 90% of milk produced in NZ is exported in about 200 different product forms. In 2009, the dairy industry earned NZ$11.3 billion: 42% of primary and 27% of total exports. The majority of the 11,000 dairy farms are operated seasonally with a high reliance on grazed pasture. Producers have a strong profit focus achieved by low production costs.

Low-cost milk production is supported by utilization of pasture *in situ*. Herd nutritional demand is managed to match supply. The feed supply and demand balance requires a condensed calving in spring to minimize herd feed demand during low pasture growth in winter and match peak feed intake with peak growth in spring (Figure 1). The development of reproductive management practices has been influenced by the unique challenges of maintaining a 365-day inter-calving interval in this seasonal system (Holmes 2001). Science innovation and farmer perception of the value of new technologies have also directed technology development that ranged through genetic selection, information technologies, feed management systems, and hormonal control of pregnancy reestablishment and calving. Reproductive practices have also been influenced by international regulatory constraints on food safety and local community pressures on environmental stewardship and animal welfare protection.

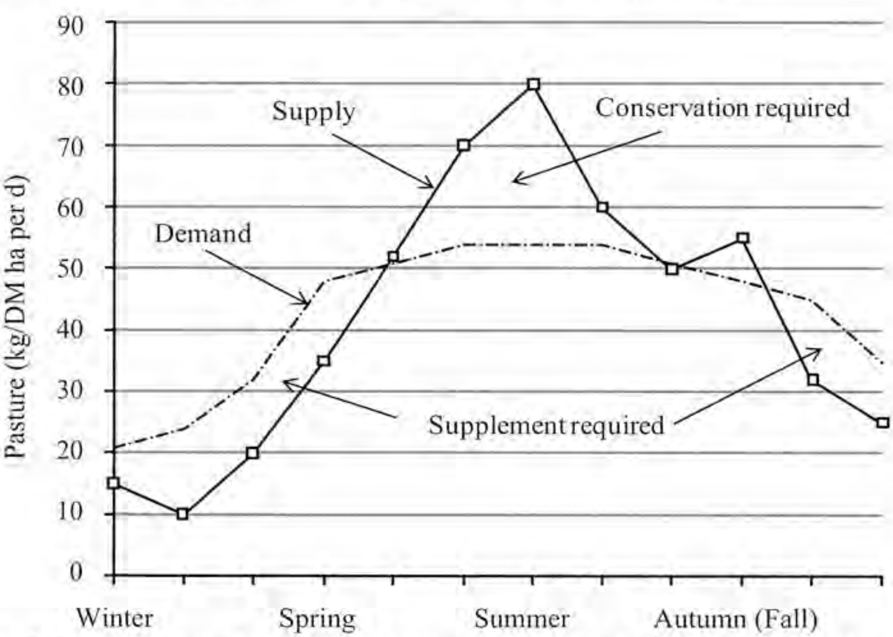


**Fig. 1.** Representation of the annual pasture supply/demand curve for the pasture-based, seasonal dairy production system in New Zealand (adapted from Macdonald et al. 2008).

This paper describes how reproductive management technologies in NZ have developed and how local and export requirements have influenced these practices. Future efforts to achieve a level of fertility that supports dairy farming goals is discussed in this context.

## Reproductive constraints in the seasonal, pasture-based dairy system

*The seasonal, pasture-based dairying system*

The low-cost pastoral system is central to economic success in an environment not distorted by agricultural subsidies. The pasture that provides 90% of dry matter on most farms is dominated by ryegrass, which has rapid spring growth but moderate summer and low winter growth. Pasture quality varies with season and growing conditions (Roche et al. 2009), and the amount a cow can readily eat constrains milk production (Kolver & Muller 1998).

To achieve a 365-day inter-calving interval, cows must resume cyclicity, display estrual behavior, and be successfully mated during a defined breeding period beginning 12 weeks after a designated "planned start of calving" date for the herd. Cows that cannot maintain this calving interval are generally culled. Artificial insemination (AI) is typically used during the first 4 to 6 weeks of the mating season to generate replacement stock, followed by natural bull mating for a total breeding period of 10 to 14 weeks.

### *Changes in farm size and operating structure*

The average NZ dairy herd in 2008 had 351 cows. Although 200 to 249-cow herds were most common, 19% had more than 500 cows, and 10% of cows were in herds greater than 1,000 (New Zealand Dairy Statistics 2008-09). Business structures have changed with increased herd size, with corporate farm ownership more common where shareholders have no day-to-day involvement, and staff roles are specialized (e.g., feeding and milk harvesting, employed managers provided with consultancy advice). Large herds present additional challenges, particularly for estrous detection and calving management.

