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Modelling the effect of temporary once-a-day milking during early lactation on dairy farm production and profitability

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Abstract

The DairyNZ Whole Farm Model was used to predict the effect of temporary once-a-day (OAD) milking during the calving period on milksolids (MS) production, farm profitability and herd body condition score (BCS) at dry-off. Farms from three regions and three independent seasons were modelled for: whole-season twice-a-day (TAD) milking of all cows (Control), OAD milking of all cows for eight days immediately post-calving and TAD milking thereafter (Col OAD), OAD milking of the herd for three weeks from the planned start of calving (PSC) and TAD milking thereafter (3 wk OAD), and OAD milking of the herd for six weeks from the PSC and TAD thereafter (6 wk OAD). Model outputs indicated MS production (kg/ha) losses of 2, 1.2 and 3.7% and profit ($/ha) losses of 6.5, 4.5 and 11.6% for the Col OAD, 3 wk OAD and 6 wk OAD regimes, respectively. Slight improvements in dry-off BCS were predicted for the OAD milking regimes, compared with the control. Milking the herd OAD for three weeks from the PSC may be the prefered strategy to offer labour, lifestyle and animal health benefits with the smallest losses of MS production and farm profit.

Keywords: once-a-day milking; milksolids; profitability; body condition score

Introduction

In pasture-based dairy systems, farmers may use once-a-day (OAD) milking for a short time early in the season to reduce the heavy workload associated with seasonally-concentrated calving (Phyn et al. 2011). In addition, OAD milking attenuates the negative energy balance that cows undergo during the early post-partum period, leading to earlier live weight and body condition gains, compared with twice-a-day (TAD) milking (McNamara et al. 2008; Rémond et al. 1999; Phyn et al. 2011). Improved cow nutritional status may also result in better reproductive performance, such as a shortened interval to first post-partum ovulation (Patton et al. 2006). The drawback of OAD milking, however, is the loss of milk production, both during the period of OAD and after switching to TAD milking, with the loss becoming greater with longer durations of OAD milking (McNamara et al. 2008; Rémond et al. 1999; Phyn et al. 2011). Therefore, milking cows OAD, even for a short period at the start of the season, results in milk revenue losses.

Farmers considering short-term OAD milking during early lactation require information on the impact of different OAD regimes on milk production and farm profitability. This will help them make informed decisions about the milk production sacrifices they are prepared to make and the associated costs compared with any potential benefits for their specific farming operations. In addition, farmers can use the information to use OAD milking strategically to maximise the benefits, while minimising lost revenue. Potential strategies include limiting the duration of OAD milking for all cows in a herd to a set period, such as the colostrum period, or applying OAD milking on a herd basis for a set period after the start of calving, such as three weeks. This latter practice is likely to reduce the total milksolids (MS) loss compared with milking each cow OAD for three weeks after they calve. This is because as more cows calve, they are subjected to increasingly shorter durations of OAD milking. Applying OAD milking on a herd basis rather than an individual cow basis may also be a more effective way of achieving reductions in workload during seasonally-concentrated calving. However, its impact on farm production and profitability is unknown.

The aim of this study was to use a whole-farm systems approach to model the effect of different strategies of milking cows OAD during early lactation on MS production, mean herd body condition score (BCS) at dry-off and farm profitability of three dairy systems from different New Zealand dairying regions.

Materials and methods

The DairyNZ Whole Farm Model (Beukes et al. 2008), with an improved Molly cow model (Hanigan et al. 2009; AG Rius, Unpublished data), was used to assess the performance of three dairy farms with two to seven year old Holstein-Friesian x Jersey crossbred cows. Three farms namely Scott farm, near Hamilton (Waikato); Telford farm, near Balclutha (Southland) and Northland Agricultural Research Farm, near Dargaville (Northland), and three independent seasons (2008/09, 2009/10 and 2010/11) were modelled (Table 1). Four milking scenarios were evaluated for each region; TAD milking of all cows throughout lactation (Control), OAD milking of all cows during the colostrum period, that is eight days immediately post-partum, extended because of OAD milking, followed by TAD milking thereafter

Table 1: Farm details for the three farms used in the modelling exercise. NARF = Northland Agricultural Research Farm; Col OAD = Once-a-day milking of all cows for eight days immediately post-partum, followed by twice-a-day milking thereafter; 3 wk OAD = Once a day milking of the herd for three weeks from planned start of calving, followed by twice a day milking thereafter; 6 wk OAD = Once a day milking of the herd for six weeks from the planned start of calving, followed by twice a day milking thereafter.

