The Genetic Improvement of Cows for Once-a-Day (OAD) Milking

A.W. McPherson, J.E. Pryce and A.M. Winkelman

LIC, Private Bag 3016, Hamilton, New Zealand.

Introduction

The relative infancy and low adoption of widespread once-a-day (OAD) milking production systems within New Zealand has resulted in most current OAD milking cows having been bred from a twice-a-day (TAD) milking background. Many may recall that Professor Colin Holmes made the following comment in 2002;

> "Cows have been selected for TAD milking: therefore they are the wrong cows for OAD"

There are numerous examples from herds that have converted to OAD milking where farmer experience tells us that some cows adapt well to OAD milking, while others find the transition difficult. Ross Goudie has reported that his top OAD milking cows peaked at 28 litres and 2.5 kg milksolids (MS) per day, culminating in over 500 kg MS per lactation in the 2005-06 season.

Such variation is the key to providing an opportunity to genetically improve cows for OAD milking production systems in order to achieve production levels equivalent to those under TAD milking. The amount of ground to be made up in average MS (kg/year) produced under OAD milking (compared with TAD milking) is indicated in Table 1.

Table 1. Differences in average annual kg milksolids (MS) produced when cows are milked once-a-day (OAD) or twice-a-day (TAD).

Age	System	Holstein-Friesian		HFxJ		Jersey	
		kg MS/c	% Diff.	kg MS/c	% Diff.	kg MS/c	% Diff.
2	OAD	226		240		217	
	TAD	269	16%	270	11%	241	10%
3	OAD	274		301		271	
	TAD	312	9%	316	5%	279	3%
4	OAD	299		326		299	
	TAD	345	13%	347	6%	306	2%
5	OAD	308		324		305	
	TAD	356	13%	358	9%	315	3%
6	OAD	311		325		300	
	TAD	355	12%	355	8%	312	4%
7	OAD	306		318		295	
	TAD	351	13%	355	10%	306	4%

OAD Index

The development by LIC of a breeding index specifically for OAD milking represents a major initiative in the history of farming OAD milking herds.

LIC introduced the OAD Index in 2003 at a time when there was insufficient data available to analyse from what were then relatively few OAD milking herds. By necessity the index utilised a "desired gains" approach in which official Animal Evaluation Unit (AEU) breeding values (bvs) for traits in the Breeding Worth (BW) formula were subjectively weighted to suit likely OAD milking requirements, e.g., additional selection pressure was applied against milk volume.

The subsequent growth in OAD milking created sufficient data by 2005 to allow LIC to start to meaningfully analyse the relationship between OAD milking and TAD milking, and to further develop the OAD Index. A test day model was used to calculate bvs for cows milked in known OAD milking herds. This initial analysis was restricted to 2 year old animals and sufficient data was available for only 4 of the traits in the BW formula (i.e., milk volume, fat, protein & somatic cell count [SCC] score).

These OAD bvs were then compared with official AEU bvs. The correlations between these estimates ranged from 0.66 to 0.81, depending on breed and trait, suggesting that OAD milking and TAD milking traits are genetically different. A correlation of 1 would indicate that two traits are the same; a substantial departure from 1, e.g., ≤ 0.8 can arbitrarily be interpreted as a genetically different trait.

This analysis has just been repeated in 2007 using new data collected since 2005, and extended to cover all age groups up to 7 year olds. The new correlation estimates are shown in Table 2.

Table 2. Correlation estimates between once-a-day (OAD) milking and twice-a-day (TAD) milking breedings values (bvs) for milk production traits using data collected from 2004/05 – 2006/07.

	Protein	Fat	Milk volume	SCC score
Holstein-Friesian	0.78	0.77	0.82	0.77
HF x J	0.76	0.81	0.82	0.82
Jersey	0.75	0.84	0.80	0.76

Although assumed to be genetically different, OAD milking and TAD milking traits are still sufficiently related to allow the development of predictive equations to estimate OAD bvs (for the 4 traits listed above) from TAD bvs for use in the OAD Index, and enable application of the OAD index to animals in the wider population. These are effectively conversion equations of bvs from TAD to OAD milking. The current OAD Index will now be updated to incorporate the revised correlation estimates.