### *Changes in breed and genotype prevalence*

Shifts in breed prevalence and crossbreeding feature strongly in the history of NZ dairying (Holmes 2001). By the early 1970s, the dominant breed had changed from Jersey to a Friesian that had been selected under local conditions from animals imported from the United States of America before 1925 (Harris & Kolver 2001). From the 1960s, North American Holstein-Friesian (NAHF) genetics were introduced with an expectation that traits for very high production would be expressed in NZ conditions. The mean proportion of these NAHF genetics in the replacement female population increased from 1.7% in 1970 to 40.6% in 2000 (Harris & Kolver 2001).

The NAHF genotype is capable of producing a large quantity of milk, but on a pasture system alone, this strain of dairy cow mobilizes large amounts of body reserves, which results in a reduced lactation length and reproductive performance (Harris & Kolver 2001; Harris & Winkelman 2000). Crossbreeding was adopted to mitigate the deleterious effect of NAHF on reducing fertility (Harris & Kolver 2001). Farmers focused on breeding cows more suited to pasture-based systems (Montgomerie 2004) and also took advantage of heterosis effects, including those that improve fertility (Harris 2005). More recently, semen from elite crossbred sires ('KiwiCross') has been available. These sires were used for 17.4% of AI breeding in 2008 (New Zealand Dairy Statistics 2008-09). Inclusion of a fertility breeding value into genetic worth estimations (Harris *et al.* 2006) could be expected to halt any further decline in genetic fertility (Montgomerie 2004).

## Reproductive management practices

### *Calving induction*

Following the discovery that calving could be pharmaceutically induced prematurely (Adams 1969), the practice of induced calving in cows that conceived late in the breeding period was widely adopted to maintain condensed calving patterns and increase final pregnancy rates by extending the mating period (Welch 1973). Compared with cows calving spontaneously, these cows produced 8% less milk over the lactation, had a 5% lower conception rate to first service, and a 2% greater non-pregnancy rate (Hayes *et al.* 1998). Some of this penalty is probably a consequence of the greater risk of periparturient disorders following induced calving (Malmo 1993). Despite these losses, inductions proved to be beneficial both biologically and economically, compared with much delayed spontaneous calving (Chesterton & Marchant 1985; Malmo 1993; Stevens *et al.* 2000). Use peaked in the 1990s with 7 to 12 % of the national herd being induced annually (Verkerk *et al.* 1997; Hayes 1998; Stevens *et al.* 2000; Xu & Burton 2003).

In an early survey of farmer attitudes, 66% of farmer respondents that did not induce (24% of total) identified welfare concerns as their reason (Williamson 1993). Most farmers that used calving induction disagreed with the statement that "Inductions cause unnecessary suffering to the cow", but did agree to concerns about calf welfare. Of the farmers that induced, 95% said that their primary motivator was to bring late calving cows into earlier production and 71% thought induced cows had more problems. Another survey conducted in 1999 (Stevens *et al.* 2000) reported that above average physical and financial performance can be achieved without the calving induction practice, although there was a positive economic benefit for the practice of inducing. This survey preceded voluntary reduction targets aiming for an industry-wide prevalence of no more than 2% induced cows by 2010.

After voluntary reduction targets had been introduced, views of farmers were again surveyed (Blackett *et al.* 2006). Regardless of whether inductions were practiced, lower non-pregnancy rates and shortening calving spread were consistent goals. Farmers expressed strong views that calving induction and hormone treatments for anestrous cows were "unpleasant" and "unnatural". Inductions were considered to mask systemic problems, affect cow health adversely, and euthanasia of premature calves was acknowledged as a distressing task. Farmers supporting the use of calving induction believed that high non-pregnancy rates and loss of high genetic merit cows were their primary barriers to reducing induction, whereas farmers with 'nil' and 'reducing' induction practices believed that their policy had not affected productivity to any great extent. Whereas some farmers were irritated that local community and overseas customers were able to influence farm practices, they recognized that their future depended on satisfying their markets.

Botha and Verkerk (2002) also explored factors influencing induction decisions and found that the most important consideration was a desire to make spring management easier and to maximize economic returns. The complexities of managing a system subject to the vagaries of weather and its influence on seasonal feed supply (Figure 1) were acknowledged as a barrier to induction reduction.