Farm details	Dairying region and modelled farm		
	Waikato (Scott)	Southland (Telford)	Northland (NARF)
Stocking rate (cows/ha)	3.0	2.9	2.9
Planned start of calving	28 June	9 August	01 July
Final dry-off date	15 May	21 May	10 May
Winter grazing	On farm	On farm	Leased block
Proportion of herd calved (%)			
3 weeks from planned start of calving	69	49	56
6 weeks from planned start of calving	89	84	80
Mean OAD duration (days/cow)			
Col OAD	8.0	8.0	8.0
3 wk OAD	7.2	5.6	3.7
6 wk OAD	24.7	18.8	18.8

Table 2: Milksolids production per ha (mean ± standard deviation) of three dairy farms when cows are milked either twice-a-day (TAD) for the whole season (TAD, control) or once-a-day (OAD) for eight days from calving (all cows), followed by TAD milking thereafter (Col OAD), or the herd is milked OAD for three or six weeks from the planned start of calving, followed by TAD milking thereafter (3 wk OAD or 6 wk OAD), over three independent seasons. NARF = Northland Agricultural Research Farm.

Milking regime	Dairying region and modelled farm		
	Waikato (Scott)	Southland (Telford)	Northland (NARF)
TAD (Control)	1,199 ± 11	1,041 ± 12	1,086 ± 8
Col OAD	1,173 ± 10	1,019 ± 16	1,069 ± 1
3 wk OAD	1,179 ± 9	1,028 ± 15	1,078 ± 6
6 wk OAD	1,143 ± 10	1,002 ± 16	1,054 ± 6

(Col OAD), OAD milking of the herd for three weeks from the planned start of calving, followed by TAD milking thereafter (3 wk OAD), and OAD milking of the herd for six weeks from the planned start of calving, followed by TAD milking thereafter (6 wk OAD). Mean BCS (Scale 1 to 10) (Roche et al. 2004) at calving across all farms was 5.1 ± 0.3 units.

Across all modelled scenarios, cows grazed perennial ryegrass-white clover pasture supplemented with pasture silage in all regions and either maize silage in Northland or turnips and swedes in Southland. Cows were allowed *ad libitum* feeding throughout the season. For each farm, the model was set-up to mimic, as much as possible, the overall seasonal management structure of the region (Nichol et al. 2003; K Wynn, Personal communication). Simulated pasture growth was climate-driven using NIWA climate data (http://cliflo.niwa.co.nz/) and the Romera et al. (2009) pasture growth model. Cows were dried-off based on individual BCS, using the decision rules of Macdonald and Penno (1998).

Model outputs were total MS production (kg/ha), mean herd BCS at dry-off, and farm operating profit ($/ha). The Fonterra seasonal milk prices per kg MS (http://www.fonterra.com/nz/en) of $5.21 (2008/09), $6.16 (2009/10) and $7.36 (2010/11) were used. Operating profit was calculated as the difference between dairy gross farm revenue and dairy operating expenses. It is important to note that the model calculates labour costs per cow. Therefore, labour cost savings as a result of OAD milking are not accounted for in operating profit.

Results

Effect of once a day milking regime on milksolids production

Once-a-day milking of all cows during the colostrum period or of the herd for a short period from the planned start of calving resulted in MS losses compared with milking the herd TAD for the entire season (Table 2). On all farms, MS production losses were greatest for the 6 wk OAD regime, intermediate for the Col OAD regime, and lowest for the 3 wk OAD regime with mean values of -3.8, -2.0 and -1.2%, respectively (Table 2). The Southland

Table 3: Operating profit ($/ha) (mean ± standard deviation) of three dairy farms when cows are milked either twice-a-day (TAD) for the whole season (TAD, control) or once-a-day (OAD) for eight days from calving (all cows), followed by TAD milking thereafter (Col OAD), or the herd is milked OAD for three or six weeks from the planned start of calving, followed by TAD milking thereafter (3 wk OAD or 6 wk OAD), over three independent seasons. NARF = Northland Agricultural Research Farm.

