June 2013

Technical Series

Issue 16

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ISSN 2230-2409

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In this issue of Technical Series...

Claire Phyn, DairyNZ Scientist, Team Leader – Lactation Biology & Mastitis

This issue of the Technical Series highlights the key outcomes of a DairyNZ-led research programme known as Strategic Lactation Management Tools.

The five-year project began in 2008 and will end this October. Its overall aim was to improve on-farm profitability and productivity by using management strategies including different milking frequencies, cow nutrition or lactation length.

The research has been funded by the Ministry of Business, Innovation and Employment (formerly the Foundation for Science, Research and Technology) and by New Zealand dairy farmers through DairyNZ Inc. It has involved a large multi-disciplinary team of researchers from DairyNZ, as well as collaborating partners, ViaLactia (a biotechnology subsidiary of Fonterra) and LIC.

The project has centred around three component experiments investigating cow responses (milk production, energy balance and body condition score [BCS]) to strategic use of different milking frequencies in pasture-based systems.

The first experiment characterised the immediate and long-term effects of milking cows once-daily (1X) for a short period immediately after calving. This study was in response to farmer interest in 1X milking during the calving period to reduce workload and improve herd BCS. It also investigated temporary thrice-daily milking during early lactation as a tool to improve milk production efficiency in high-input systems.

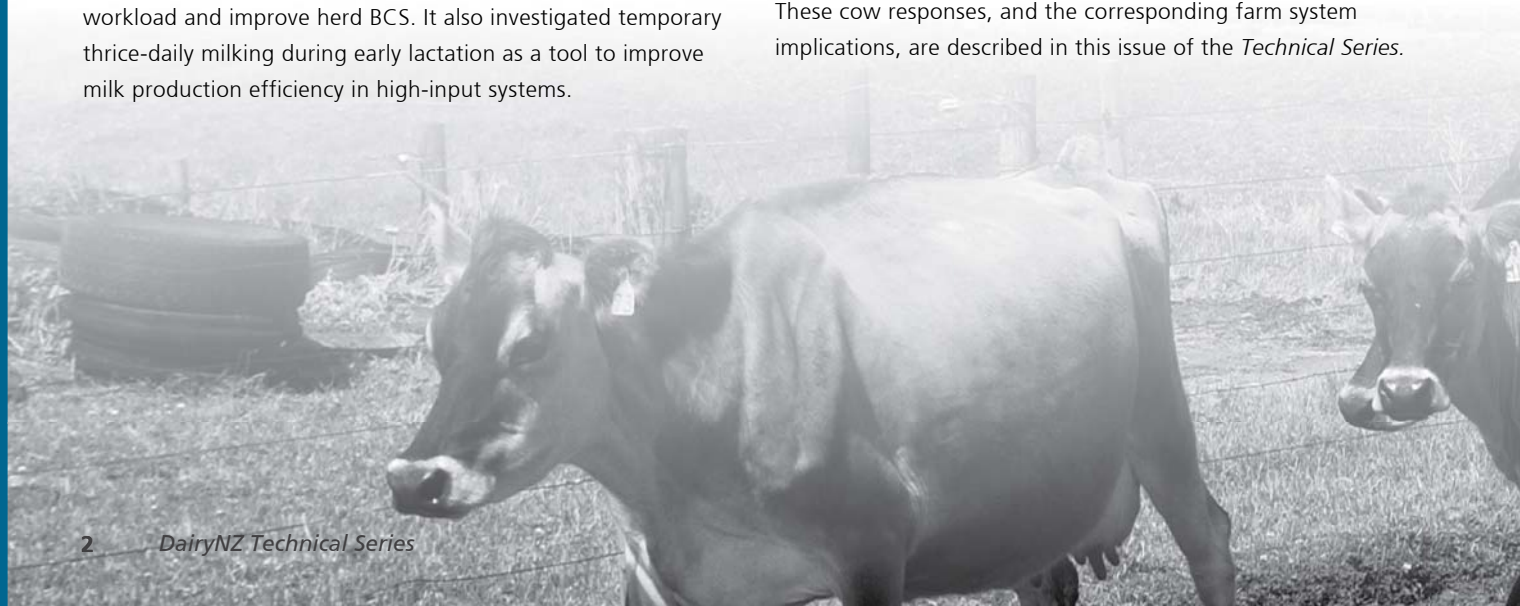
The second experiment addressed the use of 1X milking to manage a feed shortage during early lactation. The third experiment investigated if strategic increases in milking frequency and/or nutrition improved milk production during extended lactations of up to 670 days in milk (i.e. 24-month calving interval).

Production responses were recorded. In addition, blood and tissue samples were taken to study the underlying processes regulating the production responses. This approach has enabled the experimental results to be extended to various on-farm applications by improving cow models in the DairyNZ Whole Farm Model.

The upgraded model is now being used to determine the farm system implications of different lactation and nutrition management strategies, such as:

- applying short-term 1X milking on a herd basis or individual cow basis during the calving period
- comparing 1X milking with providing supplements to manage low pasture cover at the planned start of calving.

These cow responses, and the corresponding farm system implications, are described in this issue of the *Technical Series.*



Selecting cows for different 1X milking strategies

A secondary objective of the programme was to investigate the variability between cows in their production response to 1X milking and to determine if cow performance under short-term, part-season and whole-season 1X milking could be predicted using production data.

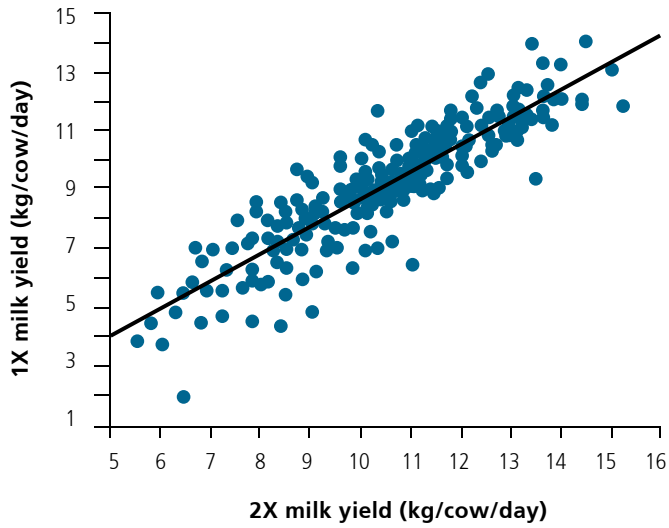
The research demonstrated that, in general, the best producing cows under 2X milking remain the best producers when switched to 1X milking at any stage of lactation (Figure 1). The lowest producers are usually the same cows at either milking frequency.

This relationship also applies when a cow is changed to whole-season 1X milking. Her milk production can be predicted from the previous season's yields under 2X milking.

Using 2X milking data to select cows for whole-season 1X milking has a large margin of error. This is because milk production under 2X milking explains only part of the variation in milk production between 1X milked cows. This relationship also weakens with longer durations of 1X milking and due to variation between seasons.

Therefore, the final stage of the programme will explore the genetic basis of variation in cow performance under whole-season 1X milking. The goal is to undertake industry-good research into the genetic improvement of 1X herds. The research will analyse the opportunities, options, and likely costs and benefits of a dedicated genetic evaluation system for whole-season 1X milking.

Figure 1. Example of the positive correlation between daily milk yield under twice-a-day (2X) and once-daily (1X) milking when 259 crossbred cows were switched to 1X milking for one week in late lactation (February).



Early lactation milking affects season's production

Claire Phyn, Jane Kay, Agustin Rius, DairyNZ Scientists; Talia Grala, DairyNZ Post-graduate Student; John Roche, DairyNZ Principal Scientist

Summary

- Milking individual cows once-daily (1X) for three weeks immediately after calving reduces whole-lactation milksolids yield.
- Milking 1X post-calving improves cow energy status, but body condition score is not improved until five to six weeks in milk.
- Strategies to maximise the labour benefits of milking 1X, whilst minimising the loss of milk revenue, include 1X milking during the colostrum period or milking the herd 1X for a set time from the planned start of calving.
- Short-term thrice-daily milking at the start of lactation does not increase milksolids production in pasture-based cows.

A short period (≤ six weeks) of once-daily (1X) milking during the calving period reduces workload and allows more time for other tasks on-farm.

An overseas study[1] indicated that temporary 1X milking during early lactation improves cow health, energy status and body condition score (BCS), but causes long-term losses in milk production even after cows are switched to twice-daily (2X) milking. Until recently, these positive and negative effects had not been investigated for grazing cows.

