# SEARCHING FOR PRODUCTIVITY GAINS THROUGH 'ONCE-A-DAY' MILKING ON NEW ZEALAND'S PASTORAL DAIRY FARMS

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## ABSTRACT

Cows that are milked once-a-day (OAD) produce less milk than when milked twice-a-day (TAD). However, these cows also require less feed because of their lower milk production. Hence stocking rates can be increased. New Zealand evidence shows that the benefits from OAD milking can include per cow savings in animal health, labour and electricity costs, plus improved pregnancy rates. A linear programming model was used to evaluate the whole farm impact of these changes. This showed that OAD milking is likely to reduce profitability. This was based on recent New Zealand research showing an average per cow production decrease of 29% for Friesian cows and 20% for Jersey cows. However, given that some cows can perform under OAD at a similar level to TAD, it is likely that selective breeding will eventually lead to per-cow losses of production that are much less than this. If per cow production losses under OAD milking can be reduced to about 10%, then this will allow cow numbers to be increased by about 6% and will provide a similar whole farm profit as under TAD. There would also be lifestyle advantages for farmers. If per cow production losses could be eliminated, then the farm working expenses under OAD on a typical New Zealand dairy farm would be reduced by about 6.5%.

**Keywords**: Once-a day milking, milk harvesting, linear programming, pastoral dairy farming

## INTRODUCTION

Dairy cows on New Zealand's pastoral based dairy farms have traditionally been milked twice a day. There are high labour inputs and lifestyle issues associated with the twice daily routine of paddock mustering the herd and harvesting the milk. Until recently, the conventional perspective has been that reduced milk production associated with the alternative of once-a-day (OAD) milking would make such a strategy uneconomic. However, recent trial data and farmer experience is leading to a re-assessment. In the most recent season several hundred farmers have moved to an OAD system and many other farmers are seriously evaluating the prospects. In this paper we report on the use of a linear programming model to integrate the on-farm and trial evidence in relation to the overall impact of OAD on farm system and farm productivity. Our focus is on situations where OAD harvesting is used as a whole of lactation strategy, rather than a short term tactical response to a specific management issue.

### Milk Production Losses

There have been only a limited number of trials to investigate the loss of milk production associated with whole of lactation OAD milking. In general, the whole of lactation losses rela-

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tive to TAD harvesting systems are between 20% and 50% (Claesson et al. 1959, Holmes et.al. 1992; Tong, et al. 2002). Although the yield loss during OAD milking is not fully understood, many physiological changes happen locally in the udder and cisterns, almost all associated with udder and cistern physical capacity (Davis et al. 1999).

The losses are both breed and farming system dependant. Jerseys have more concentrated milk than Friesians, and they tend to take a longer post-milking to reach udder capacity. Also, because pasture–based systems typically result in cows, even under TAD systems, producing less milk than can be produced under the more intensive feeding systems commonly used in Europe, USA and many other parts of the world, it is reasonable to postulate that the losses might be less for pasture-based systems than under more intensive systems. Our interest has been in relation to systems that are based, as in New Zealand, on cows that graze pasture in situ.

The best research data of OAD harvesting for a pastoral-based system comes from four years of investigation in Taranaki in New Zealand's North Island (Dexcel 2004). These trials have used both Friesian/Holstein herds and Jersey herds. These two breeds and their crosses are the predominant dairy breeds in New Zealand. The evidence from four years of trials is that Friesian cows produce on average 29% less milk during the lactation and that for Jersey cows the loss is of the order of 20%. There is also a tendency for the lactation curve to be modified in shape, with an earlier peak, and the proportional loss being greater in the second half of the lactation. What is also notable from individual cow data supplied to us by the researchers, is that some cows are able to produce under OAD harvesting at a similar level to what would be achieved under TAD, whereas other cows adapt quite poorly to this system.

