

# Measuring and reporting environmental impacts of dairy farming

Impacts of  
dairy farming

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## Abstract

**Purpose** – This study aims to explore farmers' perceptions of environmental impacts of dairying and their practices towards implementing environmental management accounting (EMA) techniques.

**Design/methodology/approach** – Semi-structured interviews were held with five dairy farmers in the South Island of New Zealand (NZ).

**Findings** – Dairy farmers perceive environmental sustainability in dairying as being able to feed people while protecting the environment so that future generations can also enjoy the natural world. Recognising the need to alter their practices to reduce environmental damage they have produced, dairy farmers use some EMA techniques, but the primary motivation is compliance with government regulations. Other motivations for using EMA techniques are high economic returns, maintaining their reputation and self-satisfaction. Barriers to implementing EMA techniques are primarily due to lack of clarity and feasibility of regulations, coercion and inadequate communication by regulators and high compliance costs.

**Originality/value** – The findings contribute to the current EMA literature by providing a better understanding of EMA practices of dairy farmers in NZ, barriers to implementing EMA and how those barriers could be reduced. It may also help NZ central and local government in developing environmental strategies and policies. Furthermore, this research is expected to help people in the dairy industry to find ways to educate farmers about how the measures that are required can help them to reduce both the environmental impacts and the costs of dairying, thus contributing to sustainable development globally.

**Keywords** Environmental management accounting, Environmental sustainability, Environmental impacts, Dairy industry

**Paper type** Research paper

## 1. Introduction

Environmental issues such as greenhouse gas emissions, climate change, water pollution and soil pollution have gained attention both in New Zealand (NZ) and internationally. The [Ministry for the Environment and Stats NZ \(2019\)](#) identifies eight adverse environmental issues in NZ:

- (1) threatened native plants, animals and ecosystems;
- (2) soil and water degradation;
- (3) land and native biodiversity reduction;
- (4) pollution of waterways in farming areas;
- (5) environmental pollution in urban areas;



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- (6) changes to freshwater ecosystems;
- (7) fishing affecting the health of NZ's ocean environment; and
- (8) high greenhouse gas emissions producing climate change.

Since environmental problems now pose a serious threat against all human activities, [Karimi \*et al.\* \(2017\)](#) propose that environmental strategies to address environmental concerns be integrated into information about economic performance. For example, businesses could adopt environmental accounting to convey environment-related information to both external and internal stakeholders ([Solovida and Latan, 2017](#)). Environmental management accounting (EMA) may assist organisations to manage natural resources, energy and pollution at the operational level and help management to consider environmental issues when making decisions, thus leading to improved environmental performance ([Schaltegger and Burritt, 2010](#)).

Dairying is one of the biggest industries in NZ and is the country's largest export earner ([TBD Advisory Ltd, 2020](#); [DCANZ, 2021](#)). This industry produces a large amount of waste, on-farm and off-farm, and requires energy-intensive processes some of which use fossil fuels as a primary energy source. This eventually results in greenhouse gas emissions ([Tarighaleslami \*et al.\*, 2019](#)), which have negative impacts on NZ people, plants and animals. The literature reviewed for this study suggests that there is a significant link between farmers' and farm owners' perceptions of environmental sustainability and farm practices. Therefore, this research explores farmers' perceptions about environmental sustainability and the adverse environmental impacts of dairying and also documents farmers' practices for implementing EMA techniques, barriers to doing so and suggestions of how to improve the identification and management of environmental costs.

Section 2 reviews the literature on EMA, the dairy industry and its impact on the environment and prior literature on farming and environmental sustainability, concluding with the research method used in this research. Section 3 presents the findings from the research, including dairy farmers' perceptions of environmental sustainability, EMA techniques they use and why, barriers to using EMA and suggestions for improvement. Section 4 discusses motivations for and barriers to EMA implementation. The concluding Section 5 highlights the contributions of this research and suggests further research.

## 2. Literature review

The Brundtland commission's report to the United Nations in 1987 highlighted the concept of sustainability in relationship to economic, ecological and social development as comprising "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" ([Brundtland, 1987](#), p. 37). Increasingly, businesses are being held accountable for environmental consequences of their activities, such as soil pollution, water pollution, air pollution and climate change ([Karimi \*et al.\*, 2017](#)).

### 2.1 *Environmental management accounting*

EMA identifies both monetary and non-monetary information related to the environmental impact of an organisation's operations ([Schaltegger and Burritt, 2000](#)). Monetary information includes the cost of consumption and management of resources like water, fuel and power, the cost of environmental assets, recycling costs and costs for violating environmental regulations ([Burritt \*et al.\*, 2002](#)). Non-monetary environmental information focuses on the physical environmental impacts of a company's corporate activities,

including the amounts of materials, energy usage and flows of waste that are likely to have an impact on the environment (Burritt *et al.*, 2002; Qian *et al.*, 2018).

The benefits of implementing EMA in organisations include reduction of expenses, innovation, cleaner production, improved pricing of products and services and increased value for shareholders (Deegan, 2003; Burritt and Schaltegger, 2010; Burritt and Saka, 2006; Agustia *et al.*, 2019). These benefits enhance the reputation of organisations for introducing environmentally friendly products into the market and conducting organisational activities with minimal negative impacts on the environment.

EMA information also helps to identify and minimise environmental expenses (Burritt and Saka, 2006). For example, a reduced volume of wastewater may reduce the costs of treatment of wastewater and plant upgrades in future (Dillard *et al.*, 2005). Minimisation of capital investments or yearly costs of operations related to the environment can increase profit margins or permit the lowering of the prices of products or services, which can, in turn, increase the organisation's market share (Gibassier and Alcouffe, 2018). In a similar manner, minimisation of potential environmental liabilities can minimise legal liability costs and foster access to clients' contracts and financing (Burritt, 2005). Also, government agencies responsible for managing solid waste can use EMA information to identify the ideal and most cost-effective services to deal with the waste, as well as which has the least negative impacts on the environment (Burritt and Saka, 2006).

However, the usage of EMA may depend on the industry. Ferreira *et al.* (2010) and Christ and Burritt (2013) found that environmentally sensitive industries, such as mining, chemical, petroleum and forestry industries, are more likely to use EMA. According to Frost and Wilmshurst (2000), the primary reasons for environmentally sensitive industries implementing EMA are regulatory compliance requirements and regulatory restrictions.

Researchers have explored EMA implementation in various countries and in a broad range of environmental sensitive industries. However, there is little related to agriculture, NZ and dairying. In NZ, the national dairy herd increased by 70% between 1994 and 2017, in a significant shift from sheep and beef farming into dairy farming (Ministry for the Environment and Stats NZ, 2019). As dairy farming is claimed to have a negative impact on the environment in terms of the soil quality, water quality and quantity, air quality and biodiversity conservation (Ministry for the Environment and Stats NZ, 2019; Baskaran *et al.*, 2009), EMA may help to mitigate the possible effects. The next section will provide the focus for this study by outlining the context of the NZ dairy industry and its environmental issues.

## 2.2 Dairying in New Zealand

The NZ dairy industry is one of the country's biggest industries, producing around 21 billion litres of milk every year (DCANZ, 2021) and it is the world's largest exporter of some dairy products such as milk powder (Granwal, 2021) and butter (Bermingham, 2017). The NZ dairy sector now contributes about 3% of NZ's gross domestic product and 20% of NZ's total exports (TBD Advisory Ltd, 2020).