Factors external to the farm are now driving change, as this reproductive management practice could affect access to international markets (Bodecker 1998). An industry-led initiative to encourage voluntary reduction of calving induction set targets on a national basis at "5% by 2005 and 2% by 2010". After a regulatory review in 2002 concluded that the procedure carries significant risk to animal welfare, a 'Code of Practice' was introduced in 2005 that specified selection criteria for candidates and procedures for animal management. This code has improved welfare outcomes and calving induction rates have fallen to approximately 5%, but in areas of rapid dairy expansion, individual herd induction rates continue to be high. The Code is currently under review, with continuing community pressure to eliminate this practice on the basis of ethical unacceptability. More stringent procedures have recently been established with industry self-regulation supporting further reductions, such that from mid-2012, no more than 4% of cows within a herd should be induced.

*Anestrous cow therapy*

Initial treatments for anestrous cows were estradiol cypionate and intra-uterine iodine infusion, but were found to be detrimental to fertility (Fielden *et al.* 1973). It was not until progesterone was used that anestrous-cow treatments became efficacious. The first treatment protocols involved insertion of a controlled internal drug-releasing (CIDR) device impregnated with progesterone for 4 to 7 days, with or without an injection of equine chorionic gonadotropin at CIDR removal; a 61% conception rate among the 85% of cows inseminated on detection of estrus was achievable (Macmillan & Peterson, 1993; Macmillan & Burke, 1986). A number of systematic changes in drug type and timing for the progesterone-based treatment were subsequently reported, all with the aim of regulating ovarian development and maximizing the proportion of treated animals being detected in estrus (McDougall *et al.* 1992; Xu *et al.* 1997; Xu *et al.* 2000). Submission rates to AI of 90% within a few days after treatment were achievable (Rhodes *et al.* 2003), and the recommended protocol became progesterone treatment for 8 days with 2 mg estradiol benzoate injected at the start of the protocol, and 1 mg estradiol benzoate injected 24 hours after progesterone withdrawal. Using this protocol, a 28-day submission rate of 93% and first-service conception rate of 47% were demonstrated in field trials; as compared with 70% and 45%, respectively, in anestrous cows left untreated (McDougall & Compton 2005). Lower conception rates compared with those routinely achieved in cycling cows are considered a consequence of insemination at the first postpartum estrus (Rhodes *et al.* 1999), rather than a treatment effect *per se*.

Although a 'GnRH-prostaglandin $F_{2\alpha}$-GnRH' treatment (GPG, e.g. 'OvSynch') was promoted as a less expensive alternative, the omission of progesterone resulted in a poorer conception rate when used in anestrous cows (McDougall 2010a). 'Progesterone priming' appears to be required to reactivate behavioral centers in the brain (McDougall *et al.* 1992) and also supports premature luteolysis (Burke *et al.* 1994). Failure of the first GnRH injection to induce formation of a functional corpus luteum, and failure of $PGF_{2\alpha}$ (7 days after GnRH) to induce complete luteolysis were seen as substantial risks when treating anestrous cows with a standard GPG protocol.

In 2007, food safety regulations changed in European Union countries and estrogen treatments for dairy cows were banned in NZ. Treatments were revised, with the most obvious change being to substitute estradiol with GnRH, while retaining progesterone as the basis of treatment (McDougall 2010a).

Although submission and pregnancy rates to AI during the first few weeks of mating were improved for anestrous cows treated with a progesterone-based protocol, it became apparent that these treatments were not improving the 6-week in-calf rate nor the non-pregnancy rate of anestrous cows (McDougall & Compton 2005; McDougall 2010a), which are the key measures of overall herd-level reproductive performance promoted by the New Zealand National Herd Fertility Project (InCalf; Blackwell 2008).

A range of alternative approaches to mitigating an anestrous problem has also been explored. Providing additional feed to high-genetic merit cows appears of limited value, because much of the additional energy is partitioned into milk production, especially in early lactation (Roche *et al.* 2006; Lucy *et al.* 2009), without benefit to cow fertility (Burke & Roche 2007; Lucy 2007). Improved feeding of cows with a higher risk of being anestrus is substantially more successful during the dry period (Burke *et al.* 1995; Chagas *et al.* 2006), when extra intake can be partitioned toward improving body condition at calving, thus reducing the postpartum anovulatory interval (Burke & Roche 2007). Burke *et al.* (2010) reported that feeding a postpartum diet with a high proportion of non-structural carbohydrate reduced the interval to first ovulation by 8 days, although other studies have not detected a benefit of concentrate feeding on fertility (Kennedy *et al.* 2003; DE Dalley *personal communication*).