Further, it was unknown if temporarily increasing milking frequency (i.e. to three or more times daily) during early lactation stimulates a long-term increase in milk production in grazing cows. In intensive, housed systems, cows milked more frequently, for as little as two weeks at the start of lactation, have greater milk production even when milked 2X for the rest of lactation[2].

Possibly, a short period of thrice-daily (3X) milking during early lactation could be used to increase whole-lactation yields in high-input pasture-based systems (i.e. systems four or five).

The work reported here determined immediate and long-term responses (milk production, energy status, BCS) of grazing cows milked 1X or 3X for a short duration (i.e. three or six weeks) at the start of lactation.

The study

The study was conducted during the 2009/10 season at DairyNZ's Lye Farm, using 150 mixed age (≥ 3 years old) Holstein-Friesian and Holstein-Friesian x Jersey crossbred cows.

Cows were assigned to one of five treatments:

1. milked 2X for the entire lactation
2. milked 1X for three weeks immediately after calving and 2X thereafter
3. milked 1X for six weeks immediately after calving and 2X thereafter
4. milked 3X for three weeks immediately after calving and 2X thereafter
5. milked 3X for six weeks immediately after calving and 2X thereafter.

Cows were offered a pasture allowance of 30 to 40 kg DM/cow per day (target post-grazing residuals of 1800 kg DM/ha). They were also fed concentrates (13 MJ ME/kg DM) at 2 kg DM/cow per day for two weeks pre-calving; 4 kg DM/cow per day from calving (July) to November; followed by 2 kg DM/cow per day until mid-November, and pasture only thereafter.

Key outcomes

Milking 1X for a short duration after calving reduces total milk production

Cows milked 1X for three or six weeks immediately after calving produced less milk over the season, compared with cows milked 2X for the entire lactation. Daily milksolids (MS) yields were 20% lower during 1X milking, and remained about 8% lower after cows were switched to 2X milking (Figure 1).

These production losses are similar to other results for milking 1X for three weeks during early lactation[3]. They can be explained by reductions in both the number and activity of milk-producing cells that remain after cows change from 1X to 2X milking[4]. Therefore, 1X milking for a short period in early lactation reduces a cow's potential to produce milk for the rest of that lactation.

Overall, cows milked 1X for three weeks post-calving produced 7% less MS over the season, whereas those milked 1X for six weeks produced 12% less MS.

These losses are consistent with previous work indicating 20% less MS when 1X milking is continued for 10 weeks post-calving (D.E. Dalley et al., unpublished data) and 30% less MS when Holstein-Friesian cows were milked 1X for the whole season[5].

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Figure 1. Milksolids yields of cows milked once-daily (1X) for either three or six weeks post-calving compared with twice-daily (2X) milking for the whole lactation. The arrows indicate when cows were switched to 2X milking.

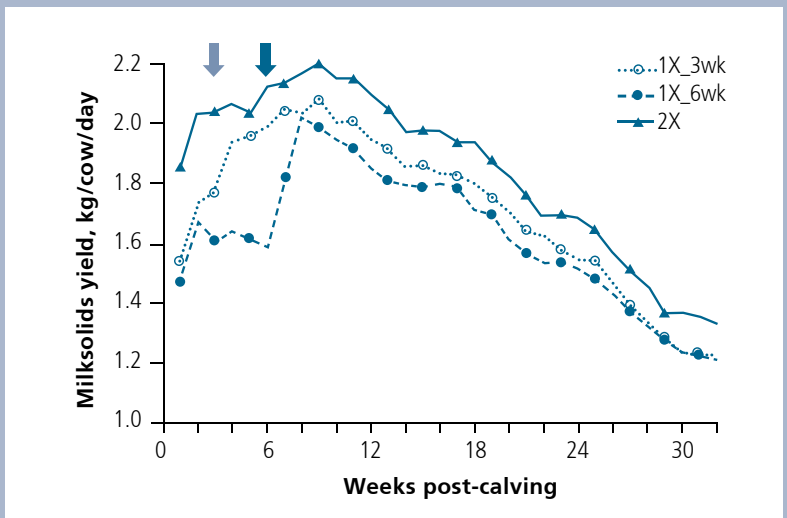

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Figure 2. Milk yields of cows milked thrice-daily (3X) for either three or six weeks post-calving compared with twice-daily (2X) milking for the whole lactation. The arrows indicate when cows were switched to 2X milking.

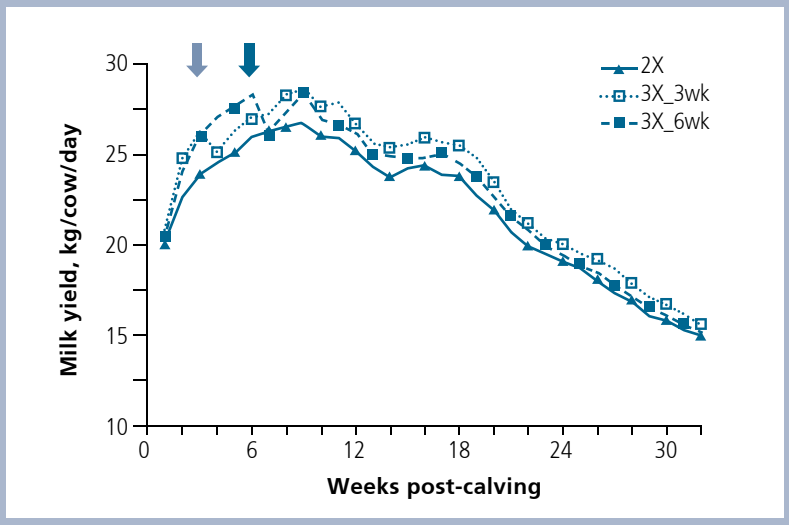
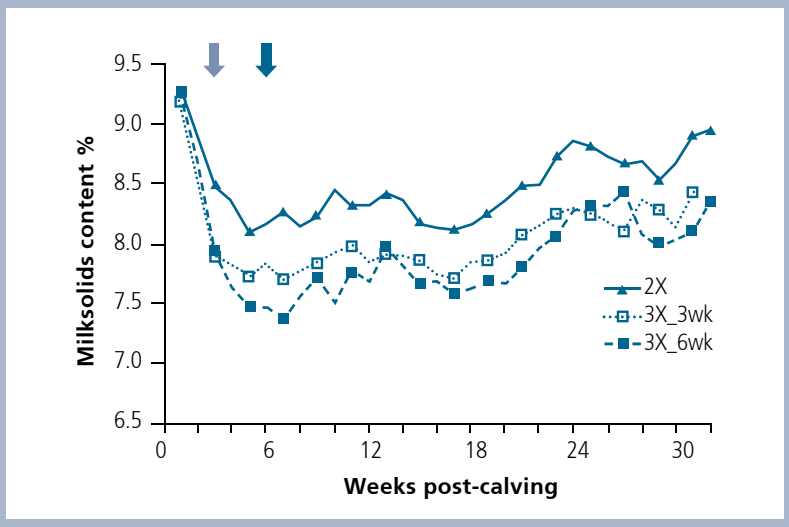


Figure 3. Milksolids content (fat % + protein %) of cows milked thrice daily (3X) for either three or six weeks post-calving compared with twice-daily (2X) milking for the whole lactation. The arrows indicate when cows were switched to 2X milking.



Although the loss is greater with longer durations of 1X milking, as little as three weeks of 1X milking during early lactation reduces the total MS produced for the season.

MS production is not increased by temporary 3X milking

Milking grazing cows 3X at the start of lactation increased milk volume without increasing MS yield.

Cows milked 3X for three or six weeks immediately after calving produced about 7% more milk during the first six weeks of lactation than those milked 2X (Figure 2). However, milk fat and protein yields were not increased because milk fat and protein percentage were reduced by 3X milking (Figure 3).

These effects persisted after cows were switched to 2X milking for the rest of lactation (Figures 2 and 3). Over the season, cows temporarily milked 3X post-calving produced slightly greater total milk yields (+5%), but similar total MS yields, compared with cows milked 2X throughout lactation.

Therefore, short-term frequent milking does not increase whole lactation MS production in pasture-based dairy systems.

Milking 1X or 3X affects cow energy status and BCS, but not reproduction

Cows milked 1X post-calving had a lower milk production but better energy status (indicated by blood metabolites and hormones) than cows milked 2X. This occurred mainly during the period of 1X milking, and disappeared two to three weeks after switching to 2X milking. It resulted in a gradual improvement in BCS (Figure 4a).