Although dairy farming in NZ began in the early days of colonisation by the Europeans, it was not an important source of income in the country. Previously, sheep farming was the most vital industry in NZ and most of the lands in the Province of Canterbury were used for sheep farming to produce fine wool and frozen meat (Stringleman and Peden, 2008). However, the NZ dairy industry has grown substantially during the past few decades, especially in the Canterbury region where land used for dairying increased by nearly 90% between 1980 and 2009 and total production escalated by 15 times (Pangborn and Woodford, 2011). This happened because the Canterbury area is flat and easy to irrigate. The adoption of new technologies, such as top-dressing of fertiliser and large scale spray

irrigation systems for increased pasture yield, and the profitability of dairy production led to Canterbury farmers changing from sheep farming to dairying (Dynes *et al.*, 2010). Furthermore, the price of land in Canterbury was cheaper than in other areas in NZ.

### 2.3 *Dairying's impact on the environment*

According to the Dairy Companies Association of New Zealand, NZ is able to produce vast milk quantities because the climate, sufficient water and fertile soil provide an ideal environment to grow grass (Pangborn and Woodford, 2011). Besides that, being an island, NZ is almost free from pests and animal infections present in other parts of the world (Pangborn *et al.*, 2016). These aspects offer the country a strong base for farming with few challenges. However, to maintain international competitiveness and increase productivity, the use of inputs such as fertiliser and cleaning products has intensified. Consequently, this industry contributes to producing greenhouse gases and uses land, water and waste management processes that have negative impacts on the environment (Ministry of Primary Industries, 2019; Parliamentary Commissioner for the Environment, 2013; Jay and Morad, 2007; Monaghan *et al.*, 2007; Flemmer and Flemmer, 2007).

Greenhouse gases such as carbon dioxide, methane and nitrous oxide comprise almost half of NZ's gross emissions (Tarighaleslami *et al.*, 2019). Methane comes from cattle. Nitrous oxide from agricultural soils mainly comes from the urine and manure of grazing animals as well as synthetic nitrogen fertiliser, which is converted to nitrous oxide by soil microbes. Diesel and petrol consumption for tractors and heavy trucks used on farms and for tankers getting milk to processing plants produce carbon dioxide directly. Further, fertilisers used to improve soil nutrient levels on-farm and feeding supplements such as grass silage and hay produce carbon dioxide indirectly.

Dairying also contributes to water pollution because excess nitrogen, chemicals, sediments and soil phosphorus enter freshwater bodies such as rivers and lakes (Parliamentary Commissioner for the Environment, 2013). For example, some NZ lakes, such as Lake Taupo in the North Island, Lakes Wairewa (Forsyth) and Waihora (Ellesmere) in the South Island, have had outbreaks of toxic algal blooms and loss of wildlife such as fish, eels and waterbirds (Parliamentary Commissioner for the Environment, 2013).

The NZ dairy industry also produces various kinds of wastes, in particular plastics, agrochemicals and dead stock. Other wastes include fertiliser bags, tyres, used oil, batteries, scrap metals, treated timber, needles and syringes.

### 2.4 *Farmers' perceptions and environmental practices*

Some prior studies have evidenced the relationship between farmers' perceptions of negative impacts on the environment and their practices targeted at reducing them. Orduño Torres *et al.* (2020) found that Mexican farmers who view climate change as an essential ecological issue are more willing to implement actions that might help to mitigate this issue, such as using less polluting machinery. Similarly, Mongolian wheat growers who perceive that soil erosion is severe are more likely to adopt sustainable agricultural practices (Puntsagdorj *et al.*, 2021). Da Motta and Ortiz (2018) confirmed that Brazilian farmers who perceive climate change to be a critical environmental issue are more inclined to participate in programmes to provide flood control and mitigate the degradation of Brazil's grazing areas. Tathdil *et al.* (2009) found that Turkish farmers' perception of sustainable agriculture resulted in them using agricultural practices which reduce the negative impacts on the environment, such as not burning residues after harvest, proper irrigation and improved use of pesticides. Marco-Fondevila *et al.* (2020) document a Spanish winery that is monitoring energy use and carbon emissions using an EMA cost accounting system.

However, Tashakor *et al.* 's (2019) survey of Australian cotton farmers' intention to use EMA found that although these farmers might be willing to do the right thing, in this case, to adopt EMA, their ability to do so is dependent on their finances and the amount of support they have. Kielbasa *et al.* (2018) found that, although most Polish farmers view environmental sustainability as a vital and inseparable component of their daily operations, some would only consider making adjustments to their current practices to improve nutrient management if they expected favourable economic results. Kazemian *et al.* (2022) found that companies in the agricultural sector that are focused on sustainability still tend to only collect short-term physical carbon emission measures, not including long-term and monetary measures.

There is limited research on the relationship between dairy farmers' perceptions about environmental sustainability and their practices for reducing adverse impacts on the environment. Creemers *et al.* (2019) collected data from 524 European dairy farmers, revealing that dairy farmers' beliefs about sustainability influence their choice of farming strategies aimed at achieving environmental sustainability. For instance, dairy farmers are more likely to reduce their existing production scale if they perceive that this production choice will reduce the negative environmental impacts of dairying. However, there are no studies of this issue in NZ. Hence, this research will add to the body of knowledge by exploring NZ dairy farmers' perceptions of environmental sustainability and adverse environmental impacts of dairying and their practices for measuring and reporting these impacts.

## 2.5 Research method

Taking an interpretive, inductive perspective, the researchers designed a qualitative study. Semi-structured interviews were carried out with five farmers selected from the Canterbury region in the South Island of NZ. Canterbury is the second largest dairy farming region in NZ and the largest in the South Island. The participants were dairy farm owners or farm managers who were involved in decision-making regarding the farm. The potential participants were identified through friends and contacts within the agricultural industry and contacted by email. Profiles of interviewees are provided in Table 1.

The interviews were carried out face-to-face in person, in various venues chosen by each interviewee, such as at their offices or farms or in a café. After initial introductions and conversation to establish rapport, the researcher first asked simple questions related to the interviewees' experience and involvement with farming before asking more sophisticated questions related to the research topic. An interview guide was designed, with possible questions and prompts, but the interviewees were free to talk in more detail or to go off on side tracks if they wanted to.

Interviewee	Owner/manager	From farming family	Gender	Interview length
Farmer 1	Manager	Yes	Female	60 min
Farmer 2	Owner	Yes	Female	80 min
Farmer 3	Owner	Yes	Male	30 min
Farmer 4	Manager	No	Male	55 min
Farmer 5	Manager	No	Male	45 min

**Source:** Table by authors

**Table 1.**  
Profiles of  
interviewees

The interviews took an average of 54 min, ranging from 30 to 80 min. All the interviews were recorded with the consent of participants and the recordings were transcribed for further analysis, with the help of NVivo 12 software, to identify codes and themes (Braun and Clarke, 2014).

### 3. Findings

The interviews explored dairy farmers' perceptions of environmental sustainability, whether they currently use any EMA techniques, reasons for implementing such techniques, barriers to using EMA and finally, their suggestions about how to improve the identification and management of environmental costs and information.