Once-daily milking is a lactational management strategy that is becoming increasingly popular to reduce energy demand (Figure 1) on the cow through a 20% reduction in milk production. Reducing milking frequency, even for only several weeks postpartum, reduces tissue mobilization and loss of body condition (McNamara et al. 2003), and 3-week submission rates to AI were observed to be 10% greater with this strategy (Rhodes et al. 1998). Cows milked once-daily for the entire lactation also had an 11% lower anestrous rate, an 8% greater 3-week submission rate to AI, and a 5-day shorter interval between calving and conception (Clark et al. 2006). Farmers view once-daily milking in early lactation as a key strategy for cows that calve in poor body condition, with the additional benefit of reducing labor requirements to offset the loss in milk revenue.

Cautionary addendums to these approaches is the positive economic argument for the individual cow by use of an effective anestrous treatment (McDougall 2010b), and likelihood that the observed responses to alternate approaches might not be achievable in all circumstances.

The possibility of a 'bull effect' as a non-hormonal strategy for anestrous cows has been explored by farmers, despite a lack of scientific evidence that bull presence can stimulate ovulation in high-genetic merit, lactating anestrous dairy cows. Norton (2008) reported a study of the reproductive performance of lactating dairy cows not seen in estrus before the start of mating when either comingled with vasectomized bulls for the first 3 weeks of mating, or with tail paint and observation only to aid heat detection. Cows exposed to bulls had a greater 3-week submission rate to AI (78% vs. 71%) and 4-week pregnancy rate (42% vs. 36%), but this strategy did not improve the 6-week pregnancy rate or the final non-pregnancy rate (Norton 2008). The costs and inconvenience of managing vasectomized bulls were noted, but not quantified, and farmer-participants believed that increased performance was due to improved heat detection.

### *Advances in semen processing and artificial breeding services*

The importance of AI for genetic gain was recognized in the 1950s, but the intense seasonal demand was challenging (James 1957), and led to extended-life fresh semen technology with low sperm doses that facilitated use of teams of elite sires (Shannon 1968). Much later, poly-L-lysine encapsulated semen was tested, but proved inferior to the routine use of Caprogen as a semen life extender (Vishwanath *et al.* 1996). By the early 1970s, 60% of herds used AI with conception rates routinely exceeding 60% (Macmillan 1974). Use of AI peaked at 85% of the national herd in the 1990s, but has recently declined to 75% (New Zealand Dairy Statistics 2008-09).

Most AI is performed by a network of professional technicians using mobile electronic recording systems, synchronized daily to the National Database records. This incorporates a tool to match sires to individual cows to reduce deleterious major gene effects and inbreeding (Lopez-Villalobos *et al.* 2004), a recognized threat where semen technologies disseminate elite genetics widely (Stichbury 1968; Lucy 2007).

Sex-sorted semen is available from within NZ (using local sires) and overseas. The economic case for sex-sorted semen is sensitive to additional costs of semen production and poorer conception rates (Underwood *et al.* 2010), so currently routine use is limited (WH McMillan *personal communication*). Increasing community concerns about surplus dairy calves slaughtered for veal and leather, or an acute shortage of replacement females, may see this re-evaluated.

### *Estrous detection*

Widespread use of AI has made heat detection a critical skill. Although the concentrated mating period is conducive to high estrous detection efficiency, as sexually active groups form easily and cows have optimal under-foot conditions to express mounting behavior, this remains the most labor intensive and skilled task in reproduction programs. Poor detection of estrus results from errors in sensitivity and specificity (Xu and Burton 1996). Errors in sensitivity (missing cows in estrus) manifest as later calving in the subsequent season with lower production, and fewer AI-bred replacement heifers, are estimated to cost NZ$160 each during the AI period. Errors in specificity (inseminating cows not in estrus) is an immediate waste of semen and time spent inseminating, provides misleading information that may influence future estrous detection and potentially terminates pregnancy if the cow has already conceived (Macmillan *et al.* 1977; Sturman *et al.* 2000; Burke *et al.* 2005).