BCS loss during the first four weeks post-calving was similar between cows milked 1X or 2X. By five to six weeks in milk, cows milked 1X had a greater BCS (about 0.2 units). By late lactation, these differences were negligible (Figure 4a). Longer durations of 1X milking following calving will achieve greater improvements in BCS[5] (Dalley et al., unpublished data).

In contrast, milking more frequently induced a much poorer energy balance during early lactation. Cows mobilised more body fat reserves (0.2 BCS units; Figure 4b) during the first week of 3X milking post-calving, but this did not persist (Figure 4b). Cows milked 3X post-calving may require more energy-dense diets than a generous allowance of high-quality pasture and a moderate amount (i.e. 4 kg DM/cow per day) of energy supplements to provide sufficient nutrients for increased milk synthesis.

Post-calving milking frequency did not affect reproductive performance. Cows temporarily milked 1X or 3X post-calving had similar anoestrous intervals and submission, conception and pregnancy rates to those milked 2X, agreeing with a previous Irish study[1].

Thus, the differences in energy status and BCS were not sufficient to alter reproduction. It remains unclear if short-term 1X milking can improve reproduction when cows calve below target BCS and/or are underfed, causing poor BCS during early lactation.

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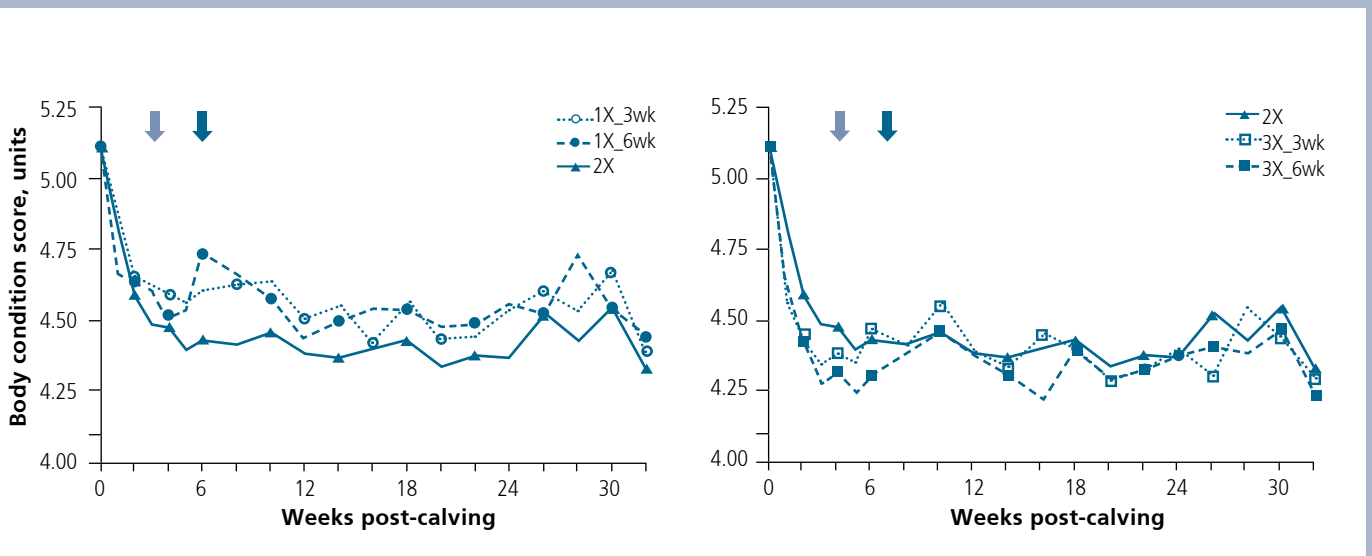
Figure 4. Body condition score of cows milked either a) once-daily (1X) or b) thrice-daily (3X) for either three or six weeks post-calving compared with twice-daily (2X) milking for the whole lactation. The arrows indicate when cows were switched to 2X milking.



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Farm system implications of milking 1X for a short period

At the farm level, several approaches can minimise the total MS loss when using short-term 1X milking in the immediate post-calving period. Confining 1X milking to the colostrum period only or milking the whole herd 1X for a set period, such as three weeks from the planned start of calving, may be useful.

Milking the herd 1X for a set time period reduces the milk production loss because more cows have shorter durations of 1X milking as calving progresses[6].

Models predict that milking the herd 1X for three or six weeks from the planned start of calving and then 2X thereafter will reduce annual farm MS production by 1-2% or 3-5%, respectively. Milking 1X during the colostrum period only (i.e. eight milkings or days) and then 2X thereafter will reduce MS production by about 2%.

The reduction in milk revenue at $6.00/kg MS and a 2% MS production loss equates to about $12,600 lost revenue/300 cow herd (assuming 350 kg MS/cow per year).

A herd-based 1X milking strategy is likely to be more effective at reducing workload and improving farmer/worker stress during calving. Less time spent on milking-related activities may save labour costs. In addition, more time is available for other tasks (e.g. grazing management, animal health, etc.).

If these areas are managed more effectively, any positive effects on animal husbandry and, therefore, milk production may partially compensate for the negative effects of 1X milking.

Conclusions

Milking cows 1X for as little as three weeks during early lactation causes sustained losses in MS production, but improves cow energy status and BCS. Limiting the duration of 1X milking to the colostrum period or using a herd-based strategy for 1X milking will reduce losses in farm milk revenue. Temporary 3X milking during early lactation, however, does not improve MS yields.

Acknowledgements

This research was funded by New Zealand dairy farmers through DairyNZ Inc. and the Ministry of Business, Innovation and Employment.

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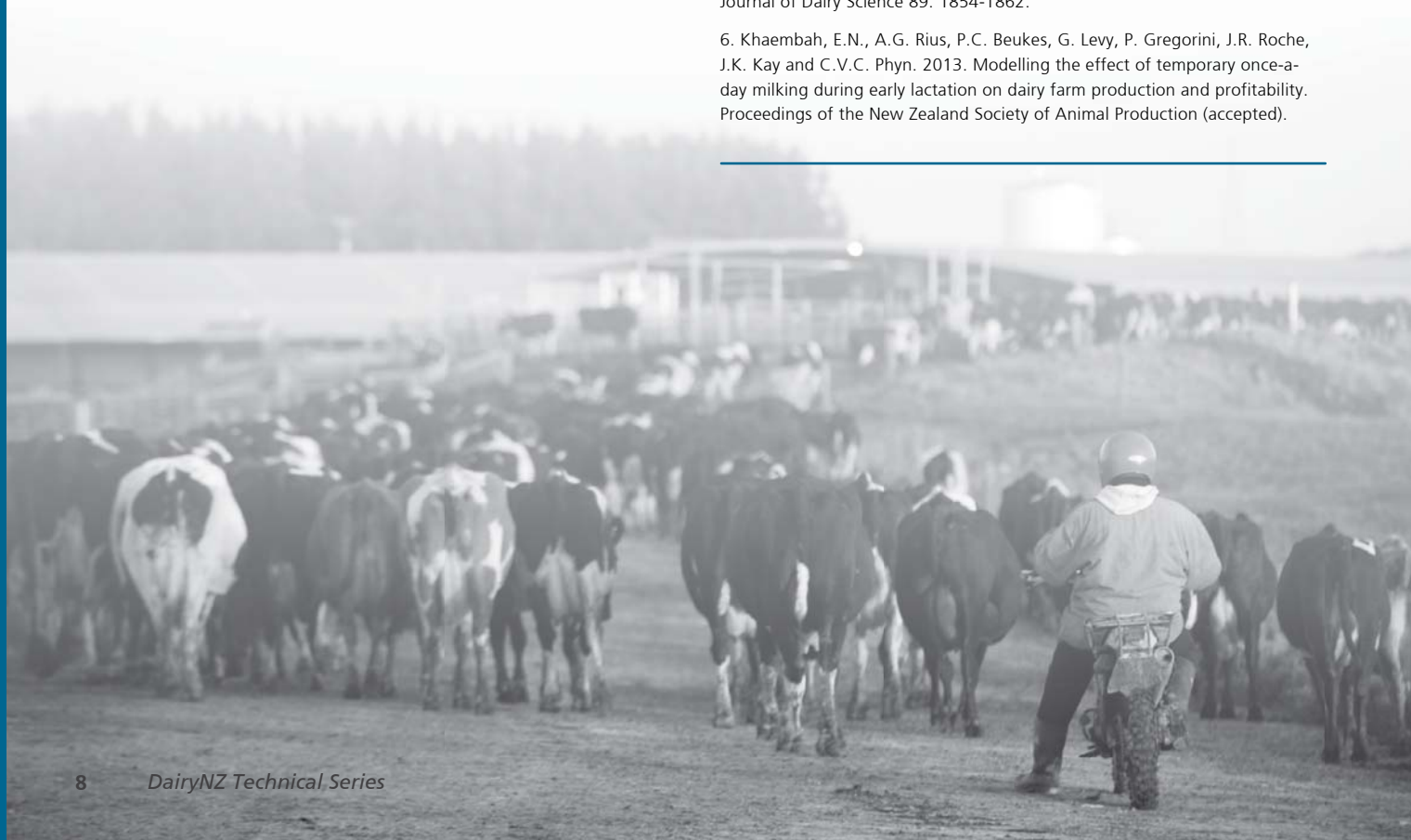

Once-daily milking during a feed shortage in early lactation

Jane Kay, Claire Phyn, Agustin Rius, DairyNZ Scientists; Talia Grala, DairyNZ Post-graduate Student and John Roche, DairyNZ Principal Scientist

Summary

Milking cows once-daily during a temporary feed shortage in early lactation

- results in additional losses in milksolids production
- does not reduce feed demand
- improves cow energy status and reduces the risk of metabolic disorders
- does not alleviate body condition score loss.