#### 3.1 Farmers perceptions of environmental sustainability

For the farmers interviewed, environmental sustainability in agriculture means to be able to supply food to people while continuing to maintain or improve the environmental impacts of their operations so that future generations can still enjoy nature as we do today.

Farmer 4 used an analogy:

*What sustainability means to me is to make sure that my generation don't [...] extract all the golds and just leave the silver and bronze for [...] future generations. [...] sustainability [...] is to make sure that my kids can carry this legacy on.*

One farmer, who recently took a course on sustainability education, claims that environmental issues are a priority that needs to be addressed as a matter of urgency:

*At the end of the day it's more that sustainability is a whole thing. If you [...] don't have enough things in place to be environmentally sustainable, you're not going to be financially sustainable (Farmer 2).*

The news media have reported the adverse impact of intensive dairying on the environment, which has put a lot of pressure on farmers. Hence, dairy farmers believe they need to improve the environmental state of their farms:

*Environmental sustainability is very important at the moment as it is such a big public concern [...] if we do not get this right, we will need to shut down (Farmer 3).*

Although all farmers interviewed are aware of the environmental impacts of intensifying dairying activities, it appears that they are more concerned about their businesses' financial sustainability and economic performance than the environment. The interviews indicate that farmers are focusing on ways to increase their farm production, which improves their economic performance. One possible explanation is that the economic outcome of dairying is more visible and tangible than the ecological condition of dairy farming land.

#### 3.2 Current environmental management accounting techniques used

Although most interviewees were not familiar with the term "Environmental Management Accounting", they all have strategies and tools to measure their environmental impact. For example, Farmer 4 mentioned:

*We do reporting on our environmental performance, our social performance and our financial performance [...] we have some metrics that we choose to use, and we report on those.*

Three particular techniques were identified in the interviews, namely, the preparation of a farm environment plan (FEP), the use of environmental online software packages and the creation and usage of environmental-related cost accounts. Details are provided below.



**3.2.1 Farm environment plan.** The Canterbury regional council, Environment Canterbury ("ECan"), requires an FEP. An FEP is a comprehensive document requiring non-monetary information, showing that the farmers have identified environmental risks on their farms and providing actions they will take to manage them. For example, an FEP specifies the area used for crops or trees (ha); the amount of water, effluent and fertiliser applied; and stock numbers and production outputs.

ECan assesses farms, giving them an A grade if the farm meets all their requirements. They will immediately send somebody from ECan to any DD grade farm to talk to the farmer about compliance and enforcement issues and possible compliance options. ECan revisits A grade farms every three years, B grade every two years, C grade every year and D grade every six months.

The farmers described the FEP as one of their main tools to address environmental issues which they recognise as being unavoidable. All their operations, from soil fertilisation, through growing grass and other crops, to extracting the milk and delivering it to the milk treatment plants, will inevitably impact the environment. Hence, having a farm environment plan is crucial for them to enable them to carry on with their business in an environmentally sustainable way.

Farmers spend a considerable amount of time making sure they comply with the FEP and do not currently report beyond the regulatory requirements of the FEP. It appears that farmers regard the FEP merely as a compliance document and that it does not assist them in determining environmental costs. In the FEP, farmers record non-monetary information related to the environment, but they do not have to disclose monetary information, such as the cost of spraying fertiliser on the paddocks and how much they need to spend to install a new irrigation system. Therefore, environmental costs might not be recorded as such:

*We have to document when we spray [fertiliser], we just don't then calculate that back to what is the cost of doing it [...] This is a little bit of work we're doing at the moment. We have a code in our ledger for effluent repairs [...] but [...] you couldn't pull out our financial reports and go, 'this is the cost of environmental management' (Farmer 1).*

*I tend to put almost all the costs into compliance or consent compliance or something like that rather than environmental, even though you could put it in the environmental box (Farmer 2).*

Furthermore, the FEP is not necessarily used. Farmer 3 stated: "[The] Farm Environment Plan [...] [is] a document everyone has to have, but a lot of the time, it goes in the drawer", and Farmer 1 mentioned that:

*the Farm Environment Plan is [considered] the best way of doing things, but the problem is [...] I'm not a hundred percent convinced it's going to change the behaviour on farm [...] [It] will [...] highlight a few things that you need to work towards.*

Farmers 1 and 4 claimed that if farmers used the FEP effectively and if the regulator ECan was clear on what information needs to be reported, then it would be a helpful way to achieve environmental sustainability.

**3.2.2 Environmental online software packages.** As part of the FEP, farmers should also use environmental management online software to calculate, monitor and analyse their farm operations. The software packages were developed using frameworks and guidelines from international bodies such as the United Nations and targets set by the central government. The calculations and level of comprehensiveness of various software systems differ depending on the support tools provided in each software package. Also, there is no specific method to calculate the inputs and outputs in the farm production processes. The two software packages that interviewees mentioned are the Agricultural Inventory Model and

OverseerFM®. These packages measure inputs, such as milk production, the number of cows and fertiliser types and amounts, and outputs, such as greenhouse gas and other farm emissions and the nutrient balance.

All five farmers interviewed use Overseer and some farmers also need to use the software system of the dairy company they supply milk to, such as the Fonterra software system:

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*[Overseer and Fonterra's] are basically separate systems [...] we use the information from Overseer in the FEPs and Fonterra's records. However the FEP and Fonterra require far more data than the Overseer Nutrient budgets (Farmer 1).*

Currently, this non-monetary information is used to report to the management team of the farm. Farmer 4 is planning to link the Overseer reports to environmental, social and governance reporting.

**3.2.3 Creation and usage of environment-related cost accounts.** Although most of the interviewees do not currently separate environmental costs from other costs in their internal financial reports and budgets, some farmers are starting to separate environmental costs from their overhead account. Farmer 2 said she already identifies direct environment-related costs and creates separate accounts when doing managerial reports:

*I've got a recycling code in my accounting system. So, the plastic wrap [...] I put that under recycling cost, then chemical drums, they do charge a small fee for that as well. So, I've put them under there (Farmer 2).*

Farmer 4 said “[we] have our own kind of reporting systems that we use to record [non-monetary] data”.

The interviewees indicated that farmers are well informed about how they could quantify the monetary cost of caring for the environment; for example, identifying the cost of the environmental compliance manager and consultants for work related to environmental compliance and actual costs of dealing with ECan (e.g. paying for consents and monitoring). Farmers are also able to identify some environment-related costs that could be allocated to their production processes. Farmer 1 said:

*[...] we must be able to determine how long the irrigation system is running and how long to spread the effluent. And then we will be able to work out the cost per hour of the power to spread that effluent, and when we know what our effluent pond bill is, we would be able to work out the depreciation.*

However, because they do not have to report the monetary information on environment-related costs and revenues, they do not practise this allocation, although it would be possible to do so. For example, Farmer 4 added:

*And the next step is we go to a full monitoring system where we are getting daily or weekly reports, but at this stage, we're not doing that [...] However, we have the capacity to [calculate and monitor the mentioned environment-related costs].*

In summary, all farmers prepare an FEP and the majority of them use environmental online software packages to collect, analyse and report the non-monetary environmental performance of their farm. Although all farmers are able to identify some monetary environment-related costs, only one farmer is actually using some environment-related cost accounts in their accounting reports. In addition, farmers mentioned that the FEP submitted to ECan is not fully used. In the next section, the reasons why farmers have implemented EMA techniques are discussed.