Milking regime	Dairying region and modelled farm		
	Waikato (Scott)	Southland (Telford)	Northland (NARF)
TAD (Control)	2,644 ± 919	921 ± 1,857	2,435 ± 1,742
Col OAD	2,512 ± 852	821 ± 1,873	2,328 ± 1,682
3 wk OAD	2,549 ± 888	841 ± 1,912	2,383 ± 1,714
6 wk OAD	2,334 ± 799	767 ± 1,858	2,260 ± 1,764

Table 4: Body condition score at dry-off (Scale 1–10; Roche et al. 2004) (mean ± standard deviation) of three dairy farms when cows are milked either twice-a-day (TAD) for the whole season (TAD, control) or once-a-day (OAD) for eight days from calving (all cows), followed by TAD milking thereafter (Col OAD), or the herd is milked OAD for three or six weeks from the planned start of calving, followed by TAD milking thereafter (3 wk OAD or 6 wk OAD), over three independent seasons. NARF = Northland Agricultural Research Farm.

Milking regime	Dairying region and modelled farm		
	Waikato (Scott)	Southland (Telford)	Northland (NARF)
TAD (Control)	4.8 ± 0.2	4.6 ± 0.3	4.7 ± 0.3
Col OAD	4.9 ± 0.2	4.7 ± 0.3	4.9 ± 0.2
3 wk OAD	4.9 ± 0.3	4.8 ± 0.3	4.7 ± 0.3
6 wk OAD	5.0 ± 0.3	4.8 ± 0.3	4.9 ± 0.3

farm had the lowest MS production, irrespective of the milking regime, while the Waikato farm was the highest producer (Table 2). The Waikato farm had the greatest absolute and relative to the Control, losses in MS production for the 3 wk OAD, Col OAD and 6 wk OAD regimes of -20, -26 and -56 kg MS/ha and -1.7, -2.2 and -4.7%, respectively (Table 2); whereas, the Northland farm had the lowest production of -17, -8, -32 kg MS/ha and -1.6, -0.7, -2.9%, respectively (Table 2).

Effect of once a day milking regime on farm operating profit

Farm profitability was lower for all OAD regimes compared with TAD milking for the whole season (Table 3). On all farms, profit losses followed a similar trend to MS production losses being greatest for the 6 wk OAD regime, intermediate for the Col OAD regime and lowest for the 3 wk OAD regime with means of -11.9, 6.8 and 4.8%, respectively (Table 3). The Southland farm had the lowest three-year mean profits across all milking scenarios. In 2008/09, the Southland farm's operating expenses exceeded gross farm revenue resulting in a net loss as reflected by the high standard deviations (Table 3). The Southland farm also had the greatest relative losses in farm profit due to the different OAD regimes which ranged from -8.7 to -16.7%, but the lowest absolute losses which ranged from -80 to -154 $/ha (Table 3). By comparison, the Waikato farm had the greatest three-year mean profits, and the greatest absolute losses in farm profit when OAD regimes were applied ranged from -95 to -310 $/ha (Table 3). The Northland farm incurred the lowest relative losses in farm profit which ranged from -2.1 to -7.2% (Table 3).

Effect of once a day milk regime on body condition score

The model predicted nil to marginal improvements in the mean dry-off BCS of the herd when short-term OAD regimes were used, compared with TAD milking of the herd for the whole season. Compared with the TAD control, the Col OAD regime resulted in mean dry-off BCS gains of 0.1 units in Waikato and Southland, and 0.2 units in Northland (Table 4). The 3 wk OAD regime did not increase dry-off BCS in Northland, but resulted in 0.1 and 0.2 greater BCS units in Waikato and Southland, respectively (Table 4). A BCS improvement of 0.2 units was predicted for the 6 wk OAD regime in all regions (Table 4).

Discussion

Farm systems modelling predicted that short-term OAD milking during the calving period reduced annual MS production and farm profitability, but marginally improved herd BCS at dry-off. Furthermore, different strategies of applying OAD milking, either on an individual cow or herd basis, altered the MS production loss and, consequently, the reduction in farm profit.

