EXTENDING LACTATION TO 670 DAYS

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Summary

- In a recent Dexcel study, a herd of 56 genetically divergent New Zealand (NZ) or overseas (OS) Holstein-Friesian (HF) cows calved in July 2003 and were milked through until May 2005 in order to achieve an extended lactation with a 24-month calving interval.
- Cows were fed 0, 3, or 6 kg DM/d of a maize/barley concentrate and grazed pasture as one herd. Supplementation did not affect days in milk (DIM), but OS HF tended to have longer lactations than NZ HF (619 vs. 590 DIM, respectively).
- The average cow produced 940 kg milksolids (MS) over a two-year lactation compared with 540 kg MS in a normal 300-day lactation. However, OS HF fed moderate to high levels of concentrate had the highest yields of milk (14,705 kg) and MS (1145 kg), and were able to produce as much MS over two-year lactation as in two single-year lactations. NZ HF fed all-pasture had the lowest production (22% reduction in MS).
- Milk produced during the entire extended lactation contained 6% more protein and 5% more milkfat compared with a normal 300-day lactation, which increased the value of milk produced.
- The results of this trial demonstrate that productive lactations of up to 650 days are biologically possible on a range of pasture-based diets. Potential future uses of extended lactation are diverse and include dairy systems with either 18- or 24-month calving intervals, seasonal or split calving, pasture only or brought-in supplementary feeds, use of once-a-day (OAD) milking through winter, or a combination of the above. Preliminary results from economic modelling of these scenarios indicate that 18-month calving intervals are currently the most profitable way to extend lactation. However, selection of high-producing animals with strong lactational persistency may result in profitable, extended lactation systems, with 24-month calving intervals.

Notes:

Introduction

Milking cows for two consecutive years, with calving and mating occurring every second year, may exploit the superior lactation persistency of high-yielding cows while improving reproductive performance. Simulation modelling indicates that extended lactation systems also have the potential to provide long-term economic and environmental benefits relative to traditionally managed farms (Rotz *et al.*, 2005). The expected benefits of extended lactations compared with 12-month seasonally calving systems include a reduced number of days dry within the cows lifetime; reduced per cow costs associated with mating, calving, animal health, and cow replacement; a more even spread of labour requirements, input costs and income throughout the year (Borman *et al.*, 2004); and improved animal well-being through reduced metabolic stress, exposure to fewer periods of high risk (eg, calving), and increased longevity (Knight, 1998). Fundamental changes in the modern cow's ability to continue producing at high yields for a much longer proportion of lactation, and consequent low fertility (Thatcher *et al.*, 2005), has been a primary driver of interest in extended lactation.

To date, the impact of level of nutrition on extended lactations has not been quantified, with most controlled studies of extended lactation having been conducted in similar confinement feeding systems with an increase in calving interval of up to 18 months (Arbel *et al.*, 2001; Bertilsson *et al.*, 1997; Knight, 1998; Rehn *et al.*, 2000), and in conjunction with the use of bST (van Amburgh *et al.*, 1997) or increased milking frequency (Osterman & Bertilsson, 2003). The application of extended lactations to seasonal farm systems has been reviewed by Borman *et al.* (2004) who contended that extended lactations could be a suitable option for some pasture-based systems, but that this would depend on cow milk production potential, ability to grow pasture or feed supplements economically, management capability, environmental constraints, herd size and labour availability. Research at Ellinbank in Victoria, Australia (Auldist *et al.*, 2007) with grazing dairy cows supplemented with 5 kg DM concentrate/day has recently shown that calving intervals of 15, 18, 21 and 24 months resulted in a MS loss of 0, 1, 5, and 6%, respectively, compared with a 12-month calving system, indicating the potential to develop successful extended lactation systems.

The study presented in this paper tested the ability of cows grazing pasture to achieve 670-day lactations when calving every two years. The first objective was to quantify the impact that level of nutrition had on achieving extended lactations. As previous studies at Dexcel have shown an interaction between the level of nutrition and cow genotype/strain the second objective was to compare the performance of HF cows of NZ or OS origin in a 24-month calving interval system.