Estrous detection efficiency in high-yielding cows managed intensively is less than 50% (Senger 1994). Although some of this inefficiency may be management-related, faster clearance rates of circulating estradiol may also lead to a weaker signal for estrus (Sangsritavong et al. 2002; Lopez et al. 2004; Wiltbank et al. 2006). Although per cow production of milksolids (fat plus protein yield) in NZ has increased by about 25% over the last 2 decades (New Zealand Dairy Statistics 2008-09), peak milk yields from well-managed high-genetic merit cows are only 25 to 35 kg/d, less even than what overseas studies define as 'low producers'! Higher producing NZ cows are unlikely to have attained the level of production that would reduce expression of estrous behavior. At a phenotypic level, there is no evidence of a negative association between milksolids (fat and protein yields) production and fertility in NZ dairy cattle (Xu & Burton 2003, Pryce & Harris, 2006).

Estrous detection efficiencies in different strains of HF dairy cattle were compared using milk progesterone measurements (Macdonald *et al.* 2008; Lucy *et al.* 2009). Overall detection efficiency averaged 84% with 16% of anticipated estruses missed, and 16% of recorded estrous observations being false positives. An increased difficulty in detecting estrus in the NAHF genetic strain was not supported by these data.

Increasing herd size reduces estrous detection performance and satisfactory levels cannot be achieved without technological aids (Senger 1994; Diskin & Shreenan 2000; Rae 2002). Tail paint is the most widely used estrous detection method in NZ, but estrous mount detector products attached to the tail-head are also popular. These aids assist with heat detection, but none advance the farmer beyond visual identification.

## External influences on reproduction management practices

Influences beyond the farm gate increasingly affect management practices on the dairy farm. The comprehensive NZ industry strategy for dairy farming's future (DairyNZ 2009) identifies external influences originating from; (1) the NZ Public; (2) Consumers and Trade; (3) Government and Regulations; and (4) Stewardship and Social Responsibility (Figure 2). On-farm factors are partitioned into those that influence production, including resource use, and those arising as a consequence of human capability in farm management activities, both of which are influenced externally.

### *The New Zealand public*

Local citizens draw their views of animal production systems from their collective knowledge, and given that the degrees of separation in the urban-rural divide in NZ are fewer than in more urbanized countries, their local knowledge tends to increase their level of trust of farmers, such that they may be more 'forgiving' of the way that production systems interact with the animals; they are, however, much less tolerant of farm practices that affect the quality of the environment, especially water quality. Regional authorities are more strictly regulating land and water use, and proposed caps on the level of nitrate leaching in some areas is forcing farmers to consider changes to their farming systems. These proposals may ultimately constrain stocking rates and milk productivity, but technological solutions to these issues without constraining milk production are more likely to result in changes to management systems in which cows spend a proportion of their time off pasture. Changes that lead to longer periods of confinement on hard surfaces, especially during the spring breeding period, may reduce estrous detection efficiency such that traditional methods used now (Macmillan *et al.* 1988) may no longer be adequate. Investment in constructed areas to stand cows off pasture for periods of time gives farmers greater flexibility for feed inputs other than pasture, and as the proposed changes to reduce levels of calving induction also take effect, there is a likelihood that some NZ farmers will consider a shift away from a strictly spring calving towards longer lactations involving both autumn and spring calving herds.

