Is there an environmental silver lining in low milk prices?

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Abstract

The global dairy market has been adversely affected by increased milk supply in Europe, the US and the Southern hemisphere. This, amidst a reduction in demand for imported dairy commodities by China and Russia, has seen a global downturn in milk prices. New Zealand dairy farmers have been faced with depressed milk price in the last few seasons, and in response to the financial pressures, have been forced to consider farm system changes to minimise the impact. Many of the system adjustments being implemented to manage the current downturn have led to improved efficiency and are similar to those that will help farmers meet existing and proposed environmental limits being enforced by regional councils.

Could the adjustments being made have lasting environmental benefits for farmers and the industry? This study aims to identify the changes in farm systems and their management as a consequence of lower milk prices, and whether these changes have improved environmental outcomes. It also aims to identify whether these outcomes are likely to last once milk price recovers, thus determining whether the current period of low milk price has a silver lining.

The key adjustments made to dairy farm systems in response to low milk price were reductions in cow numbers, fertiliser use and supplementary feed use. The methodology used to determine the environmental impacts of these adjustments involved creating typical regional farms and modelling the changes experienced from a drop in milk price in Farmax and Overseer. These adjustments had subsequent impacts on milk production. The changes observed had slight implications for environmental outputs, including nitrogen leaching and greenhouse gas emissions.

Keywords

Global downturn, milk price, environmental limits, dairy farm systems, nitrogen leaching, greenhouse gas emissions

Introduction

In recent years, the global dairy market has experienced increased supply, resulting from the removal of milk quotas in Europe, low feed prices in the US and dairy industry expansion in the Southern Hemisphere. This, in conjunction with the reduction in demand for internationally produced product by China and Russia, has led to a global downturn in milk prices.

The low milk price is driving changes in farm management and the structure of farm systems throughout New Zealand as farmers try to minimise the financial impact and maintain a viable business.

Many of the management and system changes on-farm that have improved efficiency are also in line with those that will help farmers meet existing or proposed environmental limits set by regional councils. The environmental parameters of focus in this study include nitrogen leaching[1], nitrogen conversion efficiency[2] and greenhouse gas (GHG) emissions as total CO_2 equivalents[3]. This research aims to better understand the effects of market signals and milk price volatility on farmer behaviour, with the quantification of the environmental impacts of these changes. This study also aims to inform policy decisions as environmental regulations become of increasing importance and shape the future of the New Zealand dairy industry.

While farmers have been financially pressured due to the dairy downturn, this study aims to identify whether there is a silver lining to low milk price in terms of environmental outcomes. It also aims to identify whether these outcomes are likely to be long lasting or temporary occurrences.

Method

Regional farm models were set up using Farmax and Overseer for the eight DairyNZ regions. Overseer models the environmental performance of a farm system while Farmax is a biophysical model which ensures a farm system's energy requirements are balanced.

Farmer responses were approximated using a variety of quantitative information sources and where information was not available, regional farm systems consultants and DairyNZ extension staff provided advice as to how they believe farmers in their region have adjusted their farm systems and management.

Each regional model had environmental performance quantified under three scenarios;

- a 'typical' milk price scenario
- a 'low' milk price scenario reflecting observed changes on-farm (original)
- a 'low' milk price scenario modelling more extensive changes on-farm (revised)

The revised low milk price scenario was conducted for regions which were expected to show greater reductions in cow numbers for the 2016-17 season than what had been observed to date and used in the original low milk price scenario. This was based on information provided in DairyNZ Economic Survey (DairyNZ, 2016) forecasts. This additional modelling involved further reducing peak cows milked from the original low milk price scenario in Waikato, Taranaki, Lower North Island, Canterbury and Otago- Southland. This was to assess the environmental impacts of 'sustained' low milk price accompanied by more severe changes on-farm.