Trial design

A herd of 56 genetically divergent NZ HF and OS HF grazed pasture and were individually offered 0, 3, or 6 kg DM/cow/day of a pelleted maize/barley concentrate at the

Dexcel Lye Farm from June 2003 to May 2005. Cows were allocated to the six treatments (NZ0, NZ3, NZ6, OS0, OS3, OS6) based on genotype and breeding worth (BW), and within genotype treatments were balanced for sire, liveweight and expected calving date. The average age distribution within treatments was 9% two-yr olds, 23% three-yr olds, and 68% mixed-age cows. NZ HF and OS HF had an average BW of 124 ± 31.2 and 116 ± 37.1, respectively, and a Production worth (PW) of 113 ± 60.6 and 115 ± 59.2, respectively, with the OS HF predominantly of North American ancestry.

The mean calving date was 28 July 2003 and cows were milked through until May 2005 to target 670-day lactation (i.e., 24-month calving interval). Cows were mated over an 11-week period (4 weeks AI followed by 7 weeks natural mating) beginning on 25 September 2003, 82 days after the start of calving. This provided information on reproductive performance in a normal 12-month seasonal calving system. However, in order to achieve a 24-month calving interval, pregnancies were then terminated beginning 46 days after conception. The start of the subsequent mating occurred on 28 September 2004 and consisted of 5 weeks AI followed by 6 weeks natural mating.

Cows were grazed as one herd and were offered generous pasture allowances of 50 kg DM/cow/day with a flat rate of individual concentrate feeding of 0, 3, or 6 kg DM/cow/day in the dairy at milking time. Post-grazing residuals were used to determine pasture allocation; 1800 kg DM/ha was targeted during spring and autumn and 2200-2400 kg DM/ha during summer. A 21 day grazing round was used in spring, summer and autumn, and this was slowed to a 60 day round during winter (June) followed by a 40 day round in early spring (August). A total of 846 kg pasture silage DM/cow was calculated to be consumed during the two-year lactation, and was fed for 37 days in August-September 2003 (3.6 kg DM/cow/d); 109 days from April to July 2004 (4 kg DM/cow/day); and 53 days from August to September 2004 (5.9 kg DM/cow/day) to maintain pasture residual targets.

Milk yield was recorded daily and milk composition (milkfat, protein, lactose, somatic cell counts [SCC]) determined weekly. Liveweight was recorded weekly and body condition score (BCS) measured fortnightly. Detailed measurements were also recorded for the incidence of mastitis, and reproductive data.

Notes:

Lactation length for the "normal" 12-month calving interval was calculated from time of calving to a theoretical dry-off date based on decision rules outlined in Macdonald *et al*. (2005); using BCS, time from calving, and daily milk production, with a final imposed dry-off on the 16th May. Drying off decisions for the rest of lactation were based on milk production (<4 kg milk/day for two weeks; <5 kg milk/day for two weeks during the last two months of lactation). A "normal" lactation for each treatment was defined as the period from calving to the theoretical dry-off date (calculated as 296 ± 23.6 DIM), and "normal" reproductive performance refers to outcomes of the September 2003 breeding season. "Annualised" production was defined as the production achieved during the 24-month calving interval divided by two years to give an annual production. The ratio of annualised to normal production indicates the relative advantages or disadvantages of extended lactation on an annual basis.

Research findings

Milk yield and composition

Of the 56 cows used in the trial, 93% were milking at 500 DIM and 18% were milking at 650 DIM. Supplementation did not affect lactation length, but OS HF tended to have more DIM than NZ HF (619 vs. 590 DIM, respectively), with twice as many still in milk at final dry-off (Table 1). A greater proportion of the OS HF herd was still milking at 500 DIM (100 vs. 86%) and at 550 DIM (96 vs. 80%) compared with NZ HF cows, respectively, but differences were not significant at 600 DIM (74 vs. 62%) and only a trend was apparent at 650 DIM (26 vs. 10%).