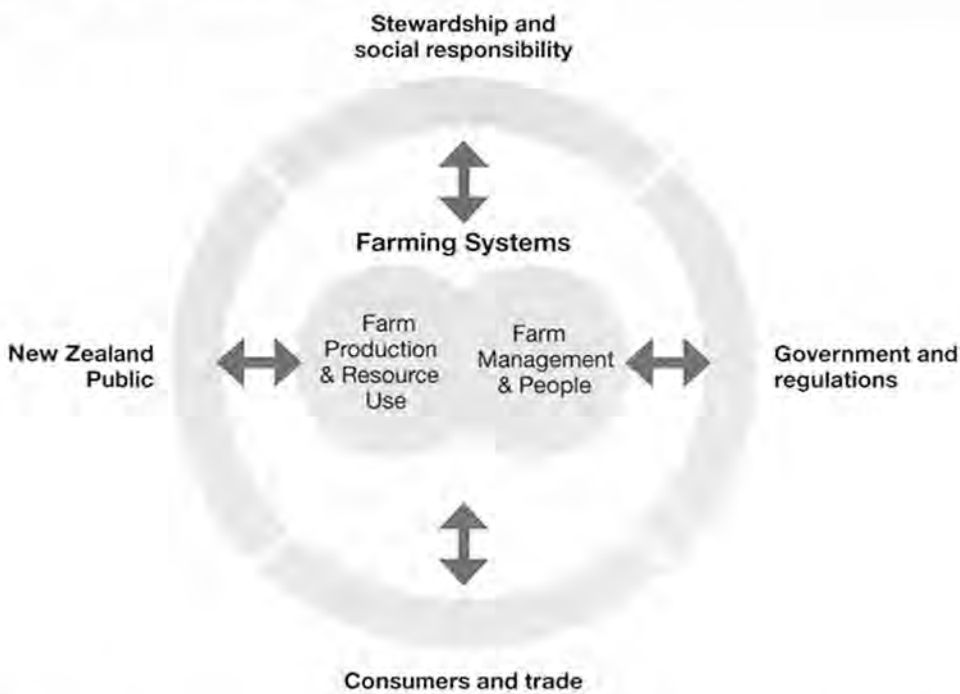


**Fig. 2.** The comprehensive New Zealand industry strategy for dairy farming's future (*www.dairynz.co.nz/file/fileid/14354*): sources of external influence over dairy farm systems in New Zealand (DairyNZ 2009).

*Consumers and trade*

Martin *et al.* (2009) referred to the increasing consumer demand for animal products that are "Clean, green and ethical" (CGE), suggesting social-sexual signaling, nutrition and genetic selection strategies as possibilities for remaining productive and profitable while delivering a 'CGE product'. Matthews (2007) noted that key international drivers for change in livestock welfare, and associated welfare regulations, included: demands and activities of non-governmental organizations, corporate and retailer actions, and international trade/animal welfare policies. Farm management practices noted as welfare sensitive issues included AI and early calf separation (Matthews 2007). Seasonally-related changes in body condition reserves associated with seasonal variation in quality and quantity of feed, inadequate protection from adverse climates, and the number of animals per stockperson are also identified among community concerns about animal welfare.

External pressure to improve performance in certain areas (e.g. to improve body condition) would tend to be congruent with industry recommendations to improve reproduction performance, but other practices noted as potential welfare topics (AI and early calf separation) are likely to be defended vigorously by mainstream industry, as these practices are considered indispensible to future success of the dairy farm business.

### *Government and regulations*

The establishment of the New Zealand Food Safety Authority (NZFSA) followed similar United Kingdom initiatives to create a transparent separation between the regulatory and compliance processes that protect food safety and those that manage food production. The consequence is that greater weight is given to consumer arguments in debates on the acceptability of products and practices that can influence food safety. For example, it was a European Community decision that led to the NZFSA ban on the use of estradiol in NZ. To some extent, processing companies can manage specific residue-related issues by segmenting their processing systems. In the case of estradiol, however, widespread use made it logistically impossible to segment the proportion of supply going to the European Union market.

### *Stewardship and social responsibilities*

Farmers in NZ have long understood that they must meet the needs of their marketplace and are generally also prepared to meet the challenges posed by the local community around resource management and animal welfare. Recently (Feb. 2010), the NZ Ministry of Agriculture and Forestry released a 'Code of Welfare for Dairy Cattle' as a tertiary regulation under the 1999 Animal Welfare Act (*www.dairynz.co.nz/file/fileid/20167*). This new code describes minimum standards of care and recommended best-practice for the management of dairy cattle. It was developed collaboratively with the dairy industry, but represents an agreed position across the wider community as to expectations for the care of dairy cattle. The code serves at a regulatory level in the prosecution of farmers that fail to meet standards, and is an important definition of expectations for 'stewardship and social responsibility'.

## Managing reproductive performance in the future

Reproductive management practices will inevitably continue to be influenced by external factors associated with food safety, animal welfare and environmental resource management, key factors that influence the perceptions of consumers. In managing these risks, there will be an increased emphasis on strategies that prevent, rather than treat, reproductive failure.

### *Exploiting the inherent fertility from the pasture-grazed, seasonal system*

Large-scale studies in Australia (Morton 2010) and NZ (Xu & Burton 2003) reported substantial variation in reproductive performance among herds within similar climates and with similar genetic compositions (Figure 3). Managerial factors were largely responsible for the variance and these studies provided crucial data to establish a hierarchy of measures from the overall measures of 6-week in-calf rate and final non-pregnancy rate to the underlying drivers (i.e. submission and conception rates) and other quantifiable areas of management that contribute to reproductive performance (Figure 4). The Australian study lead to an extension program, called 'InCalf' (Morton *et al.* 2003), to support farmers and their advisers achieve incremental gains in herd reproductive performance. This program has been adapted for use in NZ (Burke *et al.* 2008a & 2008b; Blackwell 2008). Success requires that farmers monitor and actively manage the areas that influence reproductive performance at herd level (Figure 4). They are encouraged to make full use of their advisory network, which collectively has the expertise to support the multifactorial complexity of improving reproductive performance.

