Milking options to increase flexibility and workplace attractiveness

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Summary

- Milking three times in two days (3-in-2) is a way of increasing the attractiveness of the dairy workplace.
- A farmlet study was conducted to quantify the system effects of adopting 3-in-2 at different times of the season.
- The full-season 3-in-2 herd produced 5% less milksolids than the full-season twice-a-day (TAD) herd with protein production more negatively affected than fat.
- By early May (near dry off) average body condition was 0.25 units greater for the full-season 3-in-2 herd relative to the full-season TAD herd.
- Back-calculated feed eaten decreased with increasing duration of 3-in-2.
- The results imply it may be possible to maintain or increase both profitability and sustainability with full-season 3-in-2, although budgets need to incorporate farm specific assumptions which may vary significantly from farm to farm.
- If sufficient cost reductions are not achieved this does not mean the system is unprofitable. There are many drivers for adopting 3-in-2 (e.g. less lameness, which the results of the study support).

Introduction

To attract and retain talented people, farmers are exploring options to improve the attractiveness of the dairy workplace. Dairy farm work often involves long hours (e.g. 50+ h per week), many of which are at unsociable times of the day (e.g. 4 am starts), which reduces dairy farming competitiveness relative to other industries in recruiting and retaining talented staff. Milking cows (cups-on to cups-off) takes 17 to 24 hours per farm worker per week at peak lactation. The timing of the milkings often determines the structure of the farm day. Changing milking schedules provides an opportunity to reduce work hours, increase flexibility, and enhance workplace attractiveness.

Milking three times every two days (3-in-2) is a strategy used by about 14% of herds nationally (26% in the South Island), typically post-Christmas or in late lactation. Interviews with farmers already using this system identified the following key reasons for adopting 3-in-2.

Key reasons for adopting 3-in-2		
People	Animals	Lifestyle
Staff attraction and retention	Better body condition	More flexibility
Better work hours	Less lameness	More family time
More flexibility	Better overall cow health	Improved wellbeing

The success of the system when used mid to late lactation led to the question, what are the system trade-offs for adopting 3-in-2 earlier in the season? In particular, using it through spring, during the busy calving and mating periods, when the hours of work and fatigue are typically at their greatest. Examples of potential trade-offs include: lower milk production, better body condition, fewer animal health issues, less walking, less time on concrete and more grazing time in the paddock, which could lead to a better ability to hit target grazing residuals, better pasture quality and/or pasture harvest. Conversely, lower milk production could result in less pasture harvested.

To explore these trade-offs in a system context, a 1-year farmlet study was established as part of the Ministry of Primary Industries and DairyNZ funded project 'Flexible Milking', which aims to build the confidence of farmers and advisors to adopt, optimise, and/or to support the use of 3-in-2 milking. The overall goal of the project is enhanced wellbeing and farm workplace attractiveness, while maintaining profitability. Results from this farmlet study provide useful data to better inform any decision to adopt 3-in-2 milking and when to use it.

Farmlet details

Four farmlets were established at the Lincoln University Research Dairy Farm (LURDF) in August 2019. Each farmlet was randomly allocated 11 paddocks totalling 8.2 ha and 29 predominantly Holstein-Friesian cows, which were balanced for age, genetic merit, expected calving date, body condition score and liveweight at the end of the previous lactation, as well as the days in milk, milk and milksolids yield from the previous lactation (excluding heifers). Each herd had 9 heifers (31%). Planned start of calving was 1-August. One herd was milked TAD for the full season, with the remaining three milking 3-in-2, either full season, or from December 1, or from March 1 (Figure 1). Milking intervals were 10 and 14 hours for TAD and 12-18-18 hours for 3-in-2. A date-based switch-point was chosen over a production-based trigger as it was considered to be of more value to farmers for workforce planning because the requirements are known from the outset of the season.

Figure 1. Overview of the four farmlet herds.

