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Modelling optimum switch date from twice- to once-daily milking in dairy herds

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ABSTRACT

The production of a dairy herd was simulated at two different stocking rates (3.4 cows/ha and 4.0 cows/ha) and two seasonal conditions (an average and a dry Waikato summer). Cows were milked twice-daily (TDM) for varying periods, before being switched to once-daily milking (ODM) for the remainder of the lactation. Switching from TDM to ODM during the milking season reduced the total production of the herd. With 3.4 cows/ha in an average summer, at a break-even value of labour of $100 /milking ($200 /milking) the optimum switch-over date was January 13 (October 21); a dry season brought forward this date by approximately two weeks. Increasing payout increased the break-even value of labour at a given switch-over date. Under a commonly used farmer industry guideline, break-even labour values under average (dry) conditions were $53.47 /milking ($61.47) for 3.4 cows/ha and $36.07 /milking ($33.98) at 4.0 cows/ha. A stocking rate of 4.0 cows/ha switching to ODM after peak production had a lower cash surplus than a 3.4 cows/ha stocking rate with TDM due to additional ($30,000) feed costs with the higher stocking rate. These results suggest a formal approach could be used to complement industry guidelines in deciding when to switch from TDM to ODM.

Keywords: once-daily milking; labour efficiency; lactation; dairying; stocking rate; modelling.

INTRODUCTION

Balancing the trade-off between milk production, cow live weight, milk income and reducing the costs associated with milking can be achieved by switching from twice-daily milking (TDM) to once-daily milking (ODM) during the dairy season. Production losses for individual cows being milked on ODM varied between 7-34 % (mean 19 %) in late lactation (Davis *et al.*, 1998), and from 5-50 % (mean 35 %) over an entire lactation for a whole herd (Holmes *et al.*, 1992). Farmer experiences with ODM vary widely: one farmer using ODM over the whole season with an increase in stocking rate experienced production similar to the district average (Attrill & Holmes, 1993); another farmer implementing ODM from early January in a drought year reported a 17 % depression in production (Phillips, 1988).

Differences between Jersey and Friesian cows milked on ODM are small over short periods, but Jersey cows maintain milk yield better than Friesians during long-term ODM (Davis *et al.*, 1998). Recently, Tong *et al.* (2002) found that production losses associated with ODM can be recovered in Jersey herds by increasing stocking rate by 17 %; however, this strategy was not successful with Friesian herds.

Reasons for considering ODM include the efficiency gains in farm labour, retaining valuable staff, family reasons, increasing plant utilisation and decreasing farm costs (Davis *et al.*, 1998). Time required for milking is one of the largest ties to the farm for the farmer, reducing time available for other farming activities, other financial opportunities, and family/leisure time. For farmers who employ staff, the investment in terms of both time and finance is a large commitment.

Farm costs, excluding labour associated with the afternoon milking (e.g., electricity, detergent, plant wear and tear) have been estimated to be minimal (I. Van Heuvan, personal communication). Farmers also consider it beneficial to avoid having cows walking to the dairy in the heat of the afternoon.

ODM for the entire season is rarely implemented, although farmers often choose to put their herd on ODM in the second half of the season. This latter strategy allows farmers to benefit from the higher production of TDM early in the season, while conferring the improved lifestyle and reduced costs of ODM later in the season, without the need to increase stocking rate.

Dairy farmers have developed the following empirical industry guidelines in deciding when to move the herd from TDM to ODM in the latter part of the season. Cows should change to ODM before any feed shortage occurs, ensuring sufficient pasture is available for five to ten days to make certain the herd does not experience any decrease in intake. The herd can be moved from TDM to ODM when the average production equals 10-12 litres per cow per day, and before cows become too light (P. Kane, personal communication) i.e., industry guideline condition score of 3.5. Cows with high somatic cell counts (over 200,000 cells/ml) are dried off before going on ODM to prevent milk quality problems. Cows should then be dried off to target an optimum condition score (4.5 to 5.0) on the June 1.