On all diets during the extended lactation resulting from a 24-month calving interval, OS HF produced more milk with a lower milkfat and similar protein content, produced more MS expressed as kg/cow or as a percentage of liveweight, and gave a greater milk and MS response to concentrate compared with NZ HF (Table 1). Supplementation with increasing levels of concentrate for an extended lactation produced a linear increase in yields of milk and MS, and differences in milk production between cow genotypes were greatest at the highest level of supplementation. The average cow produced 940 kg milksolids (MS) over a two-year lactation compared with 540 kg MS in a normal 300-d lactation. Annualised MS production from NZ HF was 79% of that produced in a normal 300-day lactation, compared with 94% for NA HF. However, OS HF fed moderate to high levels of concentrate had the highest yields of milk (14705 kg) and MS (1145 kg), and were able to produce as much MS over two-year lactation as in two single-year lactations. The lowest producing group were NZ HF fed all-pasture, which had a 22% reduction in MS yield on an annualised basis.

The pattern of MS production over the extended lactation is presented in Figure 1. By the end of the first normal season, cows were producing between 1.3 kg MS/day (all-grass), and 1.9 kg MS/day (6 kg DM concentrate/day). Production dropped over winter to between 0.8 and 1.7

kg MS/day across these treatments. MS peaked again in the second spring, in some cases back to 2 kg MS/day (e.g., OS cows fed 3 kg DM concentrate/day). A greater MS response during the second peak was observed in OS HF compared with NZ HF, and in cows on the 0 and 3 kg DM concentrate/day treatments compared with the 6 kg DM concentrate/day treatments. This indicates that the second peak may be a function of feeding, most likely the level of nutrition during the preceding winter, and that OS HF are likely to be in greater feed deficit during this period compared with NZ HF. Therefore, the level of nutrition during the winter period is a critical factor affecting milk production during extended lactation.

Importantly, the maintenance of high milk protein content (approx. 4.1%), and to a lesser extent milkfat content (approx. 4.7%), during the second season of an extended lactation resulted in the milk produced during the entire extended lactation containing, on average, 6% more protein and 5% more milkfat, compared with a normal 300-day lactation. This partially offset the decline in milk volume during extended lactation and increased the value of the milk produced. At a $4 payout this would boost payout to $4.14/kg MS during the second season or $4.07/kg MS for the entire extended lactation. Premiums for supply of winter milk from this system would further increase payout.

Notes:

Table 1: **Production data of New Zealand (NZ) and overseas (OS) Holstein-Friesians** grazing pasture and fed 0, 3, or 6 kg concentrate DM/cow/d during extended lactation

	Treatment					
	NZ0	**NZ3**	**NZ6**	**OS0**	**OS3**	**OS6**
Cows per treatment	10	9	10	8	9	10
Calving date (2003)	19 July	5 Aug	20 July	31 July	9 Aug	26 July
Concentrate (kg DM/cow/lactation)	0	1817	3123	0	1802	3611
Production						
Milking at final dry-off (% of herd)	20	22	0	38	56	50
Days in milk	595	608	567	623	604	630
Milk yield (kg/cow)	8908	10929	9931	10814	13962	15448
Milkfat (%)	4.88	4.62	4.24	4.46	4.19	3.92
Milk protein (%)	3.82	3.76	3.72	3.74	3.74	3.65
Milksolids (kg/cow)	762	919	789	881	1109	1180
Annualised milksolids[1] (kg/cow)	381	460	395	441	555	590
Normal milksolids[2] (kg/cow)	489	551	530	494	556	625
Ratio annualised:normal milksolids	0.78	0.83	0.75	0.89	1.00	0.94
Milksolids efficiency (% LW)	144	163	135	145	188	183
Response (g MS/kg concentrate DM)		86	9		127	83

[1]Production during the 24-month calving interval divided by two years to give an annual production

[2]Production during the period from calving to the theoretical dry-off date in a 12-month calving interval system (calculated as 296 ± 23.6 DIM)