The historical evidence from the New Zealand dairy industry is that selective breeding over time results in cows that are able to tolerate changes in milk harvesting procedures, and that practices once considered essential eventually become redundant. These practices have included hand stripping of cows after removal of the milking cups, machine stripping of cows by the use of weights placed on the cups towards the end of the milk harvest, and the hand preparation of cows to stimulate milk let-down. All of these practices have now gone from the New Zealand industry as modern cows have been bred that do not require the practices. Given the evidence that some cows are minimally effected by OAD milking systems, it is reasonable to postulate that similar progress could be achieved towards breeding whole herds of non-affected cows.

### Whole of herd production.

It is possible to partially compensate for reduced per cow production by increasing the stocking rate. It can be shown from using standard nutritional tables (ARC 1980; NRC 1989) that under New Zealand style pastoral systems, where energy rather than protein is typically the constraining feed nutrient, cows use approximately 50% of their required energy intake for maintenance, walking, grazing, and pregnancy, and approximately 50% for production of milk. This means, for example, that from a given amount of feed, if cows are only milked OAD and consequently produce 20% less milk, then under OAD it will be possible to increase the number of cows in the herd by approximately 11% relative to TAD. Similarly, if the per cow loss under OAD is 30% then it will be possible to increase the herd size by approximately 17%.

### Labour effects

The labour effects of employing an OAD system are complex. Clearly, there are labour savings to be achieved through halving the number of musterings and milk harvesting operations, but there are also some counter effects associated with milking more cows. Also, cows take longer to milk-out under OAD than TAD harvesting. Therefore the total length of each milk harvesting operation (first cups on to last cups off) is typically longer under OAD than TAD, although this may depend on specific aspects of shed design. In addition, because the herd is somewhat larger it may take a little longer to muster.

To quantify the labour impacts we asked six dairy farmers who had recently moved to once a day milking to advise us how long various operations took under the OAD and TAD systems. Some farm labour operations such as irrigation are independent of the number of cows milked, other operations such as animal health treatments are clearly related to the number of animals, and other activities such as milk harvesting are related to the frequency of milking.

**Herd replacements**

One of the difficulties associated with the New Zealand style dairy system is that it is difficult to get cows in calf each year so as to maintain the 365 day calving interval required of a seasonal production pattern. The system requires cows to become pregnant at a time when they are partitioning energy for production rather than maintaining body condition. Accordingly, a proportion of cows in every herd fails to get pregnant in sufficient time. These slow-to-breed cows are therefore culled at the end of the season. The effect of a differential 5% culling rate between TAD and OAD systems was therefore incorporated, given that OAD cows producing at a lower level are under less metabolic stress during the mating period.

**Other savings**

Empirical evidence from farmers indicates that there are animal health savings from OAD milking. In particular, lameness, which can be a major problem especially on large farms where cows walk considerable distances along laneways, is considerably reduced. In addition, there are savings in electricity and shed expenses. Accordingly, the base model was run with these expenses reduced by 10% per cow.

**The Linear Programming Model**

Linear programming (LP) was chosen as a framework to compare the various alternatives on a whole-of-farm basis. The strength of the LP approach is that the model chooses the stocking rate, calving date and feed supplementation system that optimise total farm profit. By subsequently restricting specific options (such as the TAD systems), the model is then forced to select the best of the remaining systems (such as the best OAD system).

The model was set up to mimic the overall resource structure (e.g. area, irrigation system, pasture production possibilities) of Lincoln University's dairy farm in Canterbury Province. The reasoning was that this farm is very well known within the farming community and there are regular field days held there. All data for this farm, including weekly pasture production milk production is readily available on the internet. Accordingly, farmers would be able to relate the results to a farm that they knew and understood.

The model operates on 14 day periods. Surplus feed can be made into silage and then fed at times of feed shortage. Whole crop silage can be bought in from outside the farm (a common practice), and cows can be wintered either on the farm (with consequent feed requirements) or wintered off the farm (with consequent cash costs). Nitrogen can be purchased and applied at up to 40 kg N/ha in any period (excluding during the winter), and up to a maximum of 200kg/ha per annum.