### 3.3 Motivations for implementing environmental management accounting techniques

Reasons why the farmers interviewed apply the EMA techniques include: compliance with ECan, economic returns, reputational image and self-satisfaction. These are discussed next.

**3.3.1 Compliance with ECan.** In response to international initiatives that seek to reduce environmental impacts and meet the United Nation's sustainable development goals, NZ created the Ministry for the Environment and under it the Environmental Protection Authority to serve as a national environmental advisor and regulator. ECan is responsible at the local level for taking action and developing strategies for Canterbury that match the national environmental objectives. It has also made it compulsory for farmers to submit their FEP. The farmers unanimously said that the main motivation for implementing EMA techniques is to comply with ECan. Farmer 1 mentioned:

*I would say probably 70% is regulation and 30% is because we want to improve, but that sounds bad [...] In reality, I mean [...] we know what we're doing is the right thing to do, and we probably would have gotten there anyway, but I think regulation has made [us] get there faster.*

All farmers complain that ECan does not give them enough guidance, and therefore they are quite unsure of how to comply with the regulations. All feel they need some direction on how to meet ECan requirements because they do not really understand what they should report in the FEP and consequently are struggling to complete the FEP. Farmer 4 suggested that they did "not really" have support from the regulators: "They couldn't care less to be perfectly honest with you. We've got to [comply with the regulations] and there's no idea of how we should do it".

Farmer 2 mentioned that ECan provides some support to farmers to comply with their regulations. Sometimes it is difficult for ECan to take a comprehensive approach that will satisfy all people in the dairy industry as they have to meet the central government's expectations. She added:

*There will be someone from areas [such as the irrigation company and fertiliser company] in the [discussions held], so ECan is also there and they can start to understand more what the farmers are dealing with. Farmers can also start to understand what ECan are dealing with because they're getting the pressure from the central government too.*

Farmers stated that one of the reasons why they find ways to ensure that they comply with environmental laws is for economic returns, so that the business can stay afloat:

*You have to follow all the regulations to enable your business to survive, otherwise no one will want to work with you, and you won't be able to sell your goods [...] You have to be at that standard to sell your goods and then that comes back to profitability, and you won't be profitable unless you do that (Farmer 1).*

*If we don't get this right, we'll need to shut down [...] so if farmers want to survive, they need to find ways to work with the landscape (Farmer 3).*

Farmers elaborated on various ways to ensure that they are on the right track with environmental policies. For example, they actively engage with different organisations in the dairy industry such as DairyNZ. Farmers pay a levy to these organisations to conduct research and development for better farming practices. These industry bodies will also act as advocates for farmers with central and regional government and provide various activities to update farmers on policy matters: "DairyNZ [...] are a really good resource [...] because usually they have seminars and things like that" (Farmer 2).

Another farmer mentioned that he seeks advice from Ravensdown, an agricultural fertiliser cooperative that helps farmers reduce environmental impacts. This company also

helps farmers in various ways such as by ensuring they obtain their consents from ECan and consults with farmers with regard to both the FEP and the environment online software packages. Farmer 4 claimed:

*We do rely on Ravensdown a bit for environmental reporting. So, if we have any real challenges that we can't overcome internally, then we would turn to Ravensdown for their support.*

Apart from support from large organisations, farmers also found that they learned a lot from other farmers' experiences, not just how to comply with ECan regulations but also how to reduce ecological impacts on their farm. Farmer 2 said:

*We have a pretty good rapport with all our neighbours. [Farmers] talk to each other and discuss how we could improve our farm practices to meet the existing policies and regulations.*

She also highlighted that farmers formed a discussion group to educate themselves, where farmers in the:

*area that have got under 500 cows get together every two or three months and talk about how they are doing [...] Sometimes there's one farm that might be trialling a new crop or something like that and they talk about how that worked for them or how they're managing their waterways or something like that (Farmer 2).*

Farmers said it is very hard for them to keep up with the changes in regulations. This is because a lot of farms in NZ are family businesses, which the owners manage on a day-to-day basis. Their work is continuous, daily and cannot be postponed. It is only with support from a lot of people in the industry that dairy farmers can learn and adapt to new knowledge and meet the legal requirements.

Although compliance with ECan regulations is the main factor influencing farmers' reporting and practices, a few other factors that motivate farmers were mentioned, discussed briefly below.

**3.3.2 Other factors.** Farmers stated that maintaining the business reputation is another factor motivating them to implement EMA techniques. For example, Farmer 1 said:

*The most valuable thing you own is your reputation. [...] It's our name on the gate [...] When we've got contract milkers and they employ staff [...] if [they] do something wrong it's our name that's going to be in the paper. So, we always want to do the right thing with the environment because [...] We've worked hard to build a reputation [...] to build a good brand.*

One farmer mentioned obtaining internal self-satisfaction when she invested some effort towards environmental conservation by implementing EMA techniques. She knows that implementing environmental management techniques might help in reducing the environmental impacts of dairying. She shared the following:

*For some people, it's probably more external. But for me it is a little bit internal as well [...] I don't know if you've heard of Trish Rankin. She was Dairy Woman of the year. She has done this huge environmental campaign which is part of the reason why she got the award. She is doing a lot of other things around recycling [...] she made lampshades out of old milk cups [...] When you come across people like that, you know, they inspire people [...] in the industry to do this sort of thing. (Farmer 2).*

In summary, this section explored the factors encouraging the adoption of EMA techniques. Although abiding with regulations from ECan is the main reason for applying EMA techniques, maintaining their reputation, staying afloat and self-satisfaction are also contributors to farmers' desire to protect the environment and report environmental-related information.

### 3.4 Barriers to using environmental management accounting techniques

The main barriers to adopting EMA techniques among farmers are all related to compliance with regulations. They claim that environmental proposals lack clear directives and guidance, that regulators behave coercively, that the regulations are impractical and that the compliance costs are high. Farmers said other barriers include difficulty quantifying benefits of EMA, confusing definitions and terminology, a short-term focus, problems with information collected and a lack of extrinsic motivations. These barriers are discussed next.

*3.4.1 Environmental proposals lack clear directives and guidance.* One of the biggest barriers for farmers in adopting regulators' EMA techniques is that actions are said to be urgent, but the steps that farmers need to go through to comply are not clearly communicated. For instance, the government proposed the National Policy Statement for Freshwater Management in 2019, which will require all councils to have new freshwater management plans in place by 2025. However, the freshwater management plans required farmers to comply within six months. Farmers opposed this because policies around the environment keep changing and the government does not provide clear information. To move at the same pace as the government's expectation but with vague information is difficult for farmers and "six months is too short a time to allow farmers to make farm system changes. [...] To keep up with the policies and regulations is a real challenge" (Farmer 1).

Farmers also stated that information about aspects that require urgent action are conveyed through emails. However, they argue that emails are an inappropriate method as farmers often do not read them as they are too busy. Further, it takes time for them to read and to understand the content of the policies and many cannot comprehend all the details in the environmental policies. One farmer added: "when someone gives farmers a 600-page document and says, this is a new law [...] I'd be surprised if they even read the title" (Farmer 4).