Each farmlet was managed independently using the same set of decision rules. A weekly feed wedge was used to determine the order of paddocks to graze and determine if each farmlet was in surplus/deficit and supplementation was required or pasture should be conserved. Pasture silage was the main feed supplement used, with grain offered up to 3 kg DM/cow/d for 6 weeks in autumn. After the balance date each herd typically spent two days in each paddock, equating to a 22-day rotation. A fresh break was offered after each milking meaning the paddock was divided into four breaks for herds milked TAD and three breaks for herds milked 3-in-2. Rotation length was extended to 28-29 days in April and 44 days in May. Cows were dried off between the 9th and 12th of May to ensure that average pasture cover at the 31st of May 2020 would reach the target of 2000 kg DM/ha. 169 kg N/ha was applied to each farmlet in six applications.

A milk sample was collected from each cow weekly at each milking (AM, PM, MID-morning) and analysed for fat, protein and somatic cell count. Milk yield and animal liveweight were recorded daily at each milking and body condition score assessed monthly. Pasture samples to calibrate the rising plate meter and determine botanical composition were taken monthly.

Farm system results

Key results of the farmlet experiment are presented in Figure 2 and Table 1. Data were analysed by linear regression, where a line is drawn through the data point for each herd, representing different lengths of time using 3-in-2. This means the intercept value (see Table 1) represents the expected result for 0 days of 3-in-2 (i.e. TAD), and the slope represents the deviation from this value for each day of 3-in-2. As an example of how to interpret these figures, take milksolids/cow, for 100 days of 3-in-2, a decrease of 9 kg MS/cow [100 × -0.09] could be expected from a base of 444 kg MS/cow [444 – 9 = 435 kg MS/cow for 100 days of 3-in-2]. The regression equations are not applicable beyond 262 days of 3-in-2.

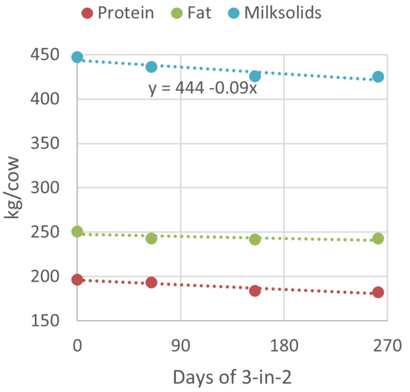

Figure 2. Effect of number of days of 3-in-2 on milk production, full-season TAD are the points on the left, full-season 3-in-2 on the right, and the March and December herds in the middle.

Table 1. Key results from the flexible milking farmlet study run at LURDF in 2019/20.

Metric	TAD	Mar	Dec	3-in-2	Intercept	Slope+
Days milked 3-in-2	0	64	155	262	-	-
Lactation milk results						
Milk (L/cow)	4870	4726	4486	4376	4847	-1.9**
Protein (kg/cow)	197	193	184	182	196	-0.06**
Fat (kg/cow)	251	243	242	243	248	-0.03NS
Milksolids (kg/cow)	447	436	426	425	444	-0.09*
Milksolids (kg MS/ha)	1588	1550	1518	1508	1577	-0.30*
Somatic cell count	205	78	260	216	157	0.03NS
Milking duration (min/cow)	3083	3205	2711	2708	3152	-1.9NS
Animal results						
BCS on 8/05/2020	4.37	4.41	4.57	4.61	4.37	0.001**
Percent of herd with a treatment#	36%	34%	37%	37%	36%	0.004%NS
Percent of herd treated for lameness	12%	7%	3%	0%	11%	-0.05%**
Percent of herd treated for mastitis	21%	24%	23%	30%	21%	0.03%NS
System results						
Pasture grown (t DM/ha)^	13.5	13.2	13.5	13.7	13.3	0.001NS
Average pasture quality (MJME/kg DM)	12.2	12.2	12.2	12.1	12.2	-0.0002NS
Pasture conserved (t DM/ha)	0.24	0.76	0.43	0.62	0.42	0.0008NS
Supplement fed (t DM/ha)	1.81	1.99	2.03	2.12	1.86	0.001*
Net supplement (t DM/ha)	-1.56	-1.23	-1.59	-1.50	-1.44	-0.0003NS
Pasture harvested (t DM/ha)	12.7	12.7	12.0	12.4	12.7	-0.002NS
Total feed eaten (t DM/ha)	14.5	14.2	14.0	13.9	14.4	-0.002*
Pasture utilisation (%)	94%	96%	90%	90%	95%	-0.02%NS
Area topped (%)	103%	134%	131%	152%	111%	0.16%NS