In pasture-based dairy systems, extreme weather events such as floods, heavy snowfalls or storms can result in severe feed shortages with negative effects on milk production, reproduction and animal welfare.

Therefore, alternative management strategies may be necessary. One strategy that is sometimes used is milking cows once-daily (1X), however, limited data exists on the short and long-term effects.

DairyNZ has determined the impact of milking cows 1X during a short-term pasture shortage in early lactation on milksolids (MS) production, body condition score (BCS) and energy status.

About the study

The study used 120 mixed-aged (≥ 3 years) Holstein-Friesian and cross-bred cows, at approximately five weeks post-calving. Cows were grazed and either fed to recommended levels (FED) with target post-grazing residuals of 1600 kg DM/ha, or underfed by 40% (UF), and milked either 2X or 1X for three weeks (Table 1).

Average daily dry matter intake (DMI) was estimated from pre

Table 1. Post-grazing residuals and estimated dry matter intake (DMI) and energy intake of cows fed to recommended levels (FED) or underfed (UF) and milked either twice (2X) or once (1X) daily for three weeks.

	FED-2X	FED-1X	UF-2X	UF-1X
Post-grazing residuals (rising plate meter clicks)	7.8	7.6	4.5	4.6
Estimated pasture DMI (kg DM/ cow/d)	13.6	14.2	8.1	8.0
Estimated energy intake (MJ ME/ cow/d)	170	177	101	99

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and post-grazing pasture mass. Energy intake was calculated from this DMI and the metabolisable energy content of the pasture (Table 1). After the treatment period, all cows were fed to target post-grazing residuals of 1600 kg DM/ha and milked 2X for 20 weeks.

Key outcomes

Milking cows 1X caused additional production losses

During the three-week treatment period, MS production was reduced by underfeeding and 1X milking (Figure 1). Cows that were underfed and milked 2X produced 26% less MS compared with cows fed to recommended levels and milked 2X. When underfed cows were milked 1X, MS production was reduced by a further 10%.

The additional loss in MS production when underfed cows were milked 1X is because underfeeding reduces the nutrients available for milk production, and 1X milking reduces the number and activity of the milk-producing cells in the udder[1].

Long-term effects of underfeeding and 1X milking

The losses in MS production caused by underfeeding and 1X milking continued after the treatment period had finished (Figure 1).

In total, over the experimental period, cows previously underfed and milked 2X produced 9% less MS (Table 2). Whereas cows previously underfed and milked 1X produced 13% less MS compared with cows fed to recommended levels and milked 2X continuously (Table 2).

The long-term losses in MS production following short periods of 1X milking in early lactation are consistent with other experiments in NZ[2] and overseas[3] and indicate 1X milking causes irreversible changes to the cells within the udder that produce milk[1,3].

Table 2. Cumulative milksolids (MS) production for the 23-week experimental period. Cows were fed to recommended levels (FED) or underfed (UF) and milked either twice (2X) or once-daily (1X) for three weeks.

Per cow	FED-2X	FED-1X	UF-2X	UF-1X
Total (kg MS)	230	211	209	200
Difference (kg MS)		19 (8%)	21 (9%)	30 (13%)

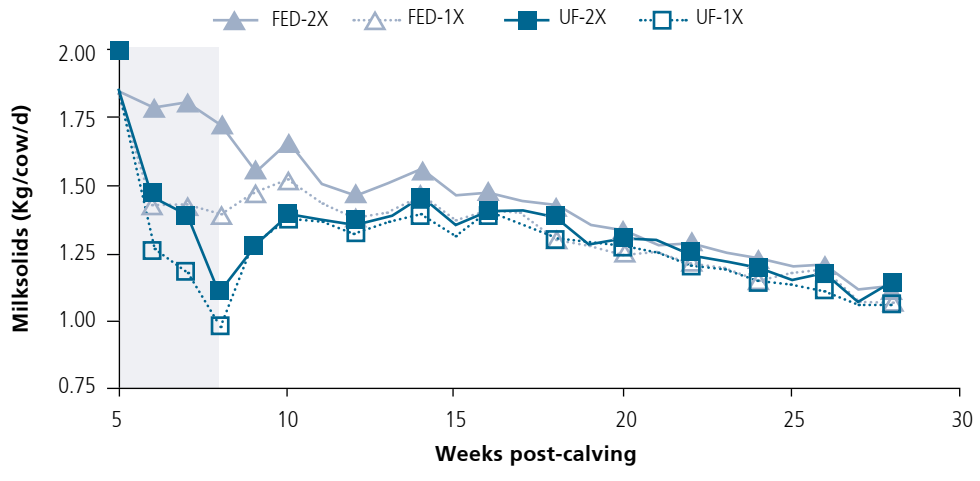
Milking 1X improves energy status

Cow energy status was improved by 1X milking. The positive effect of 1X milking on energy status occurs because energy output is reduced (via decreased milk production) with no change to energy intake (Table 1).

The lack of an effect on intake from 1X milking is consistent with another experiment in which mid to late lactation cows milked 1X or 2X had the same intakes (Kay et al., unpublished data).

Metabolic disorders can be indicated by compounds found in the blood. Blood concentrations of a ketone body (β-hydroxybutyrate) greater than 2 mmol/L are associated with an increased risk of clinical ketosis. These occurred during the first week when cows were underfed and milked 2X (Figure 2).

Figure 1. Milksolids (MS) yield from cows fed to recommended levels (FED) or underfed (UF) and milked either twice (2X) or once-daily (1X). The three-week treatment period is represented by the shaded area.



However, when underfed cows were milked 1X, the risk of ketosis was lower as average β-hydroxybutyrate concentrations did not exceed 1 mmol/L (Figure 2).

Milking 1X does not alleviate BCS loss

Although 1X milking improved the energy status of underfed cows, they still lost an average 0.2 BCS units during the three-week feed shortage. This BCS loss was the same as underfed cows that remain on 2X milking (Figure 3).

The lack of an effect of 1X milking on BCS loss in underfed cows may be because BCS is a relatively crude measure of energy status and three weeks may not have been long enough to detect subtle changes in energy stores using this method.

Other DairyNZ experiments indicate that 1X milking does improve BCS in both early and late-lactation. However, the gain in BCS is gradual, taking approximately six to eight weeks[2] (Kay et al., unpublished data).

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Figure 2. β-hydroxybutyrate concentrations of cows fed to recommended levels (FED) or underfed (UF) and milked either twice (2X) or once-daily (1X). The three-week treatment period is represented by the shaded area.