This paper examines the optimal switching date from TDM to ODM under two stocking rates and two seasonal conditions. Optimal switching date was calculated using milksolids production, cost of labour and cow's empty body weight (total cow body weight less rumen contents and conceptus), and compared to the industry guidelines.

METHODS

Feed budgets based on farming practices in Matamata, Waikato, were constructed to simulate average and dry summer conditions, using JerseyxFriesian cows stocked on an 80 ha farm at a stocking rate of either 3.4 cows/ha or 4.0 cows/ha.

Calving started on July 1 and had a 14-week spread for all scenarios. Cow intakes started at 7 kgDM/cow/day for dry cows and were increased to a maximum of 17 kgDM/cow/day at peak intakes from mid September

TABLE 1: Supplements, farm costs and stock income incorporated into the feed budgets and financial calculations for each scenario modelled.

Stocking rate	**3.4 cows/ha**		**4.0 cows/ha**	
Season	**Average**	**Dry**	**Average**	**Dry**
Supplements made (kgDM/ha)	600	600	0	0
Supplement fed (kgDM/ha)	0	375	1275	1575[1]
Farm supplement costs[2] ($)	-9600	3600	20400	25200
Farm stock income[3] ($)	26384	26384	31040	31040
Other farm costs[3] ($)	183974	183974	195206	195206

[1] in addition, cow intakes were reduced at the end of the season.
[2] supplement cost was assumed to be $0.20 per kgDM.
[3] from Dexcel (2002). Farm costs excludes feed costs.

onwards. Monthly pasture growth rates for a highly productive, nitrogen-boosted pasture in Waharoa / Matamata were used. Minimum average pasture covers in September were 1700 kgDM/ha and 1750 kgDM/ha for the 3.4 cows/ha and 4.0 cows/ha stocking rates, respectively. For the dry-season scenarios, pasture production in February and March was reduced by 30 %. Cows were dried off to achieve an average pasture cover on June 1 of 2200 kgDM/ha in all scenarios. This resulted in earlier culling and drying off dates for the higher stocking rate, and in the dry season. Supplements made and fed are shown in Table 1.

Cow performance in terms of milk production and change in empty body weight (EBW) over the lactation were predicted using a model of lactation (Vetharaniam *et al*., 2003) combined with an animal growth model (Vetharaniam *et al*., 2001). In the combined model, energy partitioning between lactation, growth, and pregnancy is dynamically altered by cow intake level and by milking frequency, making it amenable for examining responses to different milking strategies under different nutritional conditions. Simulations were started from calving date, assuming a cow EBW of 380 kg immediately after parturition and cows became pregnant 80 days after calving.

Cows were allocated to 14 weekly calving groups (denoted by *m*). The percentage of the herd that calved in each week from the July 1 (week 1 to week 14) were 5,5,7,7,8,10,10,15,8,7,5,7,3 and 3 respectively. For each stocking rate by season scenario there were 22 different scenarios run, switching to ODM from July 1 through to April 20 at two-weekly intervals. The proportion of cows milking in each week, for each of the calving groups (R*mt*), was calculated from the proportion of cows in that calving group, and the proportion dried off in that group each week.

Milk composition was assumed to be constant over the season at 5.0 % fat and 3.7 % protein, with an energy content of 3.6 MJ/litre. The amount of milk produced per week was calculated as the energy output in milk (MJ) each week from the mathematical model, divided by the energy content of the milk. The amount of milk fat and protein per week was calculated from milk production and fat and protein percentages.

The average production for each weekly period (*t*), for each of the scenarios (stocking rate x season x switchover date) was calculated as:

$$P1 = \sum_{m=1}^{14} (Pmt \times Rmt \times N) \quad (1)$$

where:
Pt = average production per cow per week in period *t*;
Pmt = average production per cow per week in period *t*, for cows calving in calving group *m*;
Rmt = proportion of the cows in the simulated herd that are from calving group *m* and milking in period *t*; and
N = number of cows in the simulated herd.