+NS = Not significant, * = P<0.1, ** = P<0.05, *** = P<0.01
^Visually calibrated rising plate meter
#Treatments included mastitis, lameness, down cows, milk fever, staggers, flystrike and dermatitis

Farm physical implications

The results presented in Table 1 provide an overall picture of the system effects of 3-in-2 milking. Milk volume decreased by 1.9 L/cow for each day of 3-in-2, however, milk component percentage increased to partially offset this. There was limited effect on fat production (not statistically significant), which aligns with earlier research[1] that milking interval does not affect fat production, whilst protein production was aligned with milk yield and therefore decreased (by -8% comparing full-season TAD with full-season 3-in-2). The magnitude of this decrease may have been affected by the higher than typical number of heifers, which research has shown are more affected by longer milking intervals[2]. Interestingly, the results show the effect of 3-in-2 was constant across the lactation, indicating there was not a certain number of days of 3-in-2 above which there was a large increase in production loss. This does not support the belief that there is a negligible production effect of switching to 3-in-2 after cows have 'peaked'. There was no effect on somatic cell score or cluster-on time, although the latter had a clear numerical decrease of 1.9 min/day with 3-in-2, which could be of practical importance in larger commercial herds. The change in milk composition decreased the ratio of protein to fat, which depending on the milk processor, may increase the value of your milk per unit. For example, using a Valued Component Ratio (VCR) of 1.31 and Component Composition Ratio (CCR) of 0.7772 (Fonterra 2020/21 estimates[3]), decreasing the protein to fat ratio of a farm from 0.79 to 0.75 would increase milk price, relative to the company average by ~$0.02/kg MS.

Alongside the decrease in milk production there was an increase in body condition, which became evident towards the end of the season, with statistical difference for April and May. However, the differences were not large, with BCS being 0.25 units higher for the full-season 3-in-2 herd relative to the full-season TAD herd on 8-May, just prior to dry off. There was significantly less lameness with 3-in-2, although overall, there was no difference in the percentage of the herd receiving a health treatment. There were numerically more cases of mastitis with 3-in-2, although this was not statistically significant and research has shown the prevalence of mastitis is not higher with OAD milking[4]. It is difficult to assess reproductive performance in small herds but there were no apparent differences, apart from a higher 3-week submission rate for the full-season 3-in-2 herd.

There were no differences apparent in the amount of pasture grown between the farmlets, nor in its quality or net amount of supplement made and fed. However, while not statistically different, there were likely differences in utilisation. At the outset of the study the decision was made to offer the same pasture allocation to all treatments to test the hypothesis that there would be no effect of treatment on production. Despite some of the energy saved from the lower production going into increased body condition, the total feed eaten/ha with 3-in-2 was less, which aligns with a greater area of pasture topped post-grazing. Therefore, the results of this study suggest pasture allocations with 3-in-2 should be re-evaluated, particularly if this reduces imported feed while maintaining pasture harvested.

There are two key considerations when evaluating these results. Firstly, that this was a one-year farmlet study, so no carry-over effects were captured. For example, depending on the winter regime, the increased body condition may have a positive effect in the following season. The second consideration is, on a commercial farm, how the extra time, now not spent milking, is utilised. With the farmlet experiment, where each farmlet was be managed independently, there was equal time and effort spent making and executing decisions. On a commercial farm, if the time that would have been spent milking is utilised for improving management decisions and/or execution then better production results may be achieved.