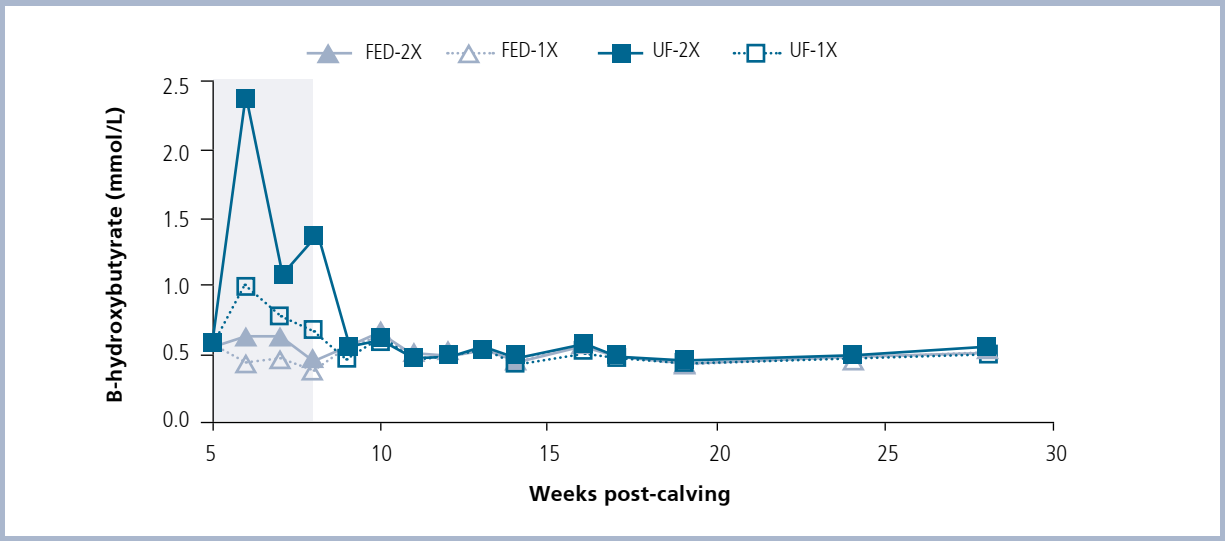
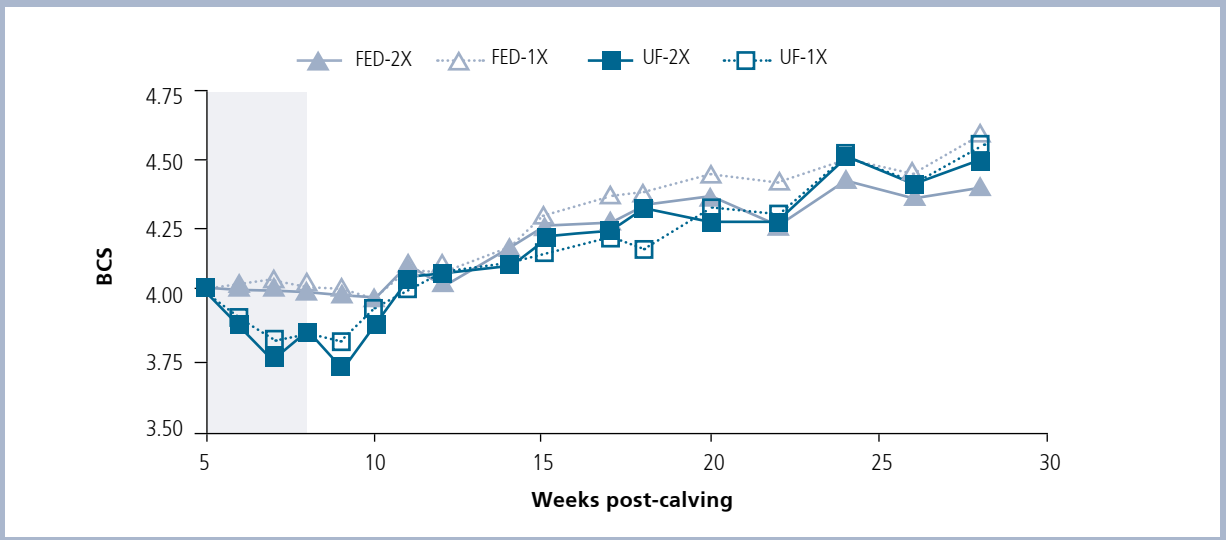


Figure 3. Body condition score (BCS) of cows fed to recommended levels (FED) or underfed (UF) and milked either twice (2X) or once-daily (1X). The three-week treatment period is represented by the shaded area.



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Current research

These results are being built into the DairyNZ Whole Farm Model[4], to predict the impact of 1X milking during a feed shortage on different on-farm scenarios.

Farm production and profitability can be estimated and the impact of 1X milking can be compared with other management options such as supplementary feeding. Results suggest that using supplementary feeds to fill a temporary pasture shortage in early lactation is more profitable than milking 1X (Khaembah et al., unpublished data).

Implications of 1X milking

During adverse events such as flooding or snow storms, 1X milking may be the only practical option and has some farm system advantages.

It allows more time to be spent on non-milking activities such as feeding supplements and pasture management. Additionally, it can reduce stress on people during a difficult period, and if supplementary feeds are delayed or unavailable, 1X milking may reduce the risk of metabolic disorders, improve cow energy status and potentially improve reproduction.

However, milking cows 1X during a feed shortage in early lactation causes additional losses in MS production, and is not an effective strategy to reduce feed demand or BCS loss.

Therefore, if faced with an acute feed deficit in early lactation, careful consideration must be given to the consequences of 1X milking, including the financial impact, before using 1X milking as a management strategy.

Further information

Further details of this experiment have been published[5,6,7]

Acknowledgements

This research was funded by New Zealand dairy farmers through DairyNZ Inc. and the Ministry of Business, Innovation and Employment.

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Supplements and thrice-daily milking during extended lactation

Agustin Rius, Jane Kay, Claire Phyn DairyNZ Scientists; John Roche, DairyNZ Principal Scientist; Stuart Morgan, DairyNZ Technical Teams Manager; Talia Grala, DairyNZ Post-graduate Student

Summary

- A short period (nine weeks) of thrice-daily milking in the late winter/early spring of an extended lactation (EL) temporarily increased daily milk volume yields, but not milksolids production.
- Supplementation with concentrates for nine weeks during an EL increased daily milk volume, protein and milksolids yields, but had no positive long-term effects on milk production once removed from the diet.
- Therefore, short-term increases in milking frequency or nutrition do not result in greater total milksolids production in pasture-based cows in an EL.

The use of overseas cow genetics in pasture-based, seasonal systems has improved individual cow production but negatively affected reproductive performance. This results in greater cow wastage and replacement costs to maintain the required 12-month calving interval.

The concept of an extended lactation (EL) has been proposed to improve reproduction, increase cow survival and reduce farm costs[1,2]. However, milk production in EL systems can be reduced relative to standard 260 to 300-day lactations with annual calving[1].

The strategic use of increased nutrition and/or frequent milking (three or more times daily) during the second half of the EL (> 300 days in milk) may improve cow performance[2,3]. Only a short period of increased milking frequency may be required to generate this response, as sustained increases in milk production occur following short-term (< six weeks) frequent milking in early and mid-lactation[4].

Similarly, cows receiving better nutrition during the second winter/spring of an EL had greater total milksolids (MS) production due to both immediate and carry-over responses[2]. It is possible that shorter periods of supplementary feeding will generate similar responses.

A DairyNZ experiment aimed to determine if a short period (nine weeks) of thrice-daily milking (3X) and concentrate supplementation, either alone or in combination, increases MS production during an EL.

The study

In May 2010, 124 mature, non-pregnant Holstein-Friesian cows (average 273 days in milk) began an EL at the Westpac Taranaki Agricultural Research Station (WTARS) in Hawera.

Cows were deliberately not bred during the previous breeding period to establish a 24-month inter-calving interval. In July

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2010, cows were assigned to one of four treatments for nine weeks.

Treatments were:

1. cows milked 2X and fed pasture only
2. cows milked 2X and fed pasture plus 6 kg DM concentrate/cow per day
3. cows milked 3X and fed pasture only
4. cows milked 3X and fed pasture plus 6 kg DM concentrate/cow per day

Cows were offered a pasture allowance of approximately 30 kg DM/cow per day (residuals ≥1600 kg DM/ha during spring and autumn and ≥2200 kg DM/ha during summer). After the treatment period, cows were fed pasture only and milked 2X for the rest of lactation until dry-off (i.e. the post-treatment period).

Key outcomes

Milking 3X increases milk but not MS production

Regardless of diet, cows milked 3X produced 10% more milk than those milked 2X, indicating that EL cows will respond to an increased milking frequency (Table 1). This response was similar to the 8% increase in daily milk yield recently reported[5] for grazing cows milked 3X for six weeks in early lactation.

Unlike during early and mid-lactation[4,5], the production increase from frequent milking during EL was not sustained when cows were switched to 2X milking (Table 1). This difference in response most likely reflects the advanced stage of lactation and highly variable individual milk production of EL cows[1,2].

Milking 3X did not increase milk fat, protein or MS yields. This is because of the lower milk fat and protein percentage in cows

Table 1. Mean cumulative milk production and milk composition from cows milked twice (2X) or thrice (3X) daily for nine weeks during an extended lactation. Following the treatment period, all cows were milked 2X until dry-off.