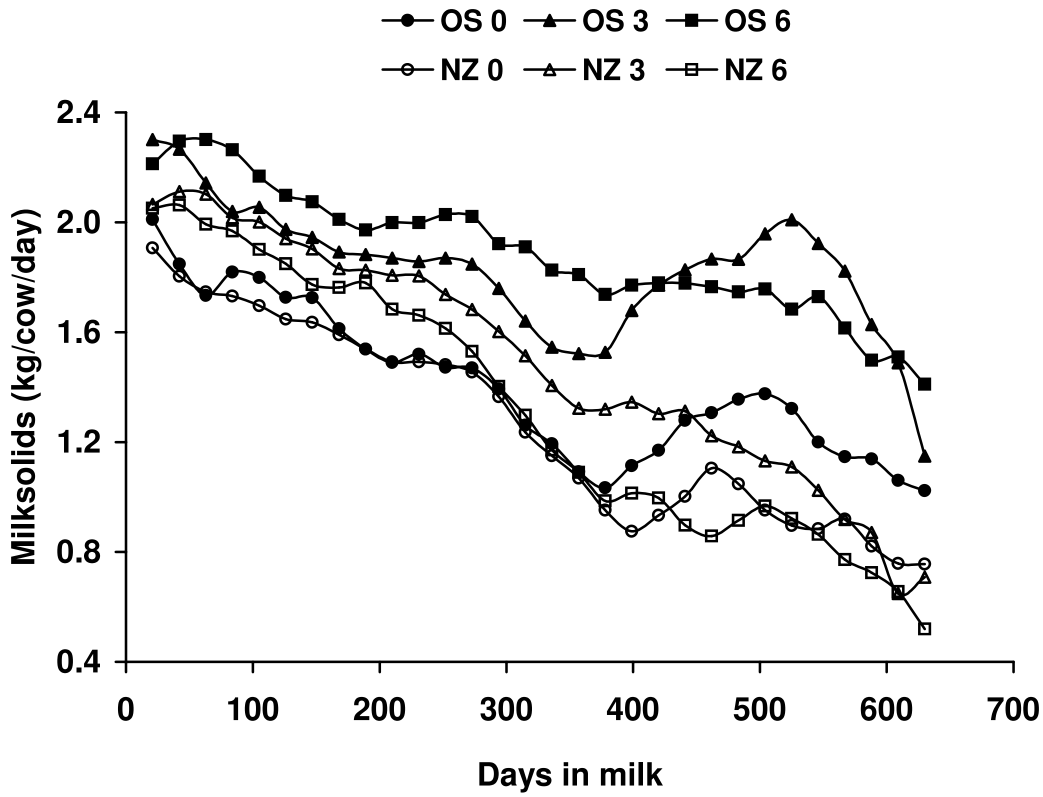

Figure 1: Average daily milksolids yield (kg/cow) of New Zealand (NZ) and overseas (OS) Holstein-Friesians grazing pasture and fed 0, 3, or 6 kg DM concentrate/cow/d during extended lactation.

Liveweight and BCS

OS HF started the lactation with a greater liveweight, but similar BCS, compared with NZ HF (Table 2 and Figure 2). Liveweight and BCS declined in early lactation for all genotypes and diets. During the extended lactation, OS HF gained less BCS and, therefore, dried off at a higher liveweight but lower BCS (1.9 units less), compared with NZ HF. Supplementation with increasing levels of concentrate for an extended lactation produced a linear increase in liveweight and BCS gain during lactation, and in final liveweight and BCS at dry off (Table 2 and Figure 2). On all dietary treatments, liveweight and BCS at dry off following an extended

Notes:

lactation were greater than if cows were dried off following normal 300-day lactation. The excessive BCS gained by NZ HF cows, especially those at the highest level of supplementation, during extended lactation presents a management issue both for the current season, and the following season. This suggests that both persistency of milk production and maintenance of acceptable body condition will be important for future selection of cows suitable for extended lactations.