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[1] Nitrogen leaching measured as kilograms of nitrogen per hectare lost to water
[2] Nitrogen conversion efficiency measured as nitrogen outputs in saleable products as a percentage of the sum of nitrogen inputs
[3] GHG emissions measured as kilograms of CO_2 equivalents per hectare

Once each regional model was complete, they were weighted by the number of herds in each region and scaled up to an industry level to estimate the environmental impacts for New Zealand. The process is outlined below.

I. The scenarios reflected farmer behaviour associated with total milk payout (milk price plus advance payments, dividends, and retrospective payments) received on average for each season. This was to assess any differences in farm system or management resulting from lower milk price.

   The ‘typical’ milk price scenario was based on a long term average payout of $6.50 and farm systems in the 2011-12, 2012-13 and 2014-15 seasons where total milk payout was close to this. These three seasons were considered typical in terms of seasonal conditions and representative of on-farm practices for a normal season. The ‘low’ milk price scenarios were based on observed and expected changes for the 2015-16 season and the 2016-17 season to date. Given this, a $4.50 per kilogram of milksolids payout was applied for the low payout scenario. The 2013-14 season was not included in the modelling as the milk payout for this season was higher than average ($7.69) meaning farmer behaviour was unlikely to be reflective of a typical season.

II. Farmax (Version 6.6.5.00) and Overseer (Version 6.2.2) models were set up for each region according to Best Practice Data Input Standards (Overseer, 2015). The regional models were constructed from a variety of information sources including; DairyNZ knowledge and expertise[4], DairyBase, DairyNZ Facts and Figures (DairyNZ, 2010), DairyNZ Economic Survey (DairyNZ, 2016), LIC Dairy Statistics (LIC, 2016), Statistics New Zealand and Landcare Research. Some regional data for a typical farm was provided from the DairyNZ Feed and Farm Systems team who had Farmax models from previous projects. This was supplemented with physical information from the National Baseline Project, including fertiliser usage patterns and effluent areas. Other information was provided by extension staff, the DairyNZ Economic Survey and LIC Dairy Statistics for physical data, including production. DairyNZ Facts and Figures were combined with regional knowledge to create pasture production growth curves that were typical of a region in an average climatic season.

   It must be noted that modelling typical farms is challenging due to the considerable variation observed between farms, even within the same region. Differences in farm size, system, management practices, rainfall and soil type, to name a few, all vary significantly between farms and regions. Essentially there is no ‘average’ farm that encompasses a region, however, best efforts were made to model farms that were representative of a typical farm in each region.

   The regional models were constructed to be consistent for factors that were not likely to be influenced as a direct result of milk price. These included: effective area, crop type and area, effluent area and system, climate, soil order and irrigation (Canterbury only). While these factors impact on nutrient losses and GHG emissions from farms, they are unlikely to change as a result of changes in milk price due to

[4] DairyNZ knowledge and expertise refers to information provided from the National Baseline Project, the DairyNZ Regional Team and Feed and Farm Systems Team

the time lag aspect of decision making or the infrastructure involved. Some features were kept consistent for lack of better information, this included number of replacements raised and grazing off information.

Pasture growth rates were held constant across the scenarios as it was assumed that pasture harvested, along with climatic conditions, would not be influenced by changes in milk price and farmers' skill sets would remain unchanged.

The soil information for each region was selected based on the dominant soil order (Landcare Research, 2016 & Waikato Regional Council, 2011) and held constant across scenarios. Soil series is the preferred data input for soil information according to Overseer Best Practice Data Input Standards, however, using soil order allowed a more generic soil to be selected that was applicable to multiple soil series and representative of the majority of farms in a region.

III. With the creation of regional models for the typical milk price scenario, extension staff were asked to review key assumptions to inform likely management and system changes as a result of the drop in milk price. Following this, alterations were made to provide regional models for the low milk price scenarios, holding the parameters discussed above constant. The adjustments included: production from the Dairy Statistics (LIC, 2016), culling patterns and rates from Statistics NZ (Statistics New Zealand, 2016), and fertiliser use from DairyBase, with an average 5% reduction in nitrogen applied to each farm.