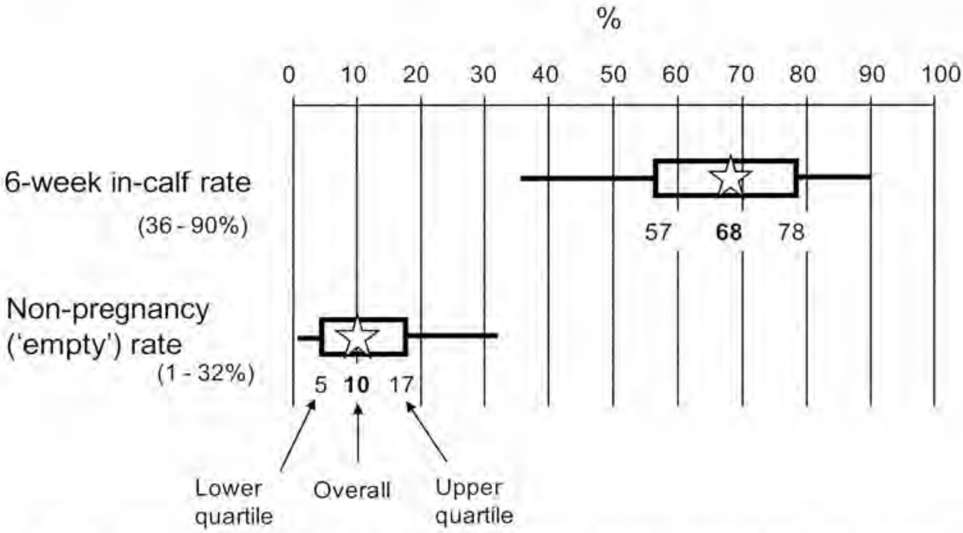


**Fig. 3.** Distribution and quartile levels of performance for the 6-week in-calf rate and non-pregnancy ('empty') rate from an industry survey involving 101,185 cow records during the 1998 to 2000 seasons in New Zealand (Xu & Burton 2003).

Inherent fertility associated with both genetics and AI practices is one of the eight managerial ingredients that influence herd reproductive performance (Figure 4). Farmers have choice over breed, and can also prioritize their preferred traits. Herd improvement companies and the national evaluation system must ensure that genetic fertility does not unwittingly decline further (Grosshans *et al.*1997; Montgomerie 2004), while acknowledging that the inclusion of multiple measures of fertility in genetic evaluation is hampered by cost and impracticality. Genomic selection methods and particular gene markers may mitigate some of these issues and advance the rate of gain in particular traits of interest (Gatley 2008). Genomic predictions increase the reliability of the breeding value for fertility by 3-4% in proven bulls, and by 20% (32 to 52%) in unproven bulls (Harris & Johnson 2010), allowing bulls as young as 2 years old to be promoted with associated increases in the rate of genetic gain.

The other seven managerial areas influencing reproductive performance at herd level are depicted in Figure 4. It can be argued that commonly used 'reproductive technologies' do not improve herd fertility. For example, hormonal treatment of noncycling cows does not improve 'overall reproductive performance' (McDougall & Compton 2005 & 2006; McDougall 2010a), and if the underlying problem is ignored, the herd becomes a 'symptomatic reactor' on an annual cycle. In contrast, reducing the proportion of late calving cows and ensuring that calving body condition score targets are achieved reduces the incidence of noncycling (McDougall *et al.* 1995; Roche *et al.* 2007), and hence improves overall reproductive performance (Xu & Burton 2003). Although most farmers and veterinarians intuitively agree, the InCalf extension program has a mandate to 'remind' and facilitate a wider adoption of this strategic approach to improving herd-level reproductive performance.