As mentioned in the previous section, farmers claimed a lack of support from the regulators that impose various policies. Although Farmer 3 said that the regulators "do a bit", Farmer 2 claimed that "the only ones that would probably give you more support is through Fonterra and the Ministry of Primary Industries".

Therefore, farmers felt overburdened and confused about what to do to meet policy goals, making it difficult for them to implement the EMA techniques. Although they demonstrated that they have environmental concerns at heart, it is the complexity of policies without support and guidance that makes it difficult for farmers to apply EMA techniques. For example, the views of two farmers on this are shown below:

*[Farmers] get overwhelmed [...] they feel like they met the last target but now need to change [...] so those who really want to get it right [are] very enthusiastic [...] then when it gets harder and harder and no support is given, and people still need to do it, some get through it, some won't (Farmer 3)*

*I can't see any of those three levels of authority (i.e., central, regional, district) have an actual common vision. Actually, most farmers are 'green' at heart. They actually want to do the right thing. However, at the moment, [there's] no support from [the central government, regional council and district council] (Farmer 4).*

*3.4.2 Coercive behaviour of the regulators.* The farmers interviewed also become demotivated about the implementation of EMA techniques because of the attitude of the regulators. They argued that the regulators simply pass on the environmental policies to farmers and use coercive methods such as threats to get them to comply with the rules.

Farmers feel that this method does not help regulators enforce compliance. As an example, Farmer 1 reported:

*[There is] this one individual in environmental regulation at the moment [...] [that] has a bad attitude [...] to farmers [...] 'I'll get you one day!' Well, that kind of behaviour doesn't build trust and it doesn't build [the feeling that] we're all in this together. The New Zealand economy and the wellbeing of citizens relies heavily on the agriculture industry. So just coming out and saying, 'If you complain and if you keep complaining, I'll make you pay more' [...] well, that kind of attitude doesn't build confidence, [...] trust or anything. So, first and foremost, I think that type of behaviour just has to be outlawed because that's not helping anyone (Farmer 4).*

In addition to the coercive method regulators use, more than half of the farmers also said that the regulators poorly communicate information about environmental policies that they put in place. As a result, farmers are struggling and claimed:

*people at the top [i.e., regulators] [...] do not really know what rules and policies are going to affect everyone (Farmer 3).*

*It's almost a top-down approach. [...] any businessman can tell you that a top-down approach will have almost no buy-in at a low level or any level. (Farmer 4).*

**3.4.3 Impractical environmental regulations.** Farmers found that the environmental regulations themselves are impractical. They have submitted environment-related documents to relevant people in the industry, such as ECan, the central Government and the milk company. In one of the documents, Farmer 1 strongly opposed a new regulation proposal for “tight restrictions on land use changes – that limits opportunities and [is] not supported by scientific evidence”. Farmer 1 also mentioned:

*Everyone knows we want fresh water, there's no debate about that [...] one hundred percent we want to do the right thing, but it has to be practical and some of the rules that come out with it [are] just not practical.*

Several of the other farmers also raised the impracticality of the regulations:

*They're not practical people [...] through their education, they've sat at a desk and go with data. And they speak their language and their words, that mean whatever, but they're not practical with it. It's like they might as well be from a different planet, speaking a different language and come out with their ideas when they don't have the practical skills (Farmer 5).*

*Sometimes there are regulations applied that are the same for everyone, but farms are so different to each other [...] For example, the amount of nitrogen that goes into the soil [...] different soil types will be different [...] There can be a feeling that they are making laws without thinking how to benefit everyone and it might be easy for this guy and hard for this guy (easy vs hard means expensive) (Farmer 3).*

*[...] about the nitrogen cap, so, [it's like having one speed limit where] it does not matter whether you are driving out in front of the school or you're on the open road, it's 60 km/h [...] that's what the 190kg N/ha is saying – it doesn't matter what soil type you're on (Farmer 1).*

*At the end of the day, I think there's a lot of people trying to get involved in farming and to regulate it, but [they] do not know what they are doing. And they [are] just making it difficult. This is just ridiculous (Farmer 5).*

**3.4.4 High compliance costs.** The compliance cost in terms of money and time is considered to be high and too much of a burden for farmers. They claimed that:

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*Our Environmental Compliance and Enhancement Manager has been there about 18 months and she hasn't got onto enhancement yet because compliance is such a massive job [...] You spend all your time trying to comply with new rules, keep up with new rules, till you cannot get to spend some time actually making the environment better [...] It's so frustrating.*

In the FEP, farmers need to disclose the ecological effect of their farm operations, such as their irrigation system, nutrient loss mitigation measures, soil management to minimise the movement of sediment and phosphorus and the water used in their dairy shed. Providing this information is a cost for farmers as they have to spend money and time on completing the FEP.

**3.4.5 Difficulty quantifying benefits of environmental management accounting.** Adding to the burden of high compliance costs is the fact that farmers argue that they cannot calculate the benefits they receive from implementing the EMA techniques in monetary terms. Farmer 4 mentioned that farmers are not aware of any “benefits that [farmers] can actually see because they have to pay a lot”. Two farmers said:

*If you're going to look at the costs, you [also] need to look at the benefits (i.e., revenue), which is sometimes harder to quantify (Farmer 1).*

*When you look at it at a macro level, we're getting forced into making long-term decisions on short-term data. For example, they are saying, 'Look, we're going to have to change our model Y to model X, but we've got no long-term validation of whether or not that's going to be sustainable and beneficial in the future'. So, there's certainly a lack in the market at the moment around linking those areas (Farmer 4).*

**3.4.6 Confusing definitions and terminology.** Farmers also claimed that it is confusing for them to comprehend some of the terminology provided in the environmental policies. For example, in management accounting, a budget is a plan that specifies expenses and revenues that an organisation expects in the future. This is also the farmers' understanding of what budgeting is. However, when ECan ask farmers to do a nutrient budget, it demands that farmers report past performance instead of taking a future view. Farmer 1 described it:

*You get to the end of the season, and you put in all [...] your physical data for the last year and then nutrient budget for the last year, whereas what we actually want is a forward looking nutrient budget.*

Thus, farm managers do not have information for planning and performance measurement, which they could use for decision-making. Farmer 1 claimed that the “definitions need to be clearer to allow people who will be affected to make a decision and clearly understand how their farming operation will be affected”.

**3.4.7 A short-term focus.** Another barrier identified in the interviews is farmers' short-term view of sustainability, focussing on economics and ways to increase productivity and profit. Farmers stated:

*If you can't make a dollar, there's no point even trying to think about [being] environmentally sustainable. I think that's where things are at in the world at the moment (Farmer 2).*

*[...] you've got to be financially sustainable first (Farmer 3).*

*I've always believed that you can never be environmentally sustainable if you're not profitable. And [...] there needs to be a level of commercial in your business (Farmer 4).*

Despite this point of view, some farmers are aware that the environmental and social aspects of sustainability are all linked to economic sustainability. “At the end of the day it’s [...] sustainability as a whole thing” (Farmer 2):

*[Some] people only care about production [...] But we have discovered that we can dial back production a bit as it is more efficient while being more environmentally sustainable (Farmer 3).*

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**3.4.8 Problems with information collected.** Farmers identified problems related to the inaccuracy of information, ineffectiveness in collation of data and inefficiencies of the systems. Since some farmers do not know how to use the equipment provided to record data on farms, the data gathered are not accurate and are problematic to use in monitoring environment-related costs and planning for their organisation. One farmer said:

