J. Dairy Sci. 98:1661–1665
http://dx.doi.org/10.3168/jds.2014-8723

Short communication: Estimation of the financial benefit of using Jersey milk at different inclusion rates for Cheddar cheese production using partial budgeting

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ABSTRACT

Partial budgeting was used to estimate the net benefit of blending Jersey milk in Holstein-Friesian milk for Cheddar cheese production. Jersey milk increases Cheddar cheese yield. However, the cost of Jersey milk is also higher; thus, determining the balance of profitability is necessary, including consideration of seasonal effects. Input variables were based on a pilot plant experiment run from 2012 to 2013 and industry milk and cheese prices during this period. When Jersey milk was used at an increasing rate with Holstein-Friesian milk (25, 50, 75, and 100% Jersey milk), it resulted in an increase of average net profit of 3.41, 6.44, 8.57, and 11.18 pence per kilogram of milk, respectively, and this additional profit was constant throughout the year. Sensitivity analysis showed that the most influential input on additional profit was cheese yield, whereas cheese price and milk price had a small effect. The minimum increase in yield, which was necessary for the use of Jersey milk to be profitable, was 2.63, 7.28, 9.95, and 12.37% at 25, 50, 75, and 100% Jersey milk, respectively. Including Jersey milk did not affect the quantity of whey butter and powder produced. Although further research is needed to ascertain the amount of additional profit that would be found on a commercial scale, the results indicate that using Jersey milk for Cheddar cheese making would lead to an improvement in profit for the cheese makers, especially at higher inclusion rates.
Key words: Jersey milk, Cheddar cheese, profit, partial budget

Short Communication

An important factor influencing revenue in a cheese-making plant is the yield of cheese from a set quantity of milk. Improving milk suitability for cheese making has been shown to be a valid way of improving cheese yield and thus revenue (Storry et al., 1983; Lucey and Kelly, 1994; Sundekilde et al., 2011). Jersey (**JS**) milk especially has been shown to be better suited for Cheddar cheese making than Holstein-Friesian (**H-F**) milk by improving cheese yield (Lundstedt, 1979; Geary et al., 2010) and reducing greenhouse gases and the environmental impact of Cheddar cheese production (Capper and Cady, 2012). However, its use commercially has been hindered by a presumed negative effect on cheese quality (Bliss, 1988) and the lack of information on the financial benefits of this method. A recent study by Bland et al. (2015) showed than when JS milk was included at different rates into H-F milk, the improvement in Cheddar cheese yield was not accompanied by detrimental changes in cheese quality. Cheese quality was evaluated through instrumental texture analysis, and professional grading scores at 3 and 8 mo and inclusion of Jersey milk did not significantly affect those parameters even if the fat content of the cheese produced with JS milk was increased. The lack of effect of the increased fat concentration on cheese texture was explained by the simultaneous reduction in moisture content and smaller casein micelle size increasing curd firmness and thus compensating for the higher fat content. Still, because of the higher price of JS milk compared with H-F milk and the difficulties of changing milk supply, the economic benefit needs to be determined before cheese makers will be confident in using JS milk more actively.

To determine the profitability of including JS milk in H-F milk supply for Cheddar cheese production, the increase in cheese yield must be weighed against increased milk costs. To explore these questions, partial budgeting was used in conjunction with sensitivity and break-even analysis. These methods are regularly used to compare alternative production practices in agriculture with limited data (Roth and Hyde, 2002).

In addition, because using JS milk was found to decrease the yield of fat and protein in whey because of an increase in protein and fat recovery (Bland et al., 2015), the financial effect on the coproducts of cheese making need to be evaluated.