The yearly production for each scenario was:

$$YP = \sum_{t=1}^{26} Pt \quad (2)$$

Production data were combined with the value of the milk components ($2.10 /kg milk fat, $5.85 /kg protein based on the Fonterra Dairy Company payout for the current season) to generate the milk income. This equated to $3.70 /kg milksolids (MS). Sensitivity analyses were conducted using $4.10 /kgMS, $3.90 /kgMS and $3.50 / kgMS.

Live weight was the average cow live weight for those cows dried off at the end of the season (weeks starting April 20 for the 3.4 cows/ha stocking rate and May 18 for the 4.0 cows/ha stocking rate). The value of an extra 30 kg live weight was assumed to equal 15 kg milksolids. The difference in milk production, milk income and live weight between each of the scenarios changing to ODM on different dates throughout the season and the scenario changing to ODM on April 20 (referred to as TDM) was calculated. Opportunity cost of labour was calculated by dividing the difference in cash surplus between the scenario and TDM by milkings saved.

A benefit of $5 per milking saved was assumed. Stock income and farm costs (other than feed) differed between stocking rates (Table 1). Feed costs for the four scenarios are also shown in Table 1.

Local farmers estimated the cost of a farm contractor to range from $ 12 - $ 30 per hour (for a contract weed sprayer to a professional fencer). For a 2.5-hour milking, a farm contractor would cost $ 52, on average. Two relief milkers would be required for the afternoon milking of a 250 – 350 cow herd at a cost of $ 104. If staff/contractors or facilities required for them were not available, and the farmer had a high opportunity cost of labour, the farmer's value of labour for the milking could be $ 200 or more.

RESULTS AND DISCUSSION

Farmers, and their farm staff, have a fixed amount of time available for farm work per day, the key is deciding

what activities will give the best return per unit of time. The optimum switch date from ODM to TDM is heavily dependant on the break-even cost of labour per milking. Farmers should be making their decision on the optimum switch-over date from TDM to ODM on the value (or opportunity cost) of the labour involved plus other management factors such as feed availability.

Maximum milk production was achieved by TDM for the whole lactation in all scenarios modelled. The earlier the switch-over date from TDM to ODM, the greater the loss in milk production, and hence, milk income (Table 2). Cows switching to ODM had a higher empty body weight at drying off. The optimum switch-over dates varied depending on the value placed on labour required per milking (Figure 1). For the 3.4 cows/ha average season, at a break-even value of $ 100 per milking, which is the cost of employing relief milkers for the herd modelled, the switch-over date was January 13. However, if the value of labour was lifted to $ 200 per milking, as could occur if staff/contractors were unavailable or the farmer had a high opportunity cost of labour, optimum switch-over date would move forward to October 21.

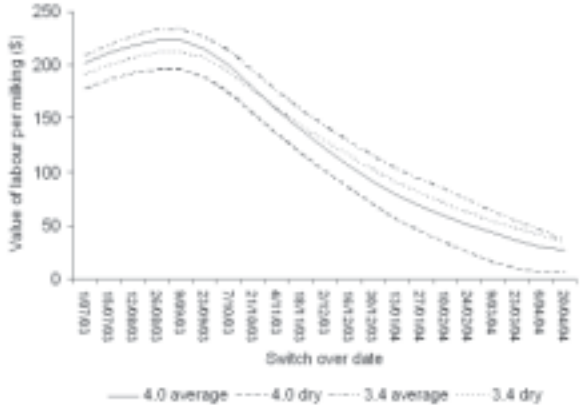
The optimal switch-over date based on the rule of thumb (switching to ODM when per cow production falls to 10-12 litres/cow/day) would be March 23 for an average season and February 10 for a dry season at both stocking rates. The value of labour per milking at these times is $ 53.47 and $ 61.47 per milking for average and dry seasons, respectively, at the 3.4 cows/ha stocking rate, and $ 36.07 and $ 33.98, respectively, at the 4.0 cows/ha stocking rate.