	Treatment[1]				Post-treatment[2]			
	2X	3X	SED[3]	P-value	2X	3X	SED	P-value
Milk yield, kg	757	835	24	<0.01	1714	1793	127	0.54
Milk protein yield, kg	32.4	33.6	1.0	0.24	89.4	88.3	6.9	0.86
Milk fat yield, kg	36.9	37.5	1.2	0.65	78.8	80.8	5.8	0.74
Milksolids yield, kg	69.3	71.0	2.2	0.42	163.2	164.4	12.4	0.95
Milk protein, %	4.31	4.08	0.03	<0.001	4.31	4.25	0.05	0.22
Milk fat, %	4.91	4.64	0.08	<0.001	5.12	5.06	0.08	0.45

[1]Milk production data from 333 to 396 days in milk (July 15 to September 16 2010)
[2]Milk production data from September 17 to individual cow dry-off
[3]SED = Standard error of the difference between means.

Table 2. Mean cumulative milk production and milk composition of cows offered a pasture allowance of 30 kg DM/cow per day (Pas) or Pas plus 6 kg of concentrate DM/cow per day (Con) for nine weeks during an extended lactation. Following the treatment period, all cows were fed pasture only until dry-off.

	Treatment[1]				Post-treatment[2]			
	Pas	Con	SED[3]	P-value	Pas	Con	SED	P-value
Milk yield, kg	764	828	24	<0.01	1787	1719	127	0.59
Milk protein yield, kg	31.7	34.3	1.0	0.01	91.5	86.2	6.9	0.44
Milk fat yield, kg	36.7	37.7	1.2	0.39	80.9	78.7	5.8	0.71
Milksolids yield, kg	68.3	72.0	2.2	0.08	169.1	157.7	12.3	0.34
Milk protein, %	4.18	4.21	0.03	0.28	4.33	4.23	0.05	0.04
Milk fat, %	4.88	4.68	0.08	<0.01	5.12	5.06	0.08	0.46

[1]Milk production data from 333 to 396 days in milk (July 15 to September 16 2010)
[2]Milk production data from September 17 to individual cow dry-off
[3]SED = Standard error of the difference between means.

milked 3X relative to 2X (Table 1), which has also been reported for early-lactating grazing cows[5].

These changes in milk composition resulted in a more dilute milk. Therefore, an increased milking frequency is not an effective or profitable strategy to improve the MS production of pasture-based cows milked for an EL.

Feeding supplements increases milk production during an EL

Irrespective of milking frequency, cows offered a concentrate supplement for nine weeks had greater yields of milk (+8%) and protein (+8%), and tended to have greater MS yields (+5.5%), relative to cows fed pasture only (Table 2).

These results are comparable to those from a previous trial[2] when cows were supplemented with concentrate for 18 weeks during the second winter/spring of an EL. However, unlike that study, responses to concentrate did not carry-over beyond the short period of supplementation (Table 2).

It is likely that longer durations of improved nutrition are required to generate increases in total MS production in cows milked for an EL[1,2].

Cows milked 3X have a greater response to supplementary feed

There was a greater response to concentrates when cows were milked 3X rather than 2X, but this effect was gradual and only detectable in the last week of treatments (Figure 1).

At that stage, when cows were milked 3X, feeding concentrate increased daily milk and MS yields by 19% and 14%, respectively. The response was only +10% for milk and +3% for MS when cows were milked 2X.

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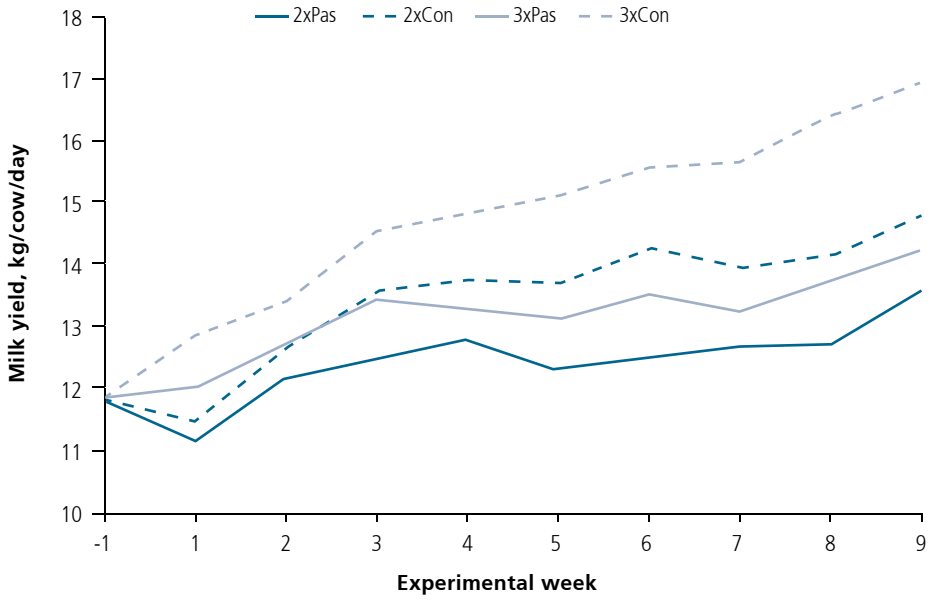
Figure 1. Milk yield of cows offered a pasture allowance of 30 kg DM/cow per day (Pas) or Pas plus 6 kg of concentrate DM/cow per day (Con) and milked twice (2X) or thrice (3X) daily for nine weeks in an extended lactation. The standard error of difference is 0.61.



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These effects meant that cows milked 3X and fed concentrates produced the most milk and MS: 19% and 8% more at week nine (respectively), than cows milked 2X and fed pasture alone (Figure 1).

Therefore, it might be possible to combine 3X milking with concentrate supplementation for longer periods to increase MS production. The effectiveness of this strategy and its implications for the farm system, including labour requirements and operating costs, require further investigation.

Supplements increase liveweight and body condition score (BCS)

Supplementing cows with concentrates increased liveweight and BCS. After nine weeks of eating concentrates, cows were 21 kg heavier and 0.4 BCS units greater than those fed pasture only (544 vs. 523 kg liveweight and 5.2 vs. 4.8 BCS units).

These differences gradually disappeared once cows returned to an all-grass diet. Along with blood metabolite and hormone data, differences in liveweight and BCS indicate that feeding concentrates increased body fat deposition and reduced body fat mobilisation.

However, compared with feeding supplements from calving to dry-off in an EL[1], a nine-week concentrate supplementation period in the second spring did not promote excessive liveweight and BCS gain. In contrast, short-term 3X milking did not alter liveweight and BCS during an EL.

Conclusions

Milking cows 3X for nine weeks during the second late winter/early spring of an EL increased milk but not MS yields. This response was not sustained after cows were returned to 2X milking.

Offering concentrates for nine weeks increased milk, protein and MS yields, but only during the period of supplementation. Therefore, temporary increases to milking frequency and nutrition do not increase total MS production in pasture-based cows milked for an EL.

Further research is required to determine if 3X milking combined with supplementation for longer than nine weeks is a profitable strategy to increase total MS production.

Acknowledgements

This research was funded by NZ dairy farmers through DairyNZ Inc. and by the Ministry of Business, Innovation and Employment.