Predictive equations for the other traits in BW (i.e., liveweight, fertility & residual survival) will be developed when adequate data becomes available from OAD milking herds. Until then TAD bvs for these traits need to be used in the OAD Index.

The OAD Index now uses the same economic weightings for each trait as used in

BW, i.e., there are no subjective weightings. The OAD Index is a ranking tool that is deliberately expressed using scaled units to avoid confusion with BW. Unlike BW, it has no "meaningful" units *per se*.

The updated OAD Index is a more accurate indicator of OAD milking performance than either its predecessor or BW.

Several other traits not included in the OAD Index (or BW) have been suggested to be of value under OAD milking, e.g., milking speed, udder conformation etc. Individual herds can still carefully apply additional selection pressure for these characteristics if required, albeit at some compromise, in the same way that secondary traits are incorporated into some TAD milking breeding plans. The Customate *Plus* mating programme is available to recommend selective matings for individual cows.

Future development of the OAD Index, beyond trait selection and improved bv estimation, will be reliant upon the provision of suitable economic data that demonstrates that the relative importance of the index traits is significantly different in OAD milking compared with TAD milking. For example, are the economic consequences of different levels of fertility, or SCC, greater or lesser under OAD milking?

Breeding Scheme Design

Is a dedicated OAD milking breeding scheme warranted? The answer to this question is ultimately dependent upon the future uptake of OAD milking. Genetic and economic factors need to be considered.

Firstly, with only 3% of New Zealand herds currently employing OAD milking, and the relative infancy of the system, it is logical to assume that the best genetics for OAD milking are still hidden away in TAD milking herds and will remain so for the immediate future.

Secondly, the size of the current and foreseeable OAD milking, artificial breeding (AB), market would likely restrict or eliminate the financial incentive for LIC to heavily invest in a full stand-alone OAD milking breeding scheme.

That said, LIC has been contract mating and sourcing a limited number of bulls from OAD milking herds for progeny testing, as well as providing annual access to *bona fide* OAD milking herds to a special selection of 40 young bulls (from the 300 already assembled for the Sire Proving Scheme) re-ranked on the basis of the OAD Index. The first of these bulls were sold in 2005 and will receive progeny test evaluations in the 2008-09 season.

Selection responses have recently been modelled for a range of possible breeding scheme designs.

1. Conventional progeny testing of 300 bulls in Sire Proving Scheme ("TAD")
2. Joint scheme where 300 bulls are sampled in both TAD and OAD milking herds, with daughter numbers in each related to relative importance ("Joint")
3. Separate schemes are run for each of TAD and OAD milking, with the 300 bulls distributed exclusively across the 2 environments related to relative importance ("2 Env't")

Figure 1 illustrates the expected response in protein yield (kg/year) across a range of correlations when the relative importance between TAD and OAD milking is in the ratio of 70%:30%, i.e., 30% of herds are milked under OAD milking, or 30% of the AB market is OAD milking. Assuming a correlation between TAD and OAD milking of 0.8, slightly improved rates of gain would be achieved where separate schemes are operated ("2 Env't). The reality, however, is that OAD milking does not constitute this high level of relative importance.