TABLE 2: Comparison of changing to once-daily milking at different dates, at stocking rates of 3.4 cows/ha and 4.0 cows/ha in an average season.

Switch Date	Milk Income ($)	Total Income[1]($)	Total Costs[2]($)	Cash Surplus ($)	Milkings Saved	Difference from TDM ($)	Labour value/ milking[3]
3.4 cows/ha							
1-Jul	283933	324150	172904	151246	294	59928	204
15-Jul	284114	324324	172974	151350	280	59824	214
29-Jul	285059	325226	173044	152182	266	58992	222
12-Aug	286884	326972	173114	153858	252	57316	227
26-Aug	290092	330009	173184	156825	238	54349	228
9-Sep	295238	334807	173254	161553	224	49620	222
23-Sep	301881	340927	173324	167603	210	43571	207
7-Oct	309102	347487	173394	174093	196	37081	189
21-Oct	315928	353573	173464	180109	182	31065	171
4-Nov	322146	358949	173534	185415	168	25758	153
18-Nov	327759	363598	173604	189994	154	21180	138
2-Dec	332789	367592	173674	193918	140	17256	123
16-Dec	337322	371043	173744	197299	126	13874	110
30-Dec	341396	374027	173814	200213	112	10961	98
13-Jan	344810	376423	173884	202539	98	8635	88
27-Jan	347872	378519	173954	204565	84	6609	79
10-Feb	350641	380381	174024	206357	70	4817	69
24-Feb	353133	382025	174094	207931	56	3242	58
9-Mar	355171	383302	174164	209138	42	2036	48
23-Mar	356795	384253	174234	210019	28	1155	41
6-Apr	358172	385046	174304	210742	14	431	31
20-Apr	359164	385548	174374	211174	0	0	0
4.0 cows/ha							
1-Jul	302656	350602	214136	136466	294	57792	197
15-Jul	302851	350793	214206	136587	280	57672	206
29-Jul	303869	351750	214276	137474	266	56785	213
12-Aug	305849	353572	214346	139226	252	55033	218
26-Aug	309374	356762	214416	142346	238	51913	218
9-Sep	314949	361686	214486	147200	224	47059	210
23-Sep	322186	368045	214556	153489	210	40769	194
7-Oct	329974	374847	214626	160221	196	34037	174
21-Oct	337236	381010	214696	166314	182	27945	154
4-Nov	343837	386423	214766	171657	168	22602	135
18-Nov	349778	391072	214836	176236	154	18022	117
2-Dec	355071	395029	214906	180123	140	14135	101
16-Dec	359774	398395	214976	183419	126	10839	86
30-Dec	363759	401083	215046	186037	112	8222	73
13-Jan	367056	403209	215116	188093	98	6166	63
27-Jan	369798	404928	215186	189742	84	4517	54
10-Feb	372085	406299	215256	191043	70	3216	46
24-Feb	374031	407411	215326	192085	56	2174	39
9-Mar	375716	408350	215396	192954	42	1305	31
23-Mar	377050	409029	215466	193563	28	696	25
6-Apr	378053	409492	215536	193956	14	302	22
20-Apr	378825	409865	215606	194259	0	0	0

[1] Total income includes milk income, stock income and income from difference in live weight.
[2] Total costs includes supplement costs and farm costs less milking $5 per milking saved.
[3] Difference from TDM milk income or cash surplus ($) divided by milkings saved.

FIGURE 1: The opportunity cost of labour for a herd changing from twice-daily milking to once-daily milking at different switch-over dates at different stocking rates (4.0 cows/ha and 3.4 cows/ha) and seasonal conditions (average or dry summer).