Table 2: Liveweight and body condition score of New Zealand (NZ) and overseas (OS) Holstein-Friesians grazing pasture and fed 0, 3, or 6 kg concentrate DM/cow/day during extended lactation

	Treatment					
	NZ0	**NZ3**	**NZ6**	**OS0**	**OS3**	**OS6**
Liveweight						
Start of lactation[1] (kg/cow)	512	508	512	623	591	605
Dry off[3] (kg/cow)	638	712	692	714	706	784
Change (kg/cow)	126	203	181	92	118	175
Body condition score (BCS)						
Start of lactation[2]	5.78	5.99	5.81	5.78	5.45	5.89
Dry off[3]	7.74	8.53	9.03	6.30	6.10	7.26
Change	1.96	2.54	3.22	0.52	0.65	1.37
Response (BCS units/t conc. DM)		0.10	0.42		0.11	0.29

[1]One week post-calving

[2]Immediately prior to calving

[3]As at actual dry-off, averaged across individual cows in each treatment

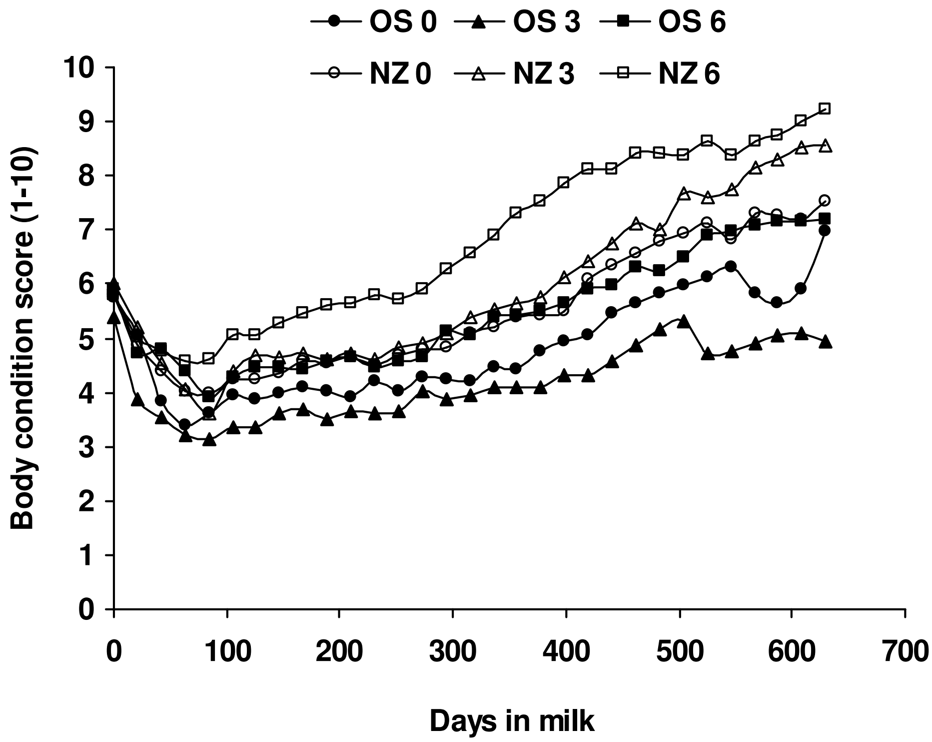

Figure 2: Average body condition score (1-10 scale) of New Zealand (NZ) and overseas (OS) Holstein-Friesians grazing pasture and fed 0, 3, or 6 kg DM concentrate/cow/d during extended lactation

SCC and incidence of mastitis

Average individual cow SCC increased by 3-fold in the extended or second season of the lactation compared with the first season, but remained below 200,000 cells/ml (Figure 3; Lacy-Hulbert *et al*., 2006). While there was no significant difference in cow SCC between genotypes in the first season (mean 56,000 cells/ml), NZ HF had a slightly higher SCC during the second season compared with OS HF (191,000 vs. 115,000 cells/ml, respectively). However, there was no observed effect of dietary treatments on cow SCC and incidence of mastitis during this study (results not shown).

Notes:

OS HF tended to have twice as many cases of clinical mastitis in the first season compared with NZ HF (59 vs. 27% of cows infected at least once, respectively), but there was no difference between genotypes in the second season (20 vs. 18%, respectively). The increase in SCC occurred regardless of infection status of the udder, and there was no increase in the incidence of clinical mastitis during extended lactation. In fact, cows experienced less mastitis during the second spring of lactation, a time of year commonly associated with calving-related increases in mastitis in NZ.