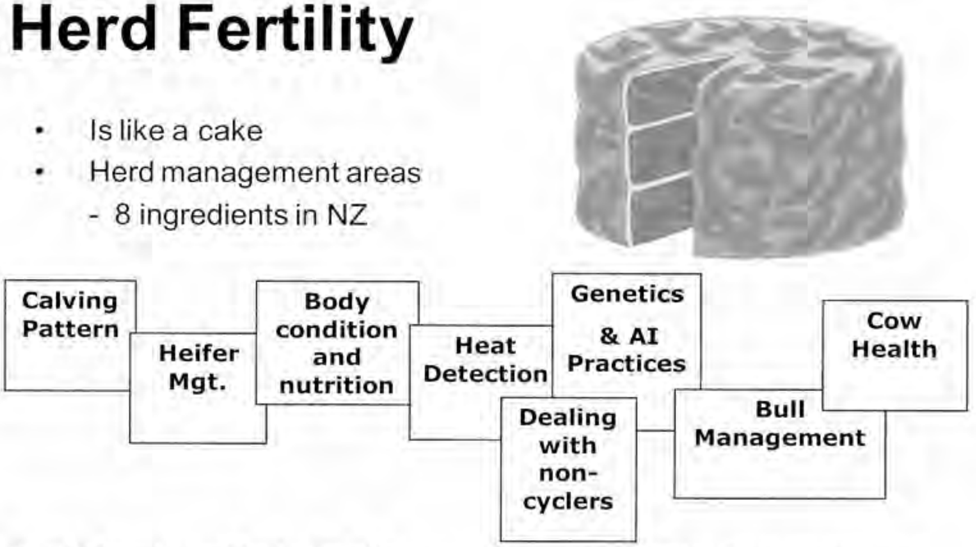


**Fig. 4.** Schematic used for the 'InCalf'extension program depicting the 8 management areas ('ingredients of the herd fertility cake') identified as being the most influential on dairy herd reproductive performance in New Zealand (Morton *et al.* 2003; Burke *et al.* 2008a).

*Advances in automation, information technology, and biosensing*

There are some time-consuming tasks in fertility management that must be performed to a high standard, and automation technologies present an opportunity to improve performance in these areas.

Substantial opportunities exist to automate estrous detection. Current technologies do not fully meet performance expectations, as they still require substantial labor input, are expensive, fragile, and can be unreliable. The major problem with current methods (viz. visually with aid of tail paint) is the laborious and somewhat skilled nature of the task (CR Burke & MB Blackwell *unpublished*). Farms may be more affected where multiple or novice staff have responsibility for estrous detection as compared with the more traditional farm managed by a single experienced operator. Farmer expectations are that an automated estrous detection system would remove the 'human' element by identifying and drafting estrous cows accurately, quickly and reliably, without disturbing the flow of the milking operation. Significant progress with automated estrous detection in NZ is reported, including use of a camera (Hempstalk *et al.* 2010) and activity-based monitoring systems (Harris *et al.* 2010).

As robotic milking systems develop for pasture-based farming, more dairy cows in NZ will be milked through robots. Robotic milking has been associated with a longer interval to first service (Kruip *et al.* 2002). It was speculated that less farmer-cow contact contributed to this difference and that cow fertility *per se* was not compromised. High levels of reproductive performance were consistently achieved in a NZ pasture-based, seasonal robotically milked herd (J. Jago *personnel communication*). The difficulty for estrous detection in this system is a lack of forced group movement, cows located at multiple sites and an overriding objective to minimize labor inputs (Burke *et al.* 2005).

Advances in information technology are expected to assist farmers, as monitoring systems and high quality records are required for managing for good reproductive performance. Information technology continues to develop with radio-frequency identification (RFID) systems to identify individual cows as part of a national animal identification and traceability initiative (NAIT), integrated with walkover weighing, and systems to draft pre-determined animals directly after milking (e.g. Protrack; LIC, Hamilton, NZ). These systems are increasingly viewed in larger herds as essential equipment, but issues remain with the integrity of tags and tag readers, which do not achieve 100% perfection in their operation.

Biosensing technologies offer opportunities for direct assessment of reproductive activity and performance indicators in areas that influence reproductive performance, such as nutrition and energy status (Miglior *et al.* 2009). When combined with automation, these technologies should aid farmer decision-making, especially in the context of minimal individual cow attention and scarcity of skilled labor. The cost-benefit argument will remain a major hurdle to widespread adoption on NZ farms.

## Conclusions

As the seasonal, pasture-based dairying system in NZ has developed, one fortunate aspect has been that a relatively high level of cow fertility has been retained. Product image and market risk factors have influenced and will continue to influence on-farm reproductive management practices. Current trends suggest that future approaches to managing reproduction will favor preventative strategies that circumvent the need to intervene with hormones, and avoid practices that have an adverse effect on perceptions of animal welfare, food safety, and the environment. Advances in strategic information capture and automation will assist farmers with the monitoring and decision-making tasks required to effectively manage fertility in the herd.

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