There were minimal changes in days in milk recorded in the Dairy Statistics (LIC, 2016) and this was therefore held constant. Imported feed was used as the 'balancing' item in Farmax due to a lack of information on changes in feed volumes from a robust sample. This was because Farmax requires that feed demand and supply are balanced, therefore one variable must be allowed to balance the others to get a viable farm system.

IV. The regional findings were scaled up to a New Zealand average, weighting by the number of herds in each region. This was calculated according to Dairy Statistics with 2014-15 herd numbers used for the typical milk price scenario and 2015-16 herd numbers for the low milk price scenarios.

Results

Under the original low milk price scenario, observed reductions in peak cows milked to date (November 2016) were used. At a national level, peak cows milked reduced by 4 cows per herd, or by 1 per cent in response to the low milk price. Production, as kilograms milksolids per hectare, reduced 3 per cent as a result of reduced cow numbers (-1%), fertiliser (-5%) and supplementary feed (-9%) inputs. The environmental impact of this decrease in milk price for nutrient losses was a 4 per cent reduction in nitrogen leaching (kg N/ha), a 4 per cent reduction in farm nitrogen surplus (kg N/ha), and no change in nitrogen conversion efficiency. The environmental impact for total GHG emissions, as CO_2 equivalents, was a 3 per cent reduction. This is comprised of a reduction in methane by 2 per cent, N_2O by 3 per cent and CO_2 by 11 per cent.

At a national level, the impacts of the low milk price scenario on nitrogen leaching and GHG emissions were minor but illustrate the likely environmental benefits experienced on an average farm. A revised low milk price scenario was also modelled to illustrate the potential environmental changes that would occur if changes in on-farm practice were more severe, such as culling a greater number of cows. Additional modelling was conducted for regions which were forecasted to show greater reductions in cow numbers for the 2016-17 season than what had been observed to date and used in the original low milk price scenario.

Under the revised low milk price scenario, it was expected that peak cows milked would reduce by 7 cows per herd, or by 2 per cent in response to 'sustained' low milk price. Production, as kilograms milksolids per hectare, dropped by 4 per cent as a result of reduced cow numbers (-2%), fertiliser (-5%) and supplementary feed inputs (-10%). The environmental impact of this decrease in milk price for nutrient losses was a 6 per cent reduction in nitrogen leaching (kg N/ha), a 1 per cent increase in farm nitrogen surplus and a 9 per cent reduction in nitrogen conversion efficiency. The environmental impact for total GHG emissions, as CO_2 equivalents, was a 4 per cent reduction. This is comprised of a reduction in methane by 3 per cent, N_2O by 4 per cent and CO_2 by 11 per cent. Changes in physical and environmental parameters for both original and revised low milk price scenarios are shown in Table 1 below.

Table 1: Summary of typical, original low milk price and revised low milk price scenarios for New Zealand

	Typical scenario	Original low scenario	% change for original low scenario	Revised low scenario	% change for revised low scenario
Peak cows milked	420	416	-1%	413	-2%
Effective area (ha)	146	146	0%	146	0%
Stocking rate (cows/ha)	2.9	2.8	-1%	2.8	-2%
Production (kg MS/ha)	1,087	1,049	-3%	1,039	-4%
Nitrogen fertiliser applied (kg N/ha)	142	135	-5%	135	-5%
Supplement use (% of total feed offered/ha)	15%	14%	-9%	14%	-10%
Nitrogen leaching (kg N/ha)	39	37	-4%	36	-6%
Farm nitrogen surplus (kg N/ha)	183	175	-4%	185	1%
Nitrogen conversion efficiency	30	30	0%	27%	-9%
Methane (CO_2 equivalents (kg/ha))	7,218	7,053	-2%	6,967	-3%
N_2O emissions (CO_2 equivalents (kg/ha))	6,334	6,161	-3%	6,099	-4%
CO_2 emissions (kg/ha)	1,372	1,223	-11%	1,215	-11%
Total GHG emissions (CO_2 equivalents (kg/ha))	14,925	14,438	-3%	14,280	-4%