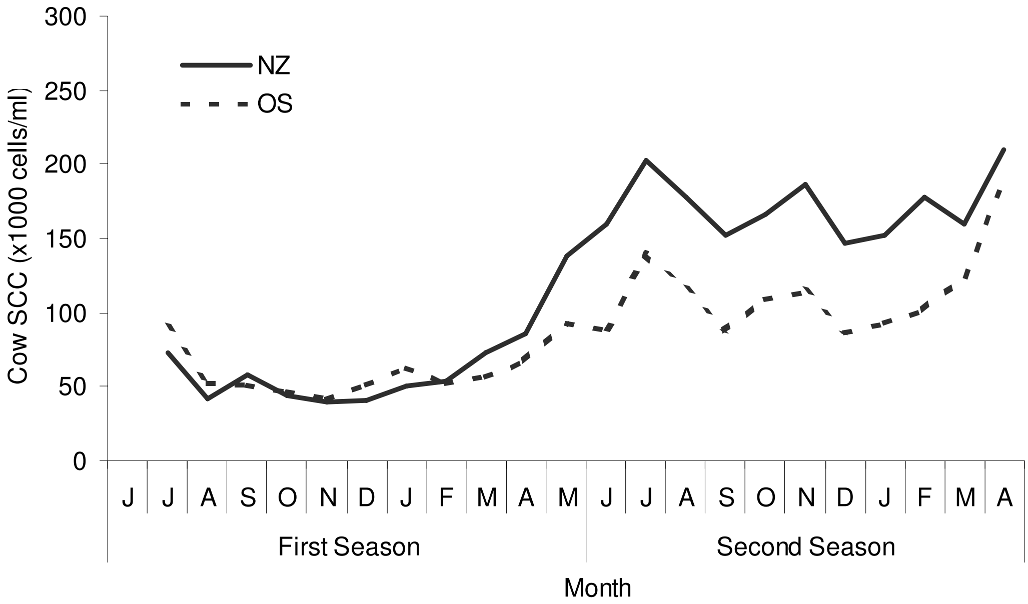

Figure 3: Average monthly individual somatic cell counts (SCC) of New Zealand (NZ) and overseas (OS) Holstein-Friesians during extended lactation. From Lacy-Hulbert *et al*. (2006)

Reproduction and fertility

In the first season, OS HF had a lower 3-week submission rate and 6-week pregnancy rate, a higher predicted empty rate and number of phantom cows (ie, cows that were inseminated once, didn't return, and were assumed pregnant but were found to be empty), and a similar first service conception rate and number of at-risk cows compared with NZ HF (Table 3). Pregnancy was then terminated beginning 46 d after conception, in order to achieve an extended lactation. Cows were re-mated in the second season, 451 day after the start of calving. All but four cows (who were treated for cystic ovaries) were cycling prior to the planned start of mating. In the extended lactation mating period, OS HF had a lower 6-week pregnancy rate, a higher final empty rate and number of phantom cows, and a similar 3-week submission rate, first service conception rate, and number of at-risk cows compared with NZ HF. Supplementation did not significantly affect reproductive parameters in either season in this study (results not shown).

Although a direct comparison of reproductive performance during normal and extended lactation is confounded in this study by year (different seasons and different breeding policy) and is limited by small numbers of cows, the results indicate that mating and calving cows every second year improves reproductive performance. However, OS HF cows continued to have poorer reproduction and fertility than the NZ HF cows, despite being in positive energy balance and having a desirable BCS at mating in the second season (Figure 2), pointing to an underlying sub fertility in this genotype.