*Farmers have to be really careful in recording what goes on and what goes off, where they go – is it into each paddock? They need to have someone to record it accurately. If [we are] being audited, we often see a difference between what a truck driver says and what is actually charged on the bill. It is a challenge for farmers (Farmer 3).*

Another farmer added that information is collated in an ineffective way. For example, collected data are stored in separate folders, depending on who are the users of the information. Thereafter, farmers need to spend time dealing with the data collected instead of focusing on the farm’s operation. Farmer 4 stated:

*I think we could collate [the information] better, and that’s a limiting factor. [...] I think we don’t have enough software in New Zealand around the collation of data. However, collection is not a problem.*

Farmer 4 added:

*So, you’ve got to bring kind of three heads to the game to try and solve the challenges. And that’s awfully hard because someone that’s good at finance doesn’t understand the environment. Someone who’s great at environment doesn’t necessarily understand operations. And it’s very hard to find someone that’s very good at all these three.*

Farmers also pointed out the inefficiencies of systems used to collect the information:

*One area that absolutely frustrates me as a farmer is that there are like 15 different platforms that I have to go onto and get the information. It would be great if you just have one dashboard and you click on environment and that pulls out all your environmental related data, click on finance, pulls your finance data then on social, it pulls all those data out, click on whatever [...] we don’t even have it for any of those individual silos (Farmer 4).*

*There is a lot of inefficiency in recording of farm data. [There] seems to be a need for a centralised system [...]. for example, the data from Overseer could be used for everyone. It is wasting a lot of time and farmers’ patience. For example, Fonterra has their own system, Ecan too, and some are redundant [...]. (Farmer 3).*

**3.4.9 A lack of extrinsic motivation.** The last barrier to implementing the EMA techniques discussed here is the lack of extrinsic motivation. Farmers argue that the operational expenses on farms are already high without considering environmental management. To ensure they are willing to take actions to obey environmental laws, they said they would require some extrinsic motivation.

The barriers to using EMA techniques discussed in this section require the NZ Government’s urgent attention if they would like to see environmentally sustainable practices in dairying.



### 3.5 Improving identification and management of environmental costs and information

Given the multiple barriers to farmers using EMA techniques, the farmers interviewed made several suggestions about what could be done to improve the identification of environmental costs and how to ensure that farmers consider environmental and other related cost information when making decisions. Five of these suggestions are presented below.

**3.5.1 Improve environment standards and regulations.** The first way is for the regulators to rethink environmental impact mitigation strategies. Farmer 1 said:

*The biggest challenge is getting regulators to understand what actually happens on farm. And I think, the Farm Environment Plans are the best way of [reducing the environmental impact on farms], but the problem is [...] I'm not one hundred percent convinced they're going to change behaviour on farm.*

Farmers suggested that regulators could produce a comprehensive policy that is relevant for other environmentally sensitive industries such as the horticulture industry. Then, dairy farmers will feel that they are not the only contributors to the environmental impact and may be more willing to work together with other industries to improve the environmental sustainability of NZ. Farmer 3 claimed that:

*[...] it is a job for people at the top to think about. [...] For example, the nitrogen limit (imposed last year) [...] that's just targeting the dairy industry in particular, and it will have an effect to reduce nitrogen by doing that. However, a lot of horticulture businesses are doing the same thing but not being targeted because the public's not aware about that.*

Given farmers' perception that environmental regulations are impractical, one farmer suggested that regulators should prove to farmers that their policy requirements are feasible so that farmers are willing to abide by their environmental regulations. He said: "They [the regulators] need to show people what's possible. This has always been an issue because what is possible here might not be for others" (Farmer 3).

**3.5.2 Integrated accounting system.** The second way to improve the identification and management of environmental costs and information is by having a centralised software package so that farmers do not have to spend a lot of time to input and pull out the information. One of the farmers said:

*Sometimes you just do lots of paperwork for the sake of doing paperwork. It seems like it. But I think once a system gets developed, this will change. So as technology gets better and cheaper, complying is getting easier (Farmer 1).*

Farmers are familiar with accounting systems, such as Xero<sup>TM</sup>, MYOB and even enterprise resource planning (ERP) systems. Hence, they suggested that integrating the identification and collection of the environmental costs within these systems would help farmers, in terms of money and time, to upload the information into the accounting system and to measure their current performance environmentally. They shared the following:

*Something like the ERP or within the accounting system will be helpful to accurately capture environmental information. [...] because obviously we have our cost structure, and we want to code things where we do, and you don't want to just chuck everything into environment. I think it is just somehow having a system where you can identify the costs in the ledger and pull a report from there (Farmer 1).*

*I think the dashboard is one of the first steps. My favourite catchphrase in our business is 'what gets measured, gets managed'. And if I want any type of performance on my farm to improve, I just start measuring the results and I get instant performance from my teams*

*because no one wants to be the poor performer or no one wants to be second – that is just in their nature, so, I believe measurement is key in our industry. We need to get better at measuring. (Farmer 4).*

*We need a system that links operations, accounting, financial, and environmental together into one system [...] it's still lacking in my view but [...] could be worked on (Farmer 4).*

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**3.5.3 Synergies between industry compliance bodies.** Environmental information needs to be shared so that different industry bodies do not have to ask for the same information from farmers, which consumes a lot of farmers' time. Farmer 1 suggested:

*Synergies between all these different compliance [tasks] and [demands for] reports are needed so we do not have to produce them so many times. For example, take a dairy farm: an inspector comes from Fonterra, speaks for two hours in your shed making sure you're doing what you need to do to meet your terms of supply. Then you have the environmental consents, so ECan come onto your farm and monitor what you're doing. And then you potentially could have a work site [visit] [...] the Department of Labour comes and makes sure your employment records are correct, [...] and the Ministry of Primary Industries (MPI) come and ensure your animal health. All of those are the pillars under Fonterra. What would be the ultimate [solution] and reduce compliance costs and headaches for farmers is for one auditor to come in [...] an external auditor doing everything – because there is a lot of the stuff you need to show them, [...] do it under a single hat and then [they] give you a certificate or whatever, that you can send to MPI, ECan and other people in the industry (Farmer 1).*

**3.5.4 Show the financial benefits of factoring in environmental costs.** Farmers recommended that regulators and policymakers consider the financial impact when designing environmental policies and show the financial benefits. If farmers could see the financial benefits of factoring environmental costs and cost savings into their operations, they would be likely to comply. For instance, farmers said:

*I think when you can see a financial benefit of everything we do environmentally, then there will be no argument. You'll do it because there will be a benefit (Farmer 1).*

*I would love to see a system [...] when there's regulation [that says] [...] here are five options from an environmental perspective and here's the capital and financial requirements and outlays, and here are the financial benefits that are expected. (Farmer 4).*

### **3.6 Farmers need to change their mindsets**

The final way suggested is by changing farmers' mindsets. All participants admitted that although they do not always agree with the policies and regulations imposed by the regulators and the milk companies, they need to overcome the problems and deal with them for a better future. Farmer 4 stressed that:

*I definitely think that we can do things better and we had our chance to do it without regulation, but we didn't do it. I feel that some of the limits are potentially aspirational. And I don't think technology is going to be the main solution [...] A lot of people think technology will take away our problems. Well, I think technology certainly will help us, and then innovation certainly will help us, but we need a change in mindset at the farm level and I would invite all farmers to start looking to themselves as food producers [...] We have to evolve, and we have to hugely change for the better future of farming.*

