Review of milk payment systems to identify the component value of lactose

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Abstract

New Zealand's export dairy product mix has shifted towards the production of whole milk powder. This has resulted in a deficit in milk lactose to meet international standardisation requirements for whole milk powder. Currently, the deficit in lactose is filled using imported lactose with an estimated cost of New Zealand dollars 300 million annually. This study compares payment systems from America, Europe, Australia and New Zealand, and outlines possible strategies for payment for lactose to New Zealand dairy farmers. The prominent milk payment system in New Zealand is the 'A+B-C' multiple component pricing system, where A and B are the monetary values per kilogram of fat and protein and C is the penalty per litre of milk volume. An alternative payment system that may encourage farmers to increase the supply of lactose could be 'F+P+L-V' where F, P and L are the monetary values of fat, protein and lactose respectively and V is the penalty per litre of milk volume. This payment system is currently in operation at one small New Zealand dairy processor. This study has shown that the 'F+P+L-V' payment system results in smaller deviation from the true value of the milk for differing breeds, milk compositions and product mixes than the current 'A+B-C' system of milk payment.

Keywords: lactose; payment system

Introduction

Milk from New Zealand's dairy herd currently has a composition of 4.77% fat, 3.80% protein and 4.76% lactose (Livestock Improvement Corporation 2013). This milk, if processed directly into whole milk powder (WMP), without standardisation, would produce WMP with a composition of 35.7% fat, 28.5% protein and 35.7% lactose. This does not comply to the required international standard with a composition of 26.5% fat, 25.1% protein and 39.8% lactose (Geary et al. 2010). In order to standardise this milk, either lactose must be purchased, or fat and protein must be removed through separation and ultra-filtration. This adds costs to the overall processing, reduces product yield and reduces milk price. Therefore, the shift in focus in New Zealand's export dairy product mix towards the production of WMP has resulted in a deficit in milk lactose. Currently the deficit in lactose is filled using imported lactose. The cost of importing lactose has been reported to be 300 million New Zealand dollars (NZD) per year (Fonterra Co-operative Group 2011). The importation of lactose into New Zealand may not be sustainable in the long term, and other strategies to reduce the deficit of lactose within New Zealand must be explored. Farmers will respond to signals through milk payment by feeding and breeding, if there is an economic benefit from doing so.

Milk payment strategies differ across the world as the markets, product portfolios, consumer and farmer preferences change. These can be from single-component pricing systems such as per litre of milk, per kilogram (kg) of milksolids (MS) (fat + protein) or per kg of total milk solids (TMS) (fat + protein + lactose + minerals), to multiple-component pricing systems (MCP). A MCP is defined as the pricing of milk on the basis of more than one component, each rewarded differently; for example, a fixed price per litre of milk with a different premium or penalty for each percentage unit fat and protein above or below a base concentration. The primary objective of MCP is that the prices paid or received for milk reflect as accurately as possible the amount and value of products that can be made from it (Emmons et al. 1990; Garrick & Lopez-Villalobos 2000) as well as the costs associated with processing that milk. The payment system should also suit the market being supplied, as using an incorrect system would lead to a greater cost to the processor and reduced returns to the farmer (Emmons et al. 1990).

The aim of this study was to review milk payment strategies and determine characteristics which would be best suited to rewarding farmers for their milk, based on the product portfolios, thereby encouraging a lift in lactose production in New Zealand.

Milk payments in other countries

Table 1 shows the milk payment systems and the average price paid per litre of milk in different countries. In the formation of Table 1, all values are for 2006 and are expressed in NZD values, using conversion rates of 1.54, 1.16, 1.94, 2.84, and 0.26 for NZD to American dollars, Australian dollars, European euros, British pounds and Danish kroner, respectively (NZForex, 2013) Countries in Table 1 were selected to compare with New Zealand as they are similar-sized countries by population (Denmark and Ireland), similar-sized dairy industries (Australia, Netherlands and Britain) or market competitors (USA).

Table 1 Comparison of milk payment systems in different countries (adapted from International Dairy Federation 2006). NZD = New Zealand dollars.