Table 3: Reproductive performance of New Zealand (NZ) and Overseas (OS) Holstein-Friesians during a normal[1] vs. extended[2] lactation mating

Treatment	**Normal**		**Extended**			**Significance level**	
	NZ	**OS**	**NZ**	**OS**	**SED**	**Normal**	**Extended**
Reproduction							
3-wk submission rate (%)	93	59	86	85	10	P<0.01	NS
First service conception rate (%)	38	19	59	48	13	P=0.12	NS
6-wk pregnancy rate (%)	62	26	79	56	12	P<0.01	P<0.05
Empty rate (%)	14	48	3	30	11	P<0.01	P<0.01
At-risk cows[3] (%)	41	41	0	0			
Phantom cows[4] (%)	0	11	0	15			

[1]Spring 2003 mating (planned start of mating 84 days after planned start of calving).

[2]Same cows during spring 2004 mating (planned start of mating 451 days after planned start of calving).

[3]Cows that had calved within 30 days of planned start of mating, had calving difficulties or twins, displayed uterine infections, discharge, or retained foetal membranes after calving, or had metabolic problems.

Notes:

[4]Cows that were inseminated once, didn't return, and were assumed pregnant but were found to be empty.

Potential extended lactation farm systems

The results of the Dexcel study have demonstrated that calving cows every second year and extending lactation across two seasons is feasible under a range of pasture-based dairy systems, challenging the traditional concept that cows need to be calved every year. This practice has direct relevance for split-calving herds, but other extended lactation farm systems may be possible, including calving every second spring, calving half the herd every spring, or milking on a portion of the herd identified as being suitable for extended lactation. Empty high-producing cows may also be milked on and given another chance to become pregnant the following season, when they would have otherwise been culled and their genetic material lost to the dairying herd. In addition, OAD milking could be used in June and July to reduce workload during the normal winter dry period in an extended lactation system.

The Dexcel Whole Farm Model has recently been revised to successfully model extended lactations and has been used to compare a range of potential extended lactation farm systems with annual seasonal systems. The extended lactation systems modelled, include: seasonal or split 18-month calving interval; seasonal or split 24-month calving interval; pasture only with no brought-in feed or pasture based with either brought-in pasture silage or concentrates; and the use of either NZ HF or OS HF cows. Preliminary results indicate that an 18-month calving interval is the most profitable way to extend lactation, with minimal losses in MS production compared with a 12-month calving interval. This supports extended lactation data from Ellinbank, Australia (Auldist *et al*., 2007). Extending lactation using a 24-month calving interval was more suited to OS HF compared with NZ HF as they had more persistent lactations and a greater MS response to supplementary feeding. Savings on reproduction (mating/calving) costs in an extended lactation system are a major driver of working farm expenses contributing to a profitable economic farm surplus (EFS).

Future extended lactation research

Ongoing work in NZ and Australia is developing methods to select cows for extended lactations, and is exploring the most profitable pasture-based systems. Individual cows vary in their ability to maintain milk production for an extended lactation, and potential exists (using cow genotype, milk production, BCS, and hormone and metabolite data) to select high-yielding animals suitable for extended lactations. Results so far indicate that cows with higher milk and MS yields, and lower BCS, during a normal 300-day lactation are more likely to have increased MS production in an extended lactation (Kay *et al*., 2007). In other words, cows which preferentially put energy into MS production rather than BCS gain will continue to milk past 300 days without getting too fat. A genetic marker(s) for extended lactation cows is also being investigated. In particular, we are interested in being able to select those cows which have a strong ‘second peak” in the second spring.

Winter feeding has been identified as a critical success factor for extended lactation, with higher nutrition during this period preventing milk production losses. A current Dexcel trial is milking 60 empty cows to achieve 650-day lactation on a pasture-based diet with either 0 or 5 kg DM concentrate/cow/day during the winter period. This trial will determine the immediate and carry-over effects of supplementary winter feeding on MS production during an extended lactation, and the information generated from this work will be used to help develop profitable and productive extended lactation systems.

Conclusions

These results indicate that productive extended lactations up to 650 days are feasible on a range of pasture-based systems, and with appropriate cow genetics and feed management may improve poor reproductive performance in high-producing dairy cows without sacrificing MS production. Further work is now underway to develop appropriate cow selection measures, and to evaluate the profitability of pasture-based extended lactation dairying systems.

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