Received August 8, 2014.
Accepted November 9, 2014.
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Partial budgeting is a method of comparing costs and benefits of alternative methods of production, in this case using different rates of inclusion of JS milk. The specific underlying assumption of our partial budgeting was that JS milk could significantly improve yield but would cost more to purchase. The model only encompasses the production stage and does not take into account the costs of transportation of milk and packaging and transportation of cheese. The fixed costs were also not included in the model because they are incurred regardless of the level of output. Furthermore, with the model being based on a set quantity of milk, starter and enzyme quantity were not modified by the addition of Jersey milk. Salt quantity was modified. However, it did not significantly influence the model, and thus, with the aim of simplification, it was not presented in this study. In addition, the revenue from whey products was not included in the partial budgeting because of the numerous uses of whey in the UK and the lack of an available market price for most of these products. Thus, the only changes seen in the partial budget were in cheese quantity and milk price.

Using JS milk was deemed more profitable than H-F milk if total positive effects were higher than total negative effects (Table 1). Total positive effect was calculated as increased incomes plus reduced costs. Total negative effect was calculated as increased costs plus reduced incomes. The additional profit (**AP**) was given on a kilogram of milk basis and expressed as pound sterling and in parentheses US dollars using the 1-yr exchange-rate average of £1 = $1.6290 using the website www.Oanda.com.

The partial budgeting was performed using the data from the study by Bland et al. (unpublished data) based on one vat production of 100 kg of milk. In this study H-F cheese making was compared with different inclusion rates of Jersey milk (25, 50, 75, and 100%) every month, over a year. The inclusions 25 and 75% were done on alternate months because of time constraints. The data set contained milk composition, cheese composition, and actual cheese yield. The average cheese composition was 34.3 ± 0.3%, 23.4 ± 0.4%, and 37.56 ± 0.3% for fat, protein, and moisture content, respectively. Actual yield was calculated from the weight of milk placed in the vat and the weight of cheese after pressing and vacuum packing and expressed as kilogram of cheese per 100 kg of milk. Milk price was calculated from the milk contract offered by the commercial Cheddar cheese maker that the cheese-making process was based on (Alvis Bros Ltd., Bristol, UK). The determination of the milk price was based on season, SCC, and milk protein and fat content as commonly done in the UK. Cheese price was based on the average monthly wholesale price for mild Cheddar cheese on the UK market, over the period of the study as reported by the study of the Kantar Worldpanel (2013). The data used are presented in Table 2 and show mean and standard error for each inclusion rate. In total 36 scenarios were analyzed.

Sensitivity analysis was used to test which inputs variable had the greatest influence on the AP. The model inputs were defined as cheese price, cheese yield, and price for milk protein and milk fat. For the 36 scenarios, the effect of a fixed change (1%) on the AP was calculated, one input at a time, and expressed as percentage change in AP.

The break-even analysis was carried out on the inputs that were found by the sensitivity analysis to have the most significant effect on the profitability of using JS milk. Using the Solver add-in (Frontline Systems Inc., Incline Village, NV) in Excel (Microsoft, Seattle, WA), the level of inputs that would give zero AP was calculated for all 36 scenarios.

The evaluation of whey revenue was based on the production of whey butter and whey powder for which UK market prices are available. Conversion of whey fat into whey butter, and whey nonfat solids into whey powder were calculated using the mass balance approach of DairyCo (2014a). Prices were determined using average monthly UK wholesale price for whey butter and whey powder over the period of the study as reported by DairyCo (2014b).

Data were subject to ANOVA and Tukey analysis using SPSS PASW Statistics 21.0 (SPSS Ltd., London, UK) to detect any statistical differences in AP and whey revenue between inclusion rates. Seasonal varia-

Table 1. Partial budget of the use of Jersey milk for Cheddar cheese making[1]

Positive effects	Negative effects
Increased incomes (J cheese yield × cheese price; £)	Increased costs (J milk quantity × J milk price; £)
Reduced costs (H-F milk quantity × H-F milk price; £)	Reduced incomes (H-F cheese yield × cheese price; £)
Total positive effects	Total negative effects
	Per vat profit difference
	Per kilogram of milk

[1]J = Jersey; H-F = Holstein-Friesian.