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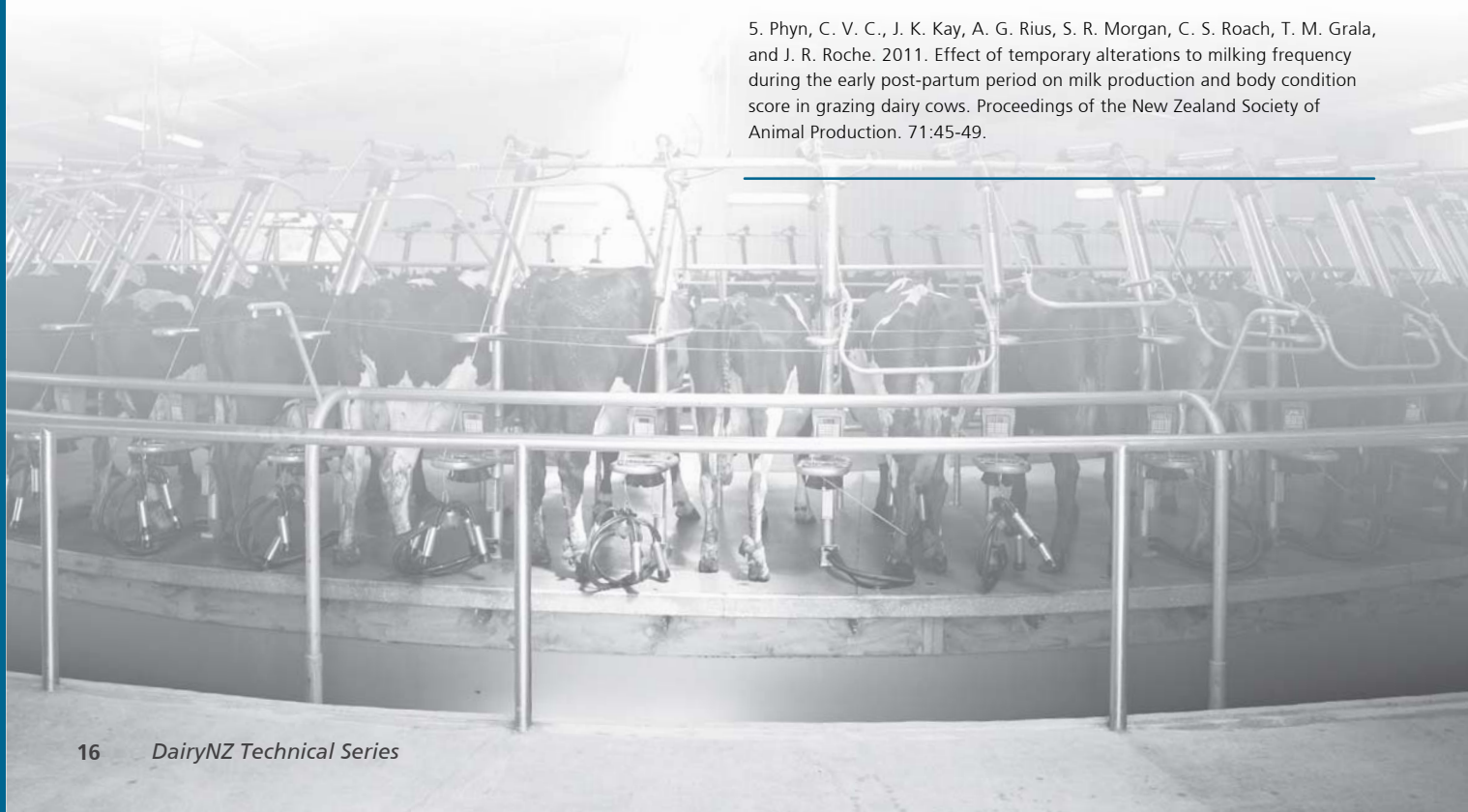

Recently published by DairyNZ

DairyNZ researchers publish their findings in high calibre national and international journals, so they remain at the leading edge of dairy industry research.

Peer reviewed (journal) publications

Edwards, J. P., J. G. Jago, and N. Lopez-Villalobos. 2013. Short-term application of prestimulation and increased automatic cluster remover threshold affect milking characteristics of grazing dairy cows in late lactation. Journal of Dairy Science, 96:1886-1893.

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Romera, A., P. Beukes, D. Clark, C. Clark, and A. Tait. 2013. Pasture growth model to assist management on dairy farms: testing the concept with farmers. Grassland Science, 59:20-29.

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Science conference publications

Haultain, J., I. Yule, A. J. Romera, B. Dela Rue, D. Clark, C. Glassey, and J. Jago. 2012. Using grazing frequency and milk yield to rank paddock performance. Page 24 in Proceedings of the 3rd Australian and New Zealand Spatially Enabled Livestock Management Symposium, Lincoln, New Zealand.

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Mandok, K. S., S. L. Greenwood, J. K. Kay, M. Crookenden, and J. R. Roche. 2012. Brief Communication: maintenance energy requirements of non-lactating, pregnant dairy cows. Proceedings of the New Zealand Society of Animal Production, 72:117-119.

For the full list of DairyNZ publications visit the news and media section of **dairynz.co.nz**

Part three: using mRNA – translation into protein

Rachel Boyle, DairyNZ Research Technician; Talia Grala, DairyNZ Post-Graduate Student; Claire Phyn, DairyNZ Scientist; Jane Kay, DairyNZ Scientist.

From previous articles:

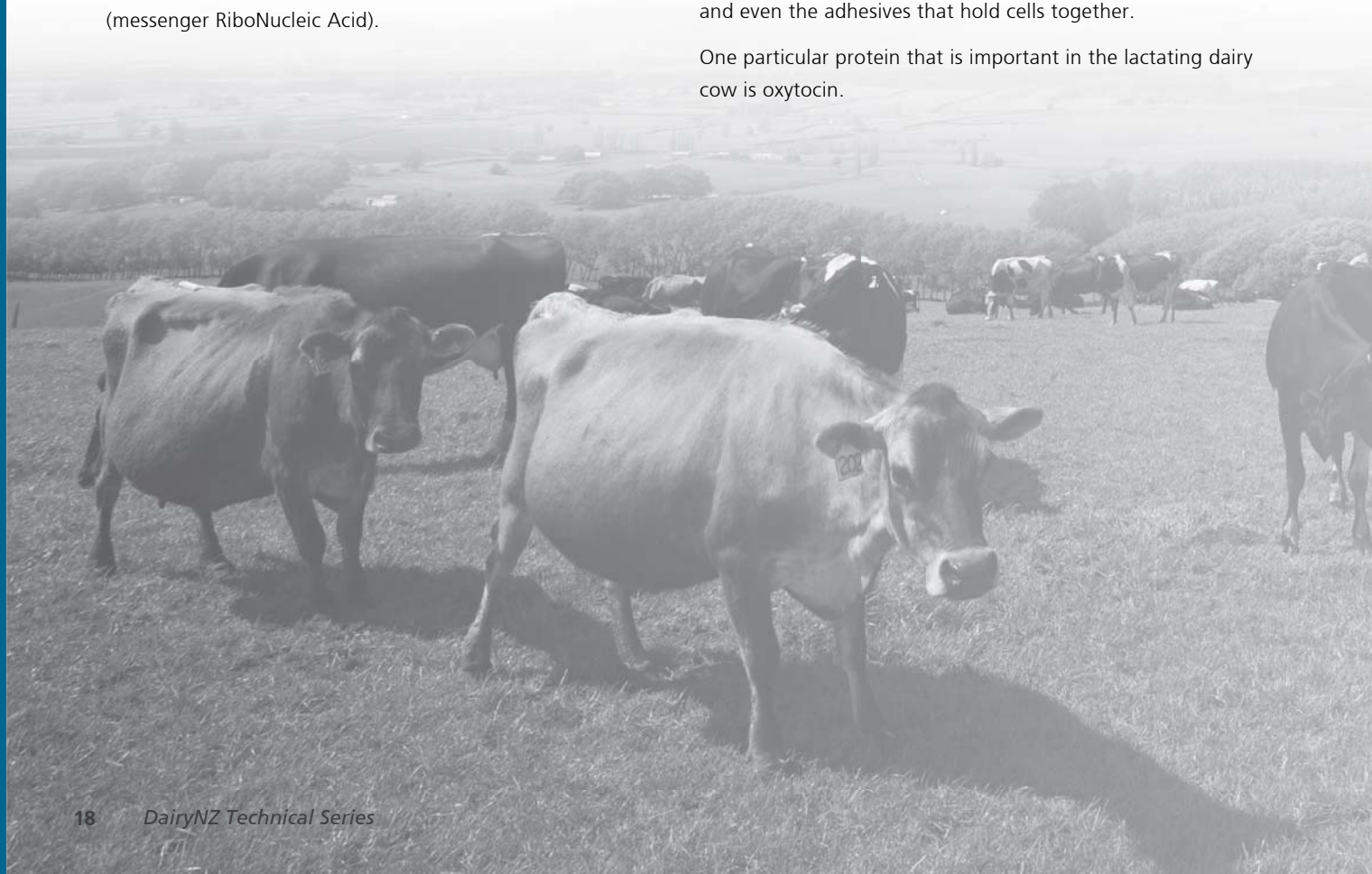
- DNA (DeoxyriboNucleic Acid) is the recipe book for life, containing the genetic code for all biological functions and structures.
- The genetic code is a DNA sequence compiled from an 'alphabet' of only four letters, which are called bases.
- Each 'recipe' is a gene with a particular purpose, but a cell can't make all the recipes at one time.
- For a gene to perform its function, a copy of the DNA sequence has to be made. The copying process is called transcription and the copy of the gene is called mRNA (messenger RiboNucleic Acid).

This article is the third in a series that explores basic genetic concepts, and how DNA relates to milk production and breeding. Here, we explain the next step in how the recipe (gene) is used to make the required product, be it a hormone, protein or enzyme.