Compositional criteria	New Zealand (Fonterra Co-operative Group)	Australia	USA	Ireland	United Kingdom	Netherlands	Denmark
Fat	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total protein (Nitrogen x 6.38)	Yes	No	No	Yes	Yes	Yes	Yes
True protein ((Nitrogen – Non-protein nitrogen) x 6.38)	No	Yes	Yes	No	No	No	No
Lactose	No	No	No	No	No	No	No
Lactose and other solids	No	No	Yes	No	No	No	No
Total milk solids	No	No	Yes	No	No	No	No
Solids-not-fat	No	No	Yes	No	No	No	No
Other (specified)	Volume penalty for cartage and drying	No	High somatic cell count penalty	No	High production volume bonus	No	No
Payment system	Kilograms of milk solids	Litres of milk	Hundredweight of milk	Litres of milk with premium on concentration		Kilograms of milk with premium on concentration	Kilograms of milk
Value of an average litre of milk in payout (NZD) excluding any levy or premium	0.36	0.32	0.43	0.51	0.51	0.62	0.64
Value of a kilogram of fat in payout (NZD)	2.36	2.61	4.10	-	5.32	6.09	-
Value of a kilogram of protein in payout (NZD)	6.76	6.55	8.06	-	9.37	10.09	-
Cartage and drying charge based on volume (NZD)	-0.04						
Government subsidy	No	No	Yes	Yes	Yes	Yes	Yes

In order to identify the components which could best reward farmers for the milk they produce, all payment systems must be considered. Some payment systems in the USA follow a hundredweight of milk plus fat or protein component, fat plus solids-not-fat (SNF), fat only, TMS, or volume of milk. The payment in the USA appears to commonly be expressed as a price per hundredweight of milk; this price is determined through the quantities of fat, and SNF in the milk. This payment system is complicated by a classification system, where each class has a different value (Jesse & Cropp 2004). Class I milk is milk used for beverage products. This includes "white" whole, low-fat and skim milk in all container sizes; chocolate and other flavoured milks; liquid butter-milk and eggnog. Class II milk is milk used for soft manufactured products such as ice cream and other frozen dairy desserts, cottage cheese, and creams such as sour cream, aerosol whipped cream and whipping cream, half and half, and coffee cream. Class III milk is milk used to manufacture cream cheese and hard cheese. Class IV milk is milk used to make butter and dry milk products, principally non-fat dry milk (Jesse & Cropp 2004). As the final value of milk to the farmer is a composite of these classes, as well as federal dairy product price-support programs, such as the milk income loss contract (MILC) (Chang & Mishra 2011), the determination of the value of independent milk components is more complicated than those reported for the New Zealand dairy industry. In Table 1, it can be seen that almost all of the component criteria are included in the payment system in the USA market as a result of the differing classes used in the USA market. The MILC system in America allows a subsidy on up to 2.4 million pounds (1,088,600 kg of milk equivalent to approximately 74,000 kg MS at 6.8% MS) of the milk produced (Chang & Mishra 2011) per farm and equates to a subsidy of US dollars (USD) 400,000 per farm (USD16.94 per hundredweight of milk).

Amies (1984) outlined the previous payment system for the British dairy industry as a payment on fat and SNF. The existing system pricing was shown to value a kg of fat versus a kg of SNF at 1.67 British pounds (UK£) and 0.96 UK£, respectively. Amies (1984) proposed a system of payment based on fat, protein and lactose. The system proposed values of 2.02, 1.77 and 0.28 UK£ per kg of fat, protein and lactose, respectively. However, this payment system was never introduced probably due to the introduction of the European Union milk quota system which was introduced on 2 April 1984.

The Irish dairy industry uses a similar payment system to New Zealand, the 'A+B-C' payment system, where A and B are the values per kg of fat and protein and C represents a volume-related processing cost per litre of milk volume. However, in the case of Ireland, for some processors, there is a penalty when lactose is below a certain concentration (Dairygold Co-operative Society Ltd. 2011). The lactose concentration penalty is -€0.10, -€0.05 and -€0.025 for concentrations below 4%, and between 4.001-4.100% and 4.101-4.200%, respectively. Lactose concentration in Ireland is used as a proxy for milk processing ability, the ease at which milk can be processed into differing milk products.

Of the 30 payment systems outlined by the International Dairy Federation (2006), 17 paid on a litre of milk basis, 10 on a kg of milk basis, and two (New Zealand and Canada) on a kg of MS basis. The exception was the USA, where payment was on a hundred weight of milk basis, and was also based on a complicated collection of class payments. The authors expect that there has been significant change since 2006, such as in Ireland.

Current milk payments in New Zealand

All milk payment systems in New Zealand are based on a form of MCP. The prominent milk payment system in New Zealand is the 'A+B-C' formula used by the Fonterra Co-operative Group. Farmers supplying the Fonterra Co-operative Group are required to hold shares in the company in proportion to the supplied quantity of MS, in addition to payment per kg of MS supplied. Farmers receive a share dividend based on the number of shares they hold. This was around NZD 0.40/share in the 2011-2012 production season. This is not included in companies which do not require farmers to have shares to supply, such as Open Country Dairy Ltd. currently the second largest dairy processor in New Zealand. Open Country Dairy Ltd. uses a similar pricing structure to the Fonterra Co-operative Group.