The only difference in farm level modelling for the revised scenario was to further reduce cow numbers in Waikato, Taranaki, Lower North Island, Canterbury and Otago- Southland as these regions were forecasted to show greater reductions in cow numbers for the 2016-17 season than what had been observed to date and used in the original low milk price scenarios. Thus, the percentage change for peak cows milked for the New Zealand weighted average was greater for the revised scenario (-1% verse -2%), resulting in lower stocking rates and production per hectare (-3% verse -4%), as shown in Figure 1.

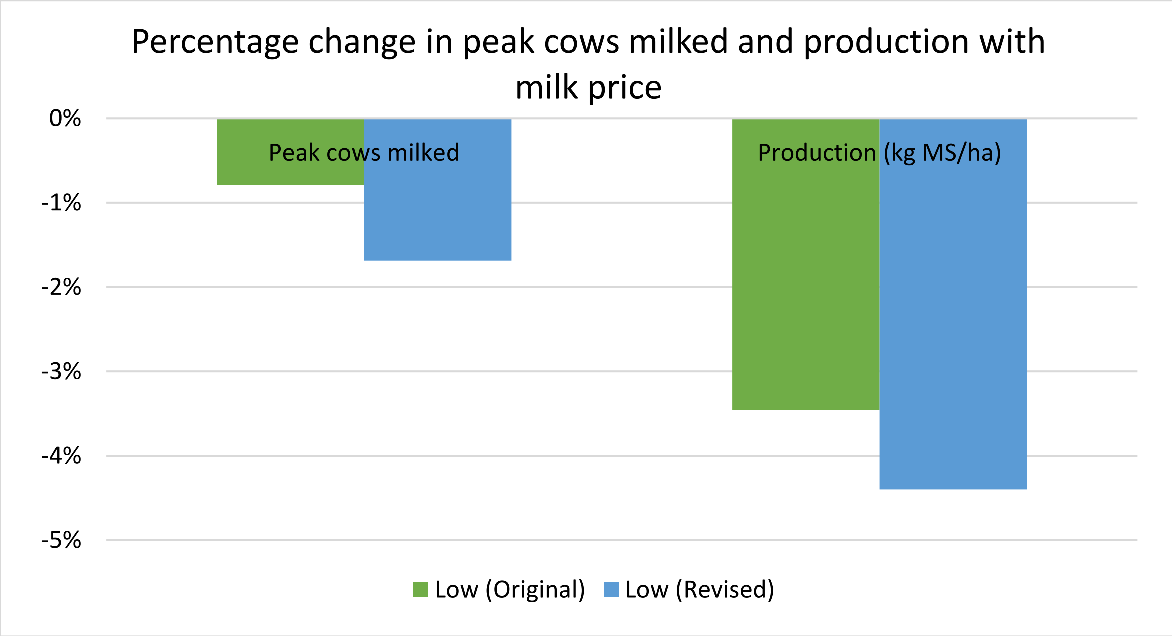

Figure 1: Percentage change in peak cows milked and production per hectare in response to low milk price

The environmental impact of further reducing cow numbers in the selected five regions for the revised scenario has further reduced nitrogen leaching (kg N/ha) from a 4 per cent decrease to a 6 per cent decrease but caused nitrogen conversion efficiency to decline by 9 per cent, which is shown in Figure 2. Total GHG emissions, as CO_2 equivalents, showed greater reductions under the revised scenario (-3% verse -4%) as methane and N_2O emissions declined with the lower stocking rate, as illustrated by Figure 3.