## 4. Discussion

### 4.1 *Motivating factors for environmental management accounting implementation*

Compliance with regulations is the main motivation for farmers to implement EMA and regulators will impose penalties on those who violate the regulations. These findings are consistent with several studies that use institutional theory to explain the motivating factors for EMA implementation (see, for example, [Hussain and Gunasekaran, 2002](#); [Jamil et al., 2015](#); [Latif et al., 2020](#)). These studies conclude that coercive pressure from local government standards and regulations could be a strong reason for organisations to implement EMA. The findings are also in line with [Lee and Gunarathne \(2019\)](#) who stated gaining legitimacy as a reason to implement EMA techniques. In addition, this study found that mimetic pressure has a significant influence on the implementation of EMA. For instance, although there are still uncertainties with the implementation of EMA techniques such as its economic benefits, farmers implement EMA techniques as the whole dairy industry is moving towards environmental sustainability. As a result, they eventually adopt the same practices as other farms and organisations in the industry. However, this finding is in contrast to [Wang et al. \(2019\)](#) and [Li \(2004\)](#) who argue that mimetic pressure is not an important motivating factor for businesses to implement EMA.

Reputation is also one of the reasons why farmers adopt EMA. Similar to [Lee and Gunarathne \(2019\)](#) who found that Australian companies pay attention to reporting environmental performance to improve their reputation and to attract potential investors, the current study found farmers adopt EMA techniques to enhance their reputation.

Although [Lee and Gunarathne \(2019\)](#) reported that a reason for implementing EMA is cost saving and prior studies showed that organisations that implemented EMA techniques are able to reduce waste processing costs and losses while processing raw materials ([Agustia et al., 2019](#); [Burritt and Saka, 2006](#)), the current study could not substantiate these findings. This is because farmers do not separate environment-related costs from their total costs. They are, therefore, simply not able to determine whether their EMA practices contribute to cost saving. Farmers cannot anticipate any reductions in their waste management costs because they are not able to quantify their environmental expenditures in monetary units.

### 4.2 *Barriers to using environmental management accounting techniques*

The study's finding that lack of guidance from the regulators is the main hindrance to implementing EMA techniques is consistent with prior studies ([Setthasakko, 2010](#); [Walker et al., 2008](#); [Mathiyazhagan et al., 2014](#); [Menon and Ravi, 2021](#)). Farmers mention that regulators lack on the ground participation and suggested that if regulators engaged directly with the farmers, that could improve trust and might result in farmers becoming more willing to comply.

This study also found that coercive behaviours, poor communication by the regulators and impractical environment regulations are major barriers to implementing EMA techniques. Regulators could be more proactive about giving clear direction to farmers on why and how they should calculate environmental costs. On the farm help would also address farmers' concerns about the complexity of and confusion about how to calculate and report the environmental costs. A win-win solution must be arrived at not only to ensure farmers comply with the EMA techniques but also so they see how this measurement and reporting can result in positive effects for both economic and environmental sustainability.

Other reasons why farmers do not implement EMA techniques to the fullest are high environmental compliance costs and lack of financial incentives. These findings are similar to those of other studies: that financial barriers such as resource constraints and lack of

financial rewards hinder organisations from implementing practices that might mitigate environmental impacts (Walker *et al.*, 2008; Bhandari *et al.*, 2019). While Kamruzzaman (2012) and Burritt and Saka (2006) argue that the implementation of EMA techniques result in reduced environmental compliance costs, the farmers in this study said they have to invest large amounts of money and time to comply with the environmental regulations, simply because they do not receive enough guidance from the regulators on ways to implement the EMA techniques.

The current study supports the findings of Burritt (2005) and Dillard *et al.* (2005) that inefficiencies in data gathering and poor systems to manage and measure environmental costs have made it difficult for managers to segregate environmental costs from total production costs. As a result, they assign environmental costs to overhead accounts. Hence, this research suggests that dairy industry bodies including regulators, dairy companies, irrigation companies, fertiliser companies and environmental software companies need to work together to develop an environmental software system that integrates all environment-related measures and costs into one robust software system. Improving the current environmental system could help farmers to improve their current environmental reporting, reduce the time and money needed to manage the environmental information and in the long-term reduce the environmental impacts of dairying.

## 5. Conclusions

The interviews with farmers provide an interesting insight into farmers' perceptions of the negative environmental impacts of dairying. Farmers view environmental sustainability in dairying as being able to supply food to people while continuing to maintain or improve the environmental impacts so that future generations can still enjoy nature as we do today. Although all interviewees acknowledged the negative impacts of dairying on the environment and hence knew that they should take actions to reduce these impacts, the main focus is on managing their businesses for profit, that is, for economic sustainability.

Farmers do use some EMA techniques, but mainly non-monetary measures. Compliance with ECan and the government is the main motivation for using EMA techniques. Barriers to EMA usage include lack of clear directives and guidance and a perception that the regulator is imposing impractical regulations which come with high compliance costs. Farmers suggested that they would feel more confident in implementing EMA techniques and be willing to make changes for a better future of dairy farming if environment standards and regulations improved, there were integrated accounting systems, synergies between industry compliance bodies and the financial benefits of factoring in environmental costs were indicated. Interviewees also suggest that farmers need to change their mindsets from criticism, complaint and resistance to taking voluntary positive steps to improve the environment.

This research could help the NZ central government and regional councils to improve their environmental policies and regulations by ensuring that the principles behind the policies are clearly communicated and guaranteeing that the measurements are not onerous but will be effective in sustaining the environment. Environmental authorities, farmers, dairy corporations, academics, accountants, environmental consultants, environmental experts and others in the dairy industry could collaborate to address concerns and develop EMA practices and feasible solutions. This, in the long run, may ensure a big decrease in environmental impacts as well as operational costs of dairying in NZ and ultimately contribute to sustainable development globally.

Although this study was carried out with only five interviewees and in one region of NZ, their responses to the questions have made a contribution to the sparse literature on EMA in

agricultural settings. Future research could validate the opinions and claims made by the interviewees by observation of what is happening on the farms and in the interactions with regulators and others involved in the sector.

The research could be expanded by obtaining comments and responses to criticisms from regulators and people able to provide training and support to farmers in their pursuit of sustainable farming practices. This study could also be extended by future research in the dairy industry in other regions of NZ as well as abroad and in other primary industry sectors.