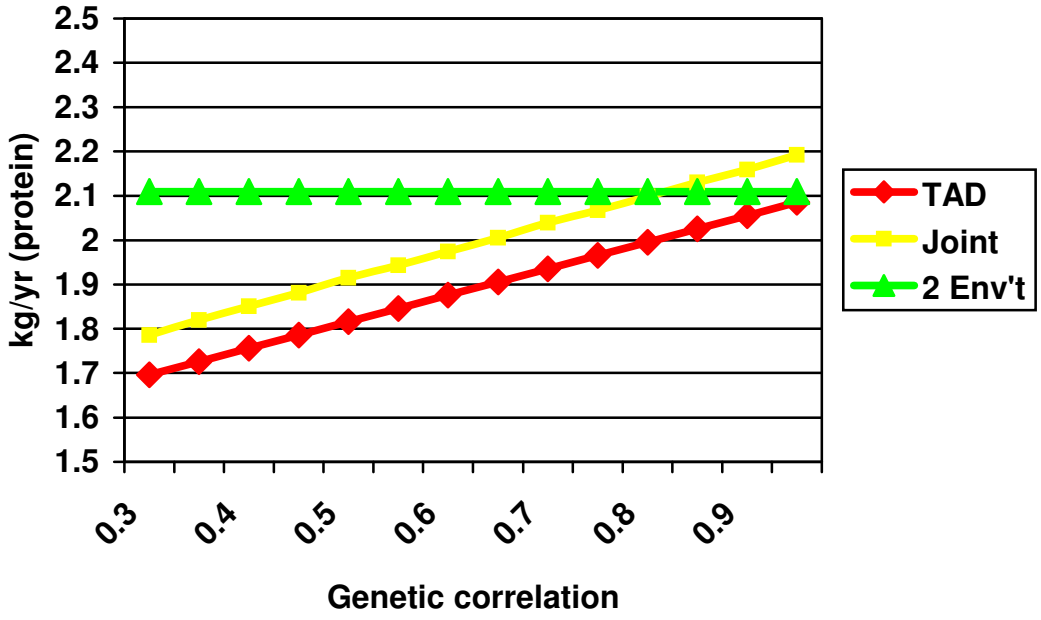

Figure 1. The expected response in protein yield (kg/yr) in relation to the genetic correlation between twice-a-day (TAD) and once-a-day (OAD) milking for possible breeding schemes (TAD vs. Joint vs. 2 Env't), when the relative importance between TAD and OAD milking is 70%:30%.