Potential implications for profitability

With these results, we can draw some broad conclusions about the likely effects of using 3-in-2 on profitability. Given the premise of this study was around making the dairy workplace more attractive and with spring being the season with the longest work hours and most fatigue this section will focus on comparison of full-season 3-in-2 relative to TAD. Full-season 3-in-2 also likely provides more opportunity to re-organise on-farm labour, which is potentially an important success factor[5]. The following examples are based on Canterbury data, because this is where the experiment was conducted.

Using the regression equation for kg MS/ha (Table 1) and a long-term milk price of $6.50/kg MS (+$0.02/kg MS for the altered protein:fat ratio) the milk revenue for full-season 3-in-2 would be approximately $478/ha less than TAD, assuming an unchanged stocking rate. Whether this can be offset is highly farm specific and the difficulty of achieving the reduction will depend on the base cost structure, similar to OAD6. In this study the TAD benchmark production was 444 kg MS/cow and for farms producing less than this it is likely that the production drop will be less, as has been observed in previous OAD work[6].

There are a number of areas where costs could potentially be saved, some of which are more certain (e.g. relating to milking) than others (e.g. relating to people, animal health). Some aspects of milking are directly related to the number of milkings, of which there were 25% fewer (e.g. detergents, teat spray, liners, milk filters, effluent collected, petrol and bike expenses relating to herding) while others relate to milking duration, of which there might be only 15% less (e.g. electricity). The $/ha value of these will vary significantly depending on dairy size and type but, taking the Lincoln University Dairy Farm as an example, could be worth approximately $70/ha ($20/cow), which still leaves a considerable gap to offset.

Experience from commercial herds that have adopted OAD suggests that if the goal is to maintain profitability then adjusting labour efficiency is a key to success[5]. Milking (and related activities) account for approximately 50% of time spent on farm[7]. If we also assume that herding and washdown accounts for around half of milking time (though highly variable from farm to farm) then we could expect full-season 3-in-2 to reduce milking time by 20% and farm labour requirements by 10%. With the average labour efficiency in Canterbury being about 70,000 kg MS/FTE, and using $65,000/FTE (wages and accommodation for a farm assistant), the 10% reduction in labour requirements would be worth about $147/ha (this reduction would equate to an increase of about 16 cows/FTE). However, it should be noted that while reducing labour would still enable increased flexibility and reduced work at unsociable hours, it may not result in reduced total hours worked. Research into 3-in-2 milking intervals such as 10-19-19, that reduce the length of the day with two milkings, may help improve workplace attractiveness further. Alternatively, making better use of the time saved may be preferable to reducing labour, particularly if this also results in increased staff retention. Increased flexibility, for example being able to use a separate pool of staff for the mid-morning milking has also been reported to be advantageous.

The simplest way to account for the value of the higher BCS is by reducing the amount of winter feed so that cows calve down in the same condition as a comparative TAD system (although alternatively with similar winter feeding it may result in improved production the following season). Using a value of $0.29/kg DM, this would be worth about $60/ha ($17/cow).

The reduction in lameness was significant. On the one hand, given the number of potential causes of lameness it is unlikely that it would be eliminated as we experienced in the farmlets, but on the other the potential benefits of less walking would likely be greater on a commercial farm compared with a relatively small research farm. Lameness is estimated to cost $250/case, so using the predicted base incidence of 11% of the herd, and a more conservative estimate of 25% fewer cases, this would be equivalent to $24/ha ($7/cow).

The costs discussed so far, where it was possible to be more definitive about the likely savings, amount to $301/ha, or about 60% of the estimated decrease in milk revenue. There are other possible savings, which are either less clear or farm specific. One of these is feed, where the message that came out of interviews with farmers already using 3-in-2 was that it was not a tool to reduce feed intake. However, few of these were using 3-in-2 full season, and there was evidence that the 3-in-2 cows were eating less (in the order of 0.6 t DM/ha or 160 kg DM/cow), which depending on the system, could allow a reduction in imported feed. A reduction in imported feed with 3-in-2 did not occur in the farmlets, likely due to the decision to offer the same pasture allocation to all treatments as noted earlier. Assuming a reduction in imported feed is possible, at $0.29/kg DM this would be equivalent to $174/ha ($50/cow).