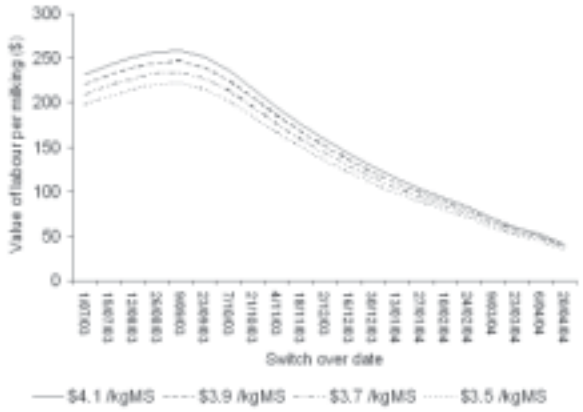
For all scenarios, the opportunity cost of labour was considerably less than the cost of a relief milker.

In a dry season, the optimum switch-over date is brought forward (Figure 1). At 3.4 cows/ha at a value of labour of $ 100 per milking, a dry season brings forward the ODM switch date by approximately two weeks. This is due to the reduction in the feed availability, and hence, milk production in the summer. This reduces the differences in milk income between ODM and TDM later in the season giving an earlier ODM switch date at a given value of labour.

Increasing payout resulted in an increasing break-even value of labour at specific switch-over dates from ODM to TDM (Figure 2). A higher payout increases the milk income lost when changing from TDM to ODM, resulting in an increase in the break-even value of labour. The difference in break-even value was greater at the beginning of the season than in the latter part of the season due to a larger decline in milk production when moving from TDM to ODM.

A farmer interested in improving farm efficiency may consider the possibility of lifting stocking rate and switching to ODM just after peak milk production. TDM more cows over peak milk production would achieve the same production as a lower stocking rate milked for a longer period, and utilise labour more efficiently by ODM for the remainder of the season. Using the scenarios modelled, the total income obtained by TDM 3.4 cows/ha over a season ($ 359,164) could be achieved by running 4.0 cows/ha and switching to ODM on December 16 ($ 359,774, Table 2). However, if farm working costs are deducted, it is not possible to achieve the 3.4 cows/ha stocking rate cash surplus ($ 211,174 for TDM). The majority of the extra cost of running the higher stocking rate is associated with feed i.e., a $ 30,000 increased feed cost for the 4.0 cows/ha stocking rate (-$ 9,600-$ 20,400, Table1). Most of this extra feed was required to support the increased stocking rate over the winter. However, the cash surplus does not take into account the opportunity cost of freeing up labour. These factors highlight the importance of considering the whole farm system when thinking about making changes.

FIGURE 2: The opportunity cost of value of labour for a herd (3.4cows/ha, average season) changing from twice-daily milking to once-daily milking at different switch-over dates at four different milk prices.



Other factors that need to be considered when deciding when to switch from TDM to ODM include animal welfare issues such as reduction in cow lameness with ODM, not walking the cows to the farm dairy in the heat of the afternoon, plant utilisation, staff satisfaction, farm family leisure time, and the opportunity for farmers to pursue other interests.

Switching from TDM to ODM during the season reduced the total milk production of the herd. The optimum switch over date from TAD to OAD varied with different values placed on labour, the season type, either dry or average and the milk solids payout received. These factors should be considered in addition to the industry empirical guidelines when farmers are considering changing the herd from TDM to ODM. Other factors such as animal welfare, plant utilisation, and labour and lifestyle issues need to be included when deciding to switch to ODM

The whole farm system needs to be considered when increasing the stocking rate and switching to ODM just after peak milk production. The total income of the 3.4 cows/ha could be generated by the higher stocking rate switching to ODM on the December 16, however the feed costs associated with the higher stocking rate were not covered by this system, resulting in a lower cash surplus than the lower stocking rate.

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