The mRNA (the copy of a gene) encodes a specific sequence of amino acids which, when joined together, form a protein (Figure 1).

There are 20 unique amino acids, which are the building blocks for all proteins. A plant or animal is made up of many different proteins. These proteins can form solid structures like hair, bone, muscle and organs, or act individually as hormones, enzymes and even the adhesives that hold cells together.

One particular protein that is important in the lactating dairy cow is oxytocin.



Oxytocin is produced by the pituitary gland (in the brain) in response to the milking routine and induces milk let-down by the udder. Oxytocin also plays a key role in reproduction, including contracting the uterus during labour.

To produce a protein such as oxytocin, a process called translation must occur (Figure 1). Inside a cell, a ribosome (or 'chef') reads the sequence of bases (letters) in the mRNA as three-letter words. Each three-letter word (called a codon) encodes an amino acid or a signal, such as start or stop.

The ribosome reads the 'start' position for the protein and then attaches one amino acid at a time, according to the mRNA sequence, to form a chain. The chain continues to grow until a 'stop' codon is encountered. Oxytocin is one of the smallest proteins produced, consisting of only nine amino acids.

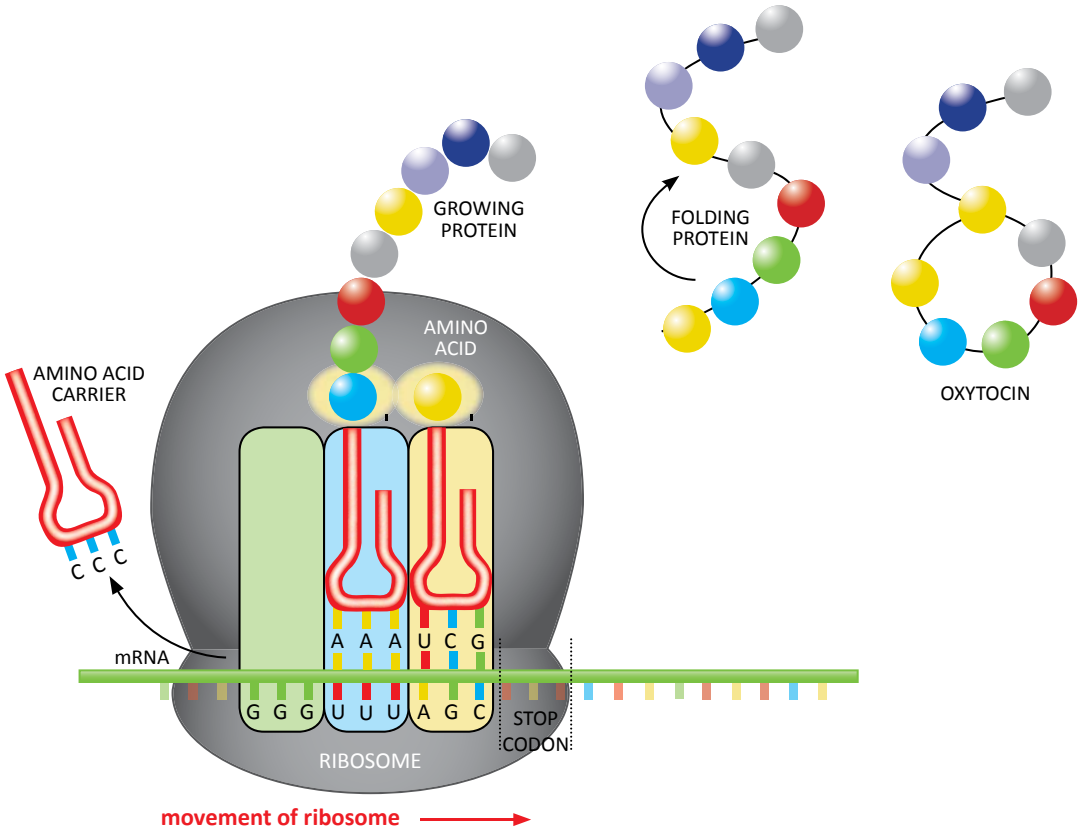
Then the ribosome detaches from the mRNA and releases the now complete chain of amino acids. Once released, this chain of amino acids may fold into a specific structure. In the case of oxytocin, the nine amino acid chain folds into a tailed loop to form the active oxytocin protein.

Parts one and two of the Delving into DNA series are available in the December 2012 and February 2013 Technical Series.

Summary

- A cell uses a recipe (gene) to make a protein.
- mRNA is translated into an amino acid chain.
- This chain folds to form a functional protein.

Figure 1. The translation of oxytocin, a hormone made up of only nine amino acids. Once the nine amino acid chain is formed, it folds to form the active oxytocin hormone.



Focus on international research

The following is a brief summary of some key science papers recently published.

Wims and others (2012) Effect of perennial ryegrass (*Lolium perenne* L.) cultivars on the milk yield of grazing dairy cows.
Animal 7: 410-421

The milk production response of dairy cows grazing monocultures of four perennial ryegrass cultivars was assessed during vegetative and reproductive growth in Ireland. Milk yield from the different cultivars was related to variations in pasture structure and nutritive value between the cultivars. The study concluded that the plant's organic matter digestibility (OMD) was an important trait affecting milk yield. By comparison, during the summer months when reproductive stem was present, sward structure was the key trait influencing cultivar performance in terms of milk yield.

DairyNZ comment: milk production is driven by the quantity of feed consumed by cows. Selection of the appropriate cultivar to maximise plant and animal performance for a given environment, is a critical decision. The DairyNZ Forage Value Index (FVI) has been designed to assist farmers with their choice of cultivar and ranks each cultivar on seasonal dry matter performance. The conclusions drawn from the Irish study support the initiative taken by DairyNZ and the New Zealand Plant Breeding and Research Association (NZPBRA) to work towards inclusion of nutritive value and persistence traits into the FVI. This will allow for informed, confident and profitable decisions when selecting seed.

For further information refer to **dairynzfvi.co.nz.**

Creighton and others (2012) Effect of Lolium perenne sward density on productivity under simulated and actual cattle grazing.
Grass and Forage Science 67: 526-534

An Irish study investigated the effect of ryegrass density on the seasonal and annual dry matter (DM) yield for three perennial ryegrass cultivars over two grazing seasons. The study reported that annual productivity of ryegrass pastures under cattle grazing was related to ryegrass density. However, the increase in annual DM with increased seeding rates from 5 to 12 kg ha^{-1} was small and there was no significant response in annual DM yield when lifting seeding rates from 20 to 30 kg ha^{-1}. The data also showed that pastures managed under a simulated cutting regime retained greater sward density than under cattle grazing, increasing the need for cultivar evaluation schemes to assess grass cultivars for DM yield under animal grazing to better quantify pasture persistence.

DairyNZ comment: pasture persistence has been recognised as a major factor contributing to poor long-term productivity of pastures in New Zealand. DairyNZ is researching the effect of seeding rate of perennial ryegrass cultivars mixed with white clover on plant species survival at research sites in Northland, Waikato and Canterbury. Persistence under dairy cow grazing is being measured for five to seven years, with the additional aim of identifying characteristics of persistent ryegrass plants that can be used in breeding programmes.

Simili da Silva and others (2013) Energy to protein ratio of grass-legume binary mixtures under frequent clipping.
Journal of Dairy Agronomy Journal 105: 482-492

This study evaluated binary mixtures of grass and legume species under cutting, with dry matter (DM) yield and nutritive value measured at two sites in Canada. The objective was to identify mixtures with greater energy:protein ratio, while maintaining DM yield. Mixtures with lucerne, particularly meadow fescue with lucerne, provided the best combination for achieving a high ratio of water soluble carbohydrate/crude protein, high DM yield and acceptable level of digestibility. This compared with a lower energy:protein ratio and yield for a white clover and tall fescue mixture. The study concluded that the long-term composition and persistence of lucerne based binary mixtures needs to be determined.

DairyNZ comment: utilising diverse pastures for reducing the environmental footprint is gaining traction around the world. However, the relationship between nitrogen use efficiency and concentration of water soluble carbohydrate continues to be widely debated. DairyNZ has a programme of work monitoring mixtures of perennial ryegrass or tall fescue with prairie grass, white clover, chicory, plantain and lucerne. So far, the seasonal and annual DM production and botanical composition over three years has been compared with a control ryegrass-clover pasture. Monitoring the persistence of these mixtures is ongoing and further research is planned to evaluate which species, within a diverse mixture, contribute to reducing nitrate leaching under New Zealand conditions.