One exception of the 'A+B-C' payment system in New Zealand is the payment system used by Synlait Milk Ltd. Synlait Milk Ltd. is a small- to medium-sized milk processor, processing approximately 500 million litres per year, that operates in the South Island of New Zealand. Most of the suppliers are within 80 kilometres of the factory. Synlait Milk Ltd. produces a range of milk powder products, including infant, whole milk, skim milk and colostrum powders. Synlait Milk Ltd. pays farmers on amounts of fat, protein and, lactose with a negative value on milk volume.

Alternative payment systems that include lactose for New Zealand dairy farmers

Encouraging farmers to increase the production of lactose could be implemented through the inclusion of lactose into the payment system. Synlait Milk Ltd. is already paying suppliers with a MCP system that includes lactose. This system is known as 'F+P+L-V', where F, P, L and V are the component values for fat, protein, lactose and milk volume processing charge. The values used for the season 2010/11 were 4.24 per kg fat, 10.34 per kg protein, 1.84 per kg lactose and -0.0324 per L milk volume (NZD). These component values were derived from a model proposed by Garrick and Lopez-Villalobos (1999). While Holmes et al. (2007) when comparing two pricing systems: 'A+B-C' and 'F+P+L-V' demonstrated that the inclusion of lactose in the payment systems reduced the values of fat and protein by between 7% and 9%, with the value per kg of lactose ranging from -0.416 to 2.00 NZD depending on the product portfolio of the milk and breeds examined.

Brog (1969) examined the accuracy, in terms of the value returned to farmers compared to an ideal 100%, of different MCP systems, and found a payment system based on 'fat + protein' had a correlation of 99.93%, relative to a payment system based on 'fat + protein + lactose'. The analysis showed that the value for lactose was small and negative, at around 4% of the value of fat or protein, which is similar to the negative weighting on milk volume of the 'A+B-C' schedule, noted by (Emmons et al. 1990). This 'fat + protein' system was noted by Brog (1969) as a highly efficient system for returning value of the components to the farmer, as well as avoiding overpayment incurring a loss to the processor. A full review of the milk payment system is required as the product portfolio of New Zealand has moved from a butter and cheese producer to a milk powder producer. Holmes et al. (2007) showed that a payment system based on 'F+P+L-V' had a smaller difference from the true value of the milk for differing breeds, milk compositions and product mixes than the 'A+B-C' system. The true value was

Table 2 Economic values and expected response in milk traits achieved through selection based on Breeding Worth. NZD= New Zealand dollars.

Trait	Economic value (NZD)	Annual response
Fat	1.79/kg	2.22 kg
Protein	8.63/kg	1.84 kg
Milk volume	-0.09/L	44 L
Live weight	-1.52/kg	-0.04 kg
Residual survival	0.15/day above average herd age	13.3 days
Fertility	7.35% increase in calving rate in first 42 days	0.30%
Somatic cell score	-38.57/unit of somatic cell score	-0.01 units of somatic cell score

defined as the income from the sale of dairy products minus milk collection, processing, storage, distribution and marketing costs.

Implications of including lactose in the breeding objective of New Zealand dairy cattle

The national breeding objective of the New Zealand dairy industry is called breeding worth (BW). The calculation of BW contains the traits in decreasing order of trait emphasis, of protein, milk volume, live weight, fat, fertility, somatic cell score and residual survival (Bryant 2012). The economic values and correlated responses are shown in Table 2. This Table demonstrates the importance of being able to calculate the response of a trait to selection pressure. Selection response estimations are required for lactose before it can be incorporated into BW, given the effect this would also have on the other traits. Without an estimate of the change in response rates, the implications of introducing a new trait into the BW objective cannot be known. Farmers could be encouraged to adopt management and breeding strategies to increase lactose production through the introduction of payment systems incorporating lactose. While this has not been demonstrated on an industry scale, breeding experiments have shown this to be theoretically possible (Vos & Groen 1998).

If lactose is included in the breeding objective, the payment system can be changed from ‘A+B-C’ to ‘F+P+L-V’. The component value of lactose in the MCP should be estimated under a different mixes of dairy products, accounting for processing cost and prices of dairy products.

The economic value of lactose to be used in the calculation of BW needs to be estimated using a farm model to account for feed costs and other farms costs and discounted gene expressions.

Conclusion

This review identified that Ireland and USA have payment systems which include lactose in some form. In New Zealand, one processor includes lactose into its payment system in the form of ‘fat + protein + lactose – volume’. This review indicates that the accuracy of the payment to the producers could be increased by the inclusion of lactose into the multiple component payment system.

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