The annual MS production loss per farm was dependent on the average duration of reduced milking frequency per cow. Loss of MS production was greatest for the 6 wk OAD regime, which had the longest average period of OAD milking per cow of approximately 21 days. Conversely, the decrease in MS production was lowest for the 3 wk OAD regime, which had the shortest average period of OAD milking per cow of approximately five days. This result is consistent with component studies (Rémond et al. 1999; Phyn et al. 2011), which indicated an increasing negative impact on milk production from increasing post-partum periods of OAD milking when applied to individual cows. Furthermore, this effect was due to an immediate reduction in milk production during the period of OAD milking that was partly sustained once the cow was switched to TAD milking for the remainder of lactation. The reduction of MS during and after OAD milking is not fully understood, but research (Boutinaud et al. 2004; Grala et al. 2011) has attributed it to a reduction in mammary cell number and activity. Hence, limiting the period of OAD milking during early lactation will reduce the total MS production loss. This effect was also demonstrated by the lower production loss for the 3 wk OAD regime compared with the Col OAD regime due to a shorter duration of OAD milking per cow. Applying OAD milking on a herd basis rather than on an individual cow basis can, therefore, limit the total MS loss for the farm.

The loss of MS production when the herd was milked OAD for a set period from the planned start of calving was also determined by the calving pattern. The Waikato farm had the most compact pattern and, consequently, the longest periods of OAD milking per cow for the 3 wk OAD and 6 wk OAD regimes. This effect explains why this farm incurred the greatest relative losses in MS production. The effect of the calving pattern was also evident on the Northland and Southland farms. The Southland farm had 7% fewer cows calving within the first three weeks from the planned start of calving compared with the Northland farm, but incurred a greater relative MS production loss for the 3 wk OAD regime because more cows calved earlier in the treatment period and were, therefore, subjected to longer periods of OAD milking. One advantage of a compact calving is that it allows full utilisation of spring pastures. Given the indication from this study that the impact of MS production loss would be greater with a tighter calving pattern, individual farmers can use their discretion to alter the duration of milking the herd OAD to reduce its negative impact.

The reduction in farm profitability from the different OAD milking regimes was proportional to the loss in MS production for each farm. Although not accounted for in the model, milking OAD reduces the number of milking events and operations. For farmers who rely on relief workers during the busy calving period, a reduction in workload may reduce extra paid labour and, thereby, lessen the negative effect of OAD milking on farm profitability. There may also be benefits from OAD milking that are not economically quantifiable. For instance, workers can use time freed by OAD milking to focus on non-milking activities, such as cow health and grazing management. If these areas are improved when OAD milking is used instead of TAD milking, they may compensate partly for the negative effects of OAD milking on MS production. The shorter working hours during OAD milking can improve labour productivity by reducing stress on workers from tiredness and exhaustion. Shorter working hours also allow extra time for family, rest and greater flexibility to engage in recreational activities. Therefore, the reduction in farm profit as a result of OAD milking could be partly countered by savings in other aspects of farm management and an improvement of labour productivity. These advantages will depend upon the individual farm system.

Compared with the Control, slight improvements to herd BCS commensurate with the OAD duration on each farm were predicted. The 3 wk OAD regime in Northland had the shortest period of OAD milking per cow of approximately four days, which probably explains the lack of an effect of this regime on herd BCS at dry-off. For the rest of the OAD milking scenarios, improved BCS at dry-off resulted primarily from BCS increases during OAD milking in early lactation, with the gain being greater with longer OAD milking durations. Improvements in BCS from short-term OAD milking are supported by previous field trials (McNamara et al. 2008; Rémond et al. 1999; Phyn et al. 2011); however, Phyn et al. (2011) reported that there were no differences in BCS during late lactation between cows milked OAD for 21 or 42 days postpartum and those milked TAD. Therefore, the marginal 0.1 to 0.2 BCS units improvements predicted in the current study could be due to model over-prediction.

In conclusion, short-term OAD milking results in the loss of MS and profitability. The magnitude of the reduction in MS production and farm profitability are proportional to the duration of OAD milking per cow. Among the regimes assessed, OAD milking for three weeks from the planned start of calving may be the best strategy to achieve labour, lifestyle and animal health benefits with the smallest negative effect on milk revenue. It is for individual farmers to decide how much MS production and profitability to forfeit in exchange for the benefits of milking OAD during the seasonal calving period.

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