Given the current variation in how cows respond to OAD milking, it was considered likely that over time it will be possible to breed cows, through appropriate selection and use of progeny-tested bulls that will be less adversely affected by the OAD harvesting practice than is the current situation. Indeed the major animal breeding company in New Zealand already has bulls ranked according to their suitability for OAD conditions. Accordingly, additional cow options were included whereby for the Friesians the per cow loss of production was reduced from 29% to 20%, 10% and 0%, based on a Friesian cow weighing 473kg pre-calving and producing 400 kg of milk solids (fat plus protein) when milked twice-a-day. This equates to a lactation of approximately 5100 litres. For the Jerseys the baseline loss of 20% was sequentially reduced to 10% and 0% based on Jersey cows weighing 364kg pre-calving and producing 344 kg of milk solids per lactation (approximately 3600 litres) when milked twice-a-day.

Obviously if given a choice, the model would choose an OAD system with zero production loss. However, by sequentially restricting particular options from being included it was possible to build up a comparison of the relative profitability of OAD milking assuming various per-cow losses of production. This provided a basis for answering the question as to the per-cow loss of production that could be compensated for by labour and other cost savings plus running more cows, and still achieving no overall loss of profit.

The model was calibrated to the existing TAD Friesian/Holstein system used at Lincoln University. By using a pasture feed utilisation percentage of 85% (considered achievable on well managed farms) and requiring the model to use the current policies of off farm wintering of dry cows and limited purchase of supplements, the model production and total farm gross margin was compared to the actual farm production. The inputs, outputs and total farm gross margin from the model were found to be very similar to the actual farm figures for the most recent season.

## RESULTS

### Friesian/Holsteins

It was found that under a Friesian system with a 29% per cow production loss under OAD (OAD29%) it was not possible through increased stocking rate and labour savings to compensate for the loss of income. Optimal stocking rate increased by 16% and milk harvesting labour decreased by 35.5%, but total net income before interest on fixed capital and taxes was reduced by NZ$159,000 (US$ 116,000) , a decrease of 32.5%

These baseline runs were undertaken with milk valued at $4.20 per kg 'milk solids'. Within the New Zealand dairy industry 'milk solids' is measured as fat plus protein but with lactose and minerals not included. This $NZ4.20 per kg milk solids equates to approximately US-24cents/litre of milk at current exchange rates.

It was found that the differences in net earnings from the OAD29% and TAD systems were only moderately sensitive to the price of milk. A 10% decrease in milk price decreased the relative difference in profit between OAD29% and TAD milking from NZ$159,000 to NZ$142,000 and a 10% increase in milk price increased the relative loss from NZ$159,000 to NZ$175,600.

The baseline runs were undertaken with milk harvesting labour costed at NZ$12 per hour. In practice, there is some variation between farms in the cost of labour, and it could be argued that this does not take account of overhead charges associated with employing, training and supervising this labour. However, sensitivity analysis showed that increasing the price of labour led eventually to both the OAD and TAD systems making an overall loss without there being any labour price at which the OAD system was more profitable than the TAD system.

The model was used to investigate two further questions. The first was to identify the maximum per-cow loss that could be compensated by the combined effect of labour and other savings plus increased cow numbers, so as to achieve no loss of net farm income. The second was to identify the likely gains in total cost efficiency in a situation where there were no per cow losses of production from the OAD system.

It was found from the model that the breakeven loss of production per cow was approximately 10%. At this point it was possible to compensate for the lost production by an increase of 6 % in stocking rate and a saving of 41% in the labour associated with milk harvesting. In practice this breakeven percentage may increase to about 12 %. For example, if milk harvesting labour were to be costed at $15 per hour instead of $12 then this would increase the breakeven percentage by just over 1%. In addition, if per head animal health costs or electricity costs were to reduce by a further 10% then each of these would increase the breakeven percentage by about 0.5%.

If it is possible to breed herds of cows whose production is unaffected by OAD milking then the expected labour savings are 44% of milk harvesting labour worth NZ$0.15 per kg of milk solids. This represents a savings of approximately 6.4% in farm operating costs.