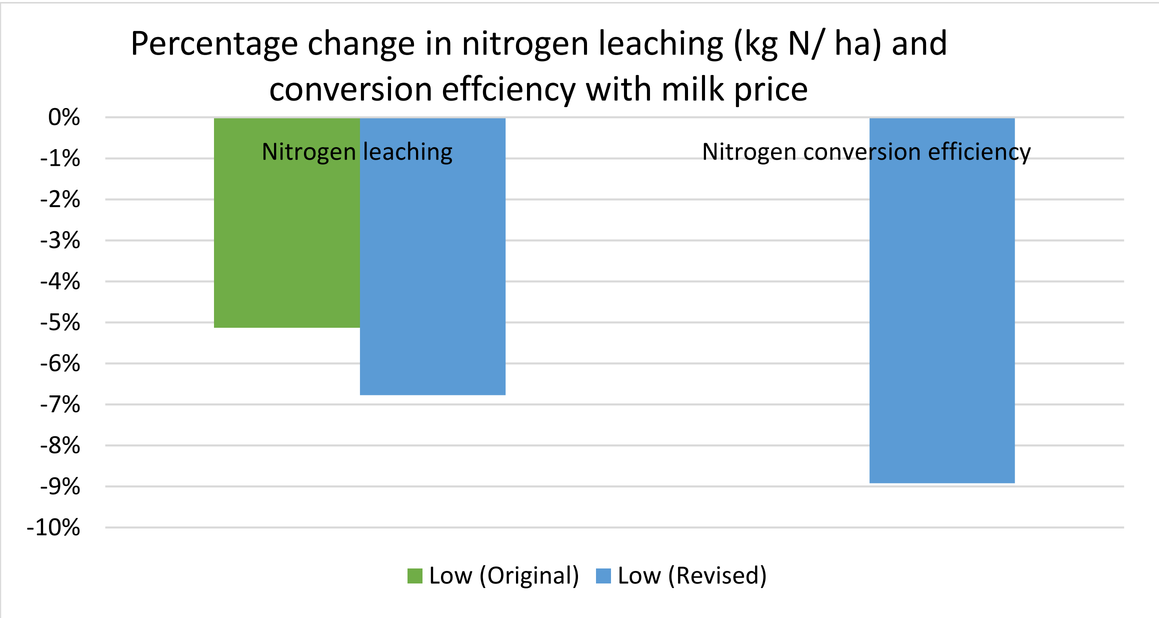

Figure 2: Percentage change in nitrogen leaching and nitrogen conversion efficiency in response to low milk price