The final category where 3-in-2 may be beneficial is in reproductive performance and the effect it has on culling and replacement rate. The farmlet study was not large enough to draw conclusions about reproductive performance but evidence from OAD milking (6-week in-calf rate of 75% v 64%, not-in-calf rate of 13% v 18% for OAD and TAD respectively[8]) would suggest some improvement is likely, albeit to a lesser extent. This could manifest itself in several ways, 1) improved calving spread and therefore more days in milk, 2) lower not-in-calf rate and therefore fewer replacements required, or 3) greater discretionary culling and therefore the same replacement rate. Evidence from OAD herds[6] would suggest farmers have not achieved more days-in-milk despite the improved calving spread (i.e. probably they have delayed planned start of calving to achieve a similar calving mid-point), nor have they lowered their replacement rate so they have likely done more discretionary culling (there is some evidence of increasing Breeding Worth relative to their TAD peers). Long term, more discretionary culling will result in a more profitable herd, however, converting this to a $/ha cost saving is not straightforward. Therefore, considering the scenario with fewer replacements, if 3-in-2 has half the benefit of OAD on the not-in-calf rate and this is used to lower the replacement rate, then 2.5% fewer replacements would be required. Using a cost of $1600/R2 to get an animal into the herd this would be equivalent to $141/ha ($40/cow), noting there would also be a decrease in cull cow income.

Overall, summing each of the potential cost savings demonstrates that by adopting full-season 3-in-2 milking it may be possible to retain or increase profitability while increasing workplace flexibility and reducing the number of unsociable hours worked. The validity of the assumptions used in the calculations above will vary significantly from farm to farm and region to region with less production loss likely in areas with lower production per cow than Canterbury. Consequently, for those considering 3-in-2 preparing a detailed budget is recommended, using the above calculations as a guide. Irrespective of whether sufficient costs can be saved relative lost production, preparing a budget will allow a value to be assigned to adopting 3-in-2 and assist with making an informed decision as to whether 3-in-2 is a good choice for an individual farm.

Environmental considerations

Any system change can affect sustainability measures. From the perspective of nitrogen (N) management, the lower milk protein production reduces the amount of N exported/ha by 8 kg N/ha. If the lower feed requirements result in less imported feed (600 kg DM/ha) then imported N would reduce by about 12 to 16 kg N/ha, depending on the protein content of the feed (meal = 12 kg N/ha, PKE = 13 kg N/ha, pasture silage or baleage = 16 kg N/ha). On balance, this would result in little change to purchased nitrogen surplus, probably a small reduction, although this relies on maintaining pasture harvested, i.e. the reduction in feed eaten comes from imported supplement. Similarly, this reduction in feed eaten would result in less methane, 13 kg CH_4/ha, equivalent to 324 kg CO_2/ha. The reduction in fuel use from herding, and less effluent captured in the pond may have additional benefits for reducing greenhouse gas emissions, as would the lower replacement rate.

Conclusions

The results of the 1-year farmlet study comparing the use of 3-in-2 for different durations in the season indicate a decrease of 0.09 kg MS/cow for each day of 3-in-2, with fat being less affected than protein. For full-season 3-in-2, economically, this equated to a $478/ha decrease in revenue. Potentially, there are sufficient cost savings to maintain or improve profitability, while improving workplace attractiveness, although it may not result in fewer hours worked if labour is reallocated. Categories where costs could be saved include shed and milking related expenses, labour, feed, lameness and replacement animals, however, the significance of these will vary significantly from farm to farm. Therefore, preparing a detailed budget to determine the likely effect for an individual farm is recommended. Adopting 3-in-2 is likely to have a small positive effect on sustainability. Finally, there are diverse reasons for adopting 3-in-2, an example being lameness, which in this study was reduced with length of time milking 3-in-2.

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