**Jerseys**

A similar set of results were obtained for the Jersey herds. However, because the baseline loss under OAD was only 20% relative to TAD (based on the four years of data from the Taranaki trial results) the net loss of income (before interest on fixed capital and taxes) was only NZ$ 76,000 or 17%.

A similar breakeven production loss per cow of approximately 10% was achieved, such that this was the production loss that could be compensated by running more cows and saving labour with the OAD system. However, a key management issue for farmers is that the selective breeding required to achieve this improvement is likely to be less than for Friesians given the different starting point for these two breeds.

## DISCUSSION AND CONCLUSIONS

It is evident that for the Lincoln University farm a shift to a OAD milking system would result in a decrease in farm profit. Why, therefore are so many farmers shifting to an OAD system?

We believe there are at least three contributing factors. The first is that on some farms there are particular physical constraints, such as a long narrow farm, where OAD systems produce additional benefits relative to TAD systems. However, probably more important is that there are considerable lifestyle advantages moving to the OAD system that are not necessarily captured in a financial analysis. For example, the industry is well known as having a high 'burn out' factor, whereby farmers who have struggled up the industry ladder to farm ownership, often after many years as farm workers and sharemilkers, are looking for an easier lifestyle once they finally achieve a secure economic position. Some of these farmers are prepared to sacrifice income to achieve this. Some farmers may also move to OAD milking as an investment; prepared to sacrifice profit in the short term as a step towards achieving long term productivity gains as cow tolerance to OAD increases.

Looking further to the future, we predict that eventually OAD milking will become a key strategy that will assist the majority of NZ dairy farmers to sustain a position of cost leadership amongst the major dairying producing countries. Sustaining a position of cost leadership is fundamental to the long term future of the industry (Woodford et al 2003). The existing competitive advantage is built upon a cost efficient model of pastoral farming but is also threatened by the difficulty of obtaining milk harvesting labour at a cost that farmers regard as economic. Development of dairy herds that can accept OAD milking without loss of per-cow production would seem achievable through a long term strategy of selective breeding. In addition, by appropriate choice of bull semen it will be possible and indeed is already possible (but with some limitations on reliability) for farmers to breed for OAD tolerance in advance of making the managerial shift. Accordingly, we predict that in the coming years OAD milking systems will be a very important source of total factor productivity gains for pastoral based dairy systems.

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## REFERENCES

Agricultural Research Council (1980). The Nutrient Requirements of Ruminant Livestock. England: Commonwealth Agricultural Bureaux.

Claesson, O., Hansson, A., Gustafsson, N., & Eskil, B. (1959). Studies on Monozygous Cattle Twins. XVII. Once-a-day milking compared with twice-a-day milking. Acta agriculturae, Scandinavica, 9, 38-58.

Davis, S.R, Farr, V.C. and Stelwagen, K. (1999). Regulation of yield loss and milk composition during once-daily milking: a review. In: Livestock Production Science, n 59, p 77-94.

Dexcel (2004) Once a day milking. Current research Accessed at www.dexcel.co.nz/main.cfm?id=264&sid=319&id2=357&an_id=319

Holmes, C. W., Wilson, G. F., MacKenzie, D. D. S., & Purchas, J. (1992). The effects of milking once daily through lactation on the performance of dairy cows grazing on pasture. Proceedings of the New Zealand Society of Animal Production, 52, 13-16.

National Research Council (1989). Nutrient Requirements of Dairy Cattle. Washington, D.C. – National Academy Press.

Tong, M. J., Clark, D. A., & Cooper, C. V. (2002). Once-a-day milking: possible and profitable? Proceedings of the New Zealand Grassland Association, 64, 33-37.

Woodford, K., Greer, J. & Phillips, A. (2003). Searching for Productivity and Competitive Advantage on New Zealand Dairy Farms, Proceedings of the 14th International Farm Management Congress, Perth, pp771-776