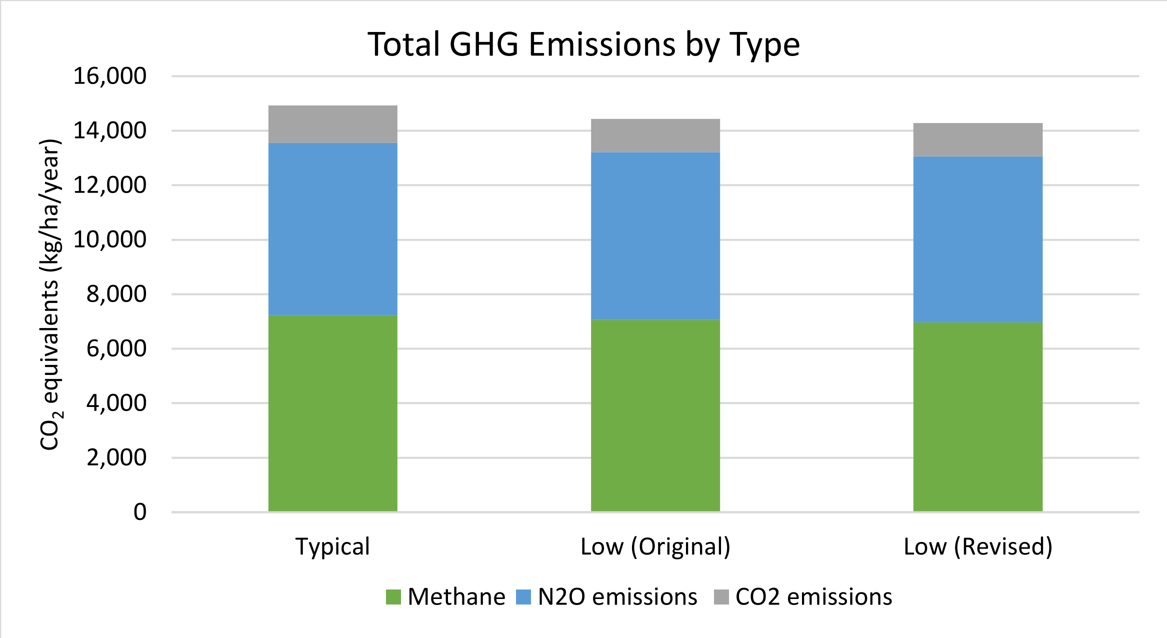

Figure 3: Total GHG emissions grouped by type for each milk price scenario

Overall, the impacts of the low milk price scenarios on nitrogen leaching and GHG emissions were minor, even under the revised scenario which modelled more severe changes in on-farm practice. It is important to note that with lower stocking rates under the revised scenario, there was also a reduction in nitrogen conversion efficiency by 9 per cent. The loss of 'efficiency' may have economic consequences for the farm.

Although farm level profitability was not the main focus of this study, Table 2 summaries the financial impacts on farm revenue, expenses and operating profit before tax modelled for the revised low milk price scenario. The impact on total revenue was a 31 per cent reduction due to lower total production and payout received by farmers. In order to minimise the financial impact, farmers reduced costs which was observed through lower farm working expenses and was modelled as a decrease from $4.24 to $3.91 per kilogram milksolids (-8%). At a national level the most significant reductions were bought in feed, farm dairy expenses, maintenance fertiliser, nitrogen fertiliser, fuel and repairs and maintenance on land and buildings. Based on this revised scenario, New Zealand dairy farms were expected to experience a 74 per cent reduction in operating profit before tax per kilogram milksolids, while only minimal environmental benefits were realised during this period of low milk price.

Table 2: Summary of the impact on farm revenue, expenses and operating profit before tax for the revised low milk price scenario

	New Zealand Weighted Average ($/kg MS)		
	Typical	**Low (revised)**	**% change**
Milk Sales	6.50	4.50	-31%
Total Revenue	6.89	4.90	-29%
Total Farm Working Expenses	4.24	3.91	-8%
Total Farm Expenses	4.63	4.32	-7%
Farm Profit before Tax	2.27	0.58	-74%

Discussion

The results showed that at a national level, the decrease in milk price, as modelled by the original low milk price scenario, has not changed on-farm behaviour in such a way that has provided significant environmental benefits. The immediate farm system and management changes observed were not as extensive as what was expected. This suggests that farmers are not restructuring their farm businesses in response to low milk price, but are making temporary changes so that they can remain viable during the downturn. The adjustments made did provide some environmental benefits, although minor, but are considered to be coincidental given the reductions in stocking rate, fertiliser use and supplementary feed inputs are well known as practices that promote reductions in nitrogen leaching and GHG emissions.

Given this, it is unlikely that many farmers would have adjusted their systems in a way that makes them better able to withstand future periods of low milk price. Although this might not be the case for all farmers, at a national level it is expected that farm businesses will be structured for a typical season. It is also expected that with changing market signals and an anticipated recovery of milk price, farmers will revert back to practices that worked well in terms of profitability during seasons of typical milk price. This is a challenge for the industry, to maintain the efficiency gains achieved during the low milk price. However, this study suggests that the minor environmental benefits observed for the original low milk price scenario are likely to also be temporary.

The revised low milk price scenario was modelled to illustrate the potential environmental changes that would occur if changes in on-farm practice were more severe. Although similar environmental benefits were observed with this scenario, there was also a reduction in nitrogen conversion efficiency by 9 per cent, compared to no change under the original low milk price scenario. This has significance for discussion on a sustainable growth strategy for dairy as this loss of 'efficiency' may have economic consequences. Consideration of this parameter may allow for nitrogen leaching and GHG emissions reductions while improving the efficiency of nitrogen use, particularly from fertiliser and feed inputs. This is of importance as farms may want to de-intensify their farm system to reduce nitrogen leaching and GHG emissions in the light of constrained nutrient limits set by regional councils.