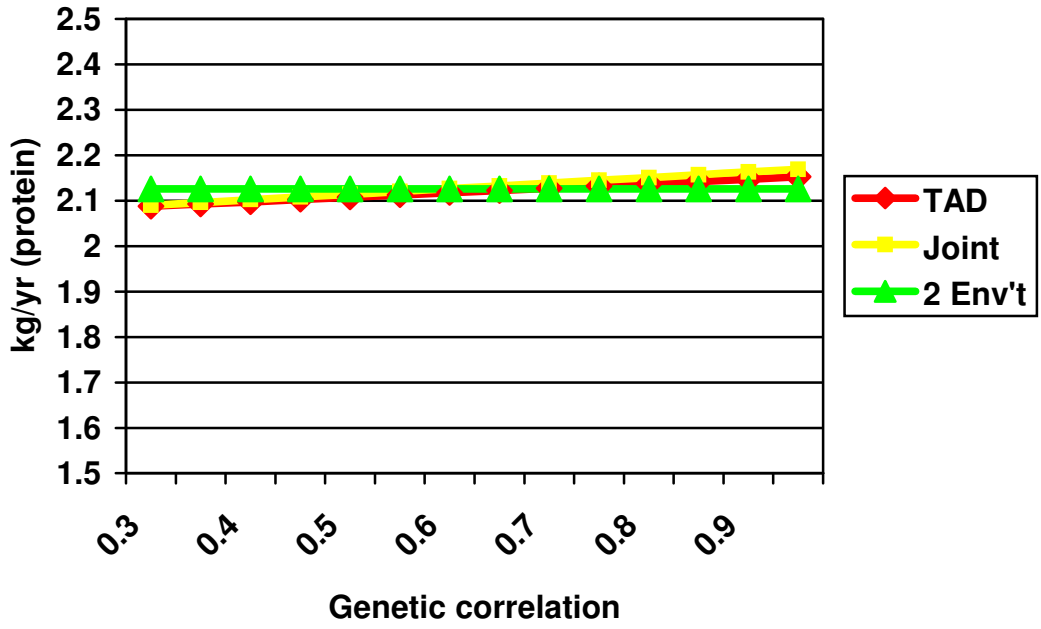

Figure 2. The expected response in protein yield (kg/yr) in relation to the genetic correlation between twice-a-day (TAD) and once-a-day (OAD) milking for possible breeding schemes (TAD vs. Joint vs. 2 Env't), when the relative importance between TAD and OAD milking is 95%:5%.

Therefore, Figure 2 illustrates the expected response in protein yield (kg/year) across a range of correlations when the relative importance between TAD and OAD is in the ratio of 95%:5%, i.e., 5% of herds are milked under OAD milking, or 5% of the AB market is OAD milking. This scenario is much more representative of the true situation. Almost irrespective of the underlying correlation, there is no genetic advantage in operating either joint or separate breeding schemes for OAD milking. Figure 3 illustrates the break-even points where separate TAD milking and OAD milking breeding schemes become viable for various correlations and relative importance.

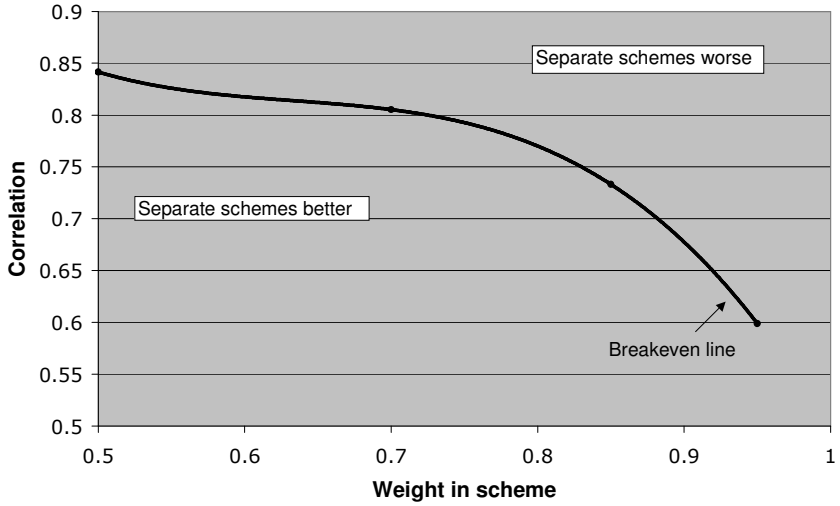

Figure 3. The break-even points where separate breeding schemes for twice-a-day (TAD) and once-a-day (OAD) milking become viable, based upon the relationship between the genetic correlation between TAD and OAD milking, and the relative importance of TAD milking to OAD milking (weight in scheme).

The optimal breeding scheme design for OAD milking depends on the genetic correlation with TAD milking and its relative importance (market share). When correlations are low, separate schemes are preferable, although this is countered where the relative importance of OAD milking is low. Assuming a genetic correlation with TAD milking of 0.8, the relative importance of OAD milking would need to increase to 30% to make separate breeding schemes desirable.

Summary

Variation exists in OAD milking performance that can be genetically exploited. The development of the OAD Index by LIC was an important milestone and is currently the best tool for OAD milking herds to use to select sires of future replacements. Refinement of the OAD Index will progressively occur as suitable genetic and economic data becomes available.

Significant investment in a dedicated OAD milking breeding scheme to specifically generate bulls for OAD milking systems will not be economic until the relative importance (market size) of OAD milking increases. This would require a significant expansion from the status quo. Hence, continuation of the current programme in which young bulls are predominantly sampled in TAD milking herds, but some are selected using OAD Index and made available for joint sampling in OAD milking herds, remains the preferred option within a breeding scheme reliant on progeny testing.