The results suggest that although there were some minor flow-on environmental benefits for reducing costs, if improved environmental outcomes are not of direct focus, it is unlikely that on-farm practice will change in a way that will significantly impact this. The worsening nitrogen conversion efficiency in the revised low milk price scenario perhaps demonstrates that measures to reduce costs in response to low milk price do not guarantee improved environmental outcomes. Although the observed management changes underlying this modelling provided environmental benefits and show similarities to changes that help farmers meet environmental limits set by regional councils, other means to reduce costs may not have shown an improvement in environmental parameters.

As both original and revised low milk price scenarios showed similar impacts on environmental parameters (nitrogen leaching differed by 2% and GHG emissions differed by 1%), further de-intensification did not significantly add to the environmental benefits observed. This suggests that in order to successfully mitigate nutrient losses and GHG emissions, more specific and comprehensive mitigation options should be applied to the entire farm system. Farms should aim to reduce nitrogen leaching (kg N/ha) and GHG emissions (kg CO_2 equivalents/ha) in ways that maintain or improve nitrogen conversion efficiency and suit the cost structure of the farm to minimise impacts on profitability. Ideally, farms should aim to set production where nitrogen from fertiliser and feed inputs are optimised, whilst maintaining the profitability of the farm business.

While the impact on profitability was not the main focus of this study, the revised milk price scenario demonstrated a reduction in total farm working expenses by 8 per cent. This is reflective of farmers adjusting their farm management to minimise losses, which had coincidental benefits for nitrogen leaching and GHG emissions. A challenge going forward for farmers will be maintaining the cost efficiency gains in the face of increasing milk price. A volatile milk price can have severe implications for farm profitability if the system is not positioned to handle such changes. Volatile milk price may not have direct, significant implications for environmental outcomes, but it is likely to have indirect effects as smaller profit margins would restrict nutrient loss mitigation options that can be applied on-farm. Low milk price may constrain possible opportunities to address environmental regulations through mitigation such as investment in infrastructure (including effluent systems, irrigation and off-pasture structures).

Farmers are also likely to respond differently to changes in milk price compared to changes required under environmental regulation. This reflects the change in marginal benefits experienced at a typical milk price relative to a low milk price. For example, a decrease in production is relatively more expensive with a higher milk price compared to a lower milk price, while some mitigation options may be more desirable than others when the milk price is either high or low.

This study does not attempt to quantify whether the behaviour of farmers in response to low milk price is sustainable long term. For example, observed reductions in fertiliser expenses in order to minimise losses, are expected to be temporary as much of this decrease comes from deferring maintenance fertiliser applications to a later date. If this persists long term, this would soon impact on-farm productivity and profitability as soil fertility declines. This reflects a temporary, management change intended to minimise losses. However, any on-farm changes in response to environmental regulations must be sustainable long term as these potentially become the 'new normal'.

Conclusion

The decrease in milk price has not changed on-farm behaviour in such a way that has provided significant, or long lasting environmental benefits. Improvements in the environmental parameters of focus to this study could be considered as coincidental as the changes observed on-farm were similar to those that would help farmers meet environmental limits set by regional councils. The results suggest that New Zealand dairy farmers have not significantly restructured their farm business to suit low milk price seasons, but instead have made management adjustments in order to remain viable during the downturn. Therefore, behaviour is likely to revert back to that of a typical season once milk price recovers, meaning the minor environmental benefits shown are likely to be temporary. In addition to this, periods of low, or volatile milk price puts constraints on farmers as farm profitability determines the financial feasibility of mitigation options such as investment in infrastructure that may be required to meet environmental regulation set by regional councils. Based on the findings of this study there is unlikely to be an environmental silver lining in low milk prices.

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