## References

- Agustia, D., Sawarjuwono, T. and Dianawati, W. (2019), "The mediating effect of environmental management accounting on green innovation-firm value relationship", *International Journal of Energy Economics and Policy*, Vol. 9 No. 2, pp. 299-306, available at: [www.econjournals.com/index.php/ijeep/article/view/7438](http://www.econjournals.com/index.php/ijeep/article/view/7438)
- Baskaran, R., Cullen, R. and Colombo, S. (2009), "Estimating values of environmental impacts of dairy farming in New Zealand", *New Zealand Journal of Agricultural Research*, Vol. 52 No. 4, pp. 377-389, doi: [10.1080/00288230909510520](https://doi.org/10.1080/00288230909510520).
- Birmingham, F. (2017), "Milk it: How New Zealand's dairy exports conquered the world", *Global Trade Review*, 9 May, available at: [www.gtreview.com/magazine/volume-15issue-5/milk-new-zealands-dairy-exports-conquered-world/](http://www.gtreview.com/magazine/volume-15issue-5/milk-new-zealands-dairy-exports-conquered-world/)
- Bhandari, D., Singh, R.K. and Garg, S.K. (2019), "Prioritisation and evaluation of barriers intensity for implementation of cleaner technologies: framework for sustainable production", *Resources, Conservation and Recycling*, Vol. 146, pp. 156-167, doi: [10.1016/j.resconrec.2019.02.038](https://doi.org/10.1016/j.resconrec.2019.02.038).
- Braun, V. and Clarke, V. (2014), "What can 'thematic analysis' offer health and wellbeing researchers?", *International Journal of Qualitative Studies on Health and Well-Being*, Vol. 9 No. 1, p. 26152, doi: [10.3402/qhw.v9.26152](https://doi.org/10.3402/qhw.v9.26152).
- Brundtland, G.H. (1987), "Our common future: call for action", *Environmental Conservation*, Vol. 14 No. 4, pp. 291-294, doi: [10.1017/S0376892900016805](https://doi.org/10.1017/S0376892900016805).
- Burritt, R.L. (2005), "Challenges for environmental management accounting", in Rikhardsson, P.M., Bennett, M., Bouma, J.J. and Schaltegger, S. (Eds), *Implementing Environmental Management Accounting: Status and Challenges*, Springer, Cham.
- Burritt, R.L. and Saka, C. (2006), "Environmental management accounting applications and eco-efficiency: case studies from Japan", *Journal of Cleaner Production*, Vol. 14 No. 14, pp. 1262-1275, doi: [10.1016/j.jclepro.2005.08.012](https://doi.org/10.1016/j.jclepro.2005.08.012).
- Burritt, R.L. and Schaltegger, S. (2010), "Sustainability accounting and reporting: fad or trend?", *Accounting, Auditing and Accountability Journal*, Vol. 23 No. 7, pp. 829-846, doi: [10.1108/09513571011080144](https://doi.org/10.1108/09513571011080144).
- Burritt, R.L., Hahn, T. and Schaltegger, S. (2002), "Towards a comprehensive framework for environmental management accounting: links between business actors and environmental management accounting tools", *Australian Accounting Review*, Vol. 12 No. 27, pp. 39-50, doi: [10.1111/j.1835-2561.2002.tb00202.x](https://doi.org/10.1111/j.1835-2561.2002.tb00202.x).
- Christ, K.L. and Burritt, R.L. (2013), "Environmental management accounting: the significance of contingent variables for adoption", *Journal of Cleaner Production*, Vol. 41, pp. 163-173.
- Creemers, S., Van Passel, S., Vigani, M. and Vlahos, G. (2019), "Relationship between farmers' perception of sustainability and future farming strategies: a commodity-level comparison", *AIMS Agriculture and Food*, Vol. 4 No. 3, pp. 613-642, doi: [10.3934/agrfood.2019.3.613](https://doi.org/10.3934/agrfood.2019.3.613).
- Da Motta, R.S. and Ortiz, R.A. (2018), "Costs and perceptions conditioning willingness to accept payments for ecosystem services in a Brazilian case", *Ecological Economics*, Vol. 147, pp. 333-342, doi: [10.1016/j.ecolecon.2018.01.032](https://doi.org/10.1016/j.ecolecon.2018.01.032).

- Dairy Companies Association of New Zealand (2021), "About the NZ dairy industry", available at: [www.dcanz.com/about-the-nz-dairy-industry/](http://www.dcanz.com/about-the-nz-dairy-industry/)
- Deegan, C.M. (2003), *Environmental Management Accounting: An Introduction and Case Studies for Australia*, Institute of Chartered Accountants in Australia, Perth.
- Dillard, J., Brown, D. and Marshall, R.S. (2005), "An environmentally enlightened accounting", *Accounting Forum*, Vol. 29 No. 1, pp. 77-101, doi: [10.1016/j.accfor.2004.12.001](https://doi.org/10.1016/j.accfor.2004.12.001).
- Dynes, R.A., Burggraaf, V.T., Goulter, C.G. and Dalley, D.E. (2010), "Canterbury farming: production, processing and farming systems", *Proceedings of the New Zealand Grassland Association*, Vol. 72, pp. 1-8, available at: [www.grassland.org.nz/publications/nzgrassland\\_publication\\_5.pdf](http://www.grassland.org.nz/publications/nzgrassland_publication_5.pdf)
- Ferreira, A., Moulang, C. and Hendro, B. (2010), "Environmental management accounting and innovation: an exploratory analysis", *Accounting, Auditing and Accountability Journal*, Vol. 23 No. 7, pp. 920-948, doi: [10.1108/09513571011080180](https://doi.org/10.1108/09513571011080180).
- Flemmer, C.L. and Flemmer, R.C. (2007), "Water use by New Zealand dairy farms, 1997-2000", *New Zealand Journal of Agricultural Research*, Vol. 50 No. 4, pp. 479-489, doi: [10.1080/00288230709510316](https://doi.org/10.1080/00288230709510316).
- Frost, G.R. and Wilmshurst, T.D. (2000), "The adoption of environment-related management accounting: an analysis of corporate environmental sensitivity", *Accounting Forum*, Vol. 24 No. 4, pp. 344-365, doi: [10.1111/1467-6303.00045](https://doi.org/10.1111/1467-6303.00045).
- Gibassier, D. and Alcouffe, S. (2018), "Environmental management accounting: the missing link to sustainability?", *Social and Environmental Accountability Journal*, Vol. 38 No. 1, pp. 1-18, doi: [10.1080/0969160x.2018.1437057](https://doi.org/10.1080/0969160x.2018.1437057).
- Granwal, L. (2021), "Dairy cow share in New Zealand 2020, by breed", *Statista*, available at: [www.statista.com/statistics/1102335/new-zealand-dairy-cow-share-by-breed/](https://www.statista.com/statistics/1102335/new-zealand-dairy-cow-share-by-breed/)
- Hussain, M. and Gunasekaran, A. (2002), "Non-financial management accounting measures in Finnish financial institutions", *European Business Review*, Vol. 14 No. 3, pp. 210-229, doi: [10.1108/09555340210427094](https://doi.org/10.1108/09555340210427094).
- Jamil, C.Z.M., Mohamed, R., Muhammad, F. and Ali, A. (2015), "Environmental management accounting practices in small medium manufacturing firms", *Procedia - Social and Behavioral Sciences*, Vol. 172, pp. 619-626, doi: [10.1016/j.sbspro.2015.01.411](https://doi.org/10.1016/j.sbspro.2015.01.411).
- Jay, M. and Morad, M. (2007), "Crying over spilt milk: a critical assessment of the ecological modernization of New Zealand's dairy industry", *Society and Natural Resources*, Vol. 20 No. 5, pp. 469-478, doi: [10.1080/08941920701211991](https://doi.org/10.1080/08941920701211991).
- Kamruzzaman, M. (2012), "Framework of environmental management accounting: an overview", *SSRN Electronic Journal*, p. 2179031, doi: [10.2139/ssrn.2179031](https://doi.org/10.2139/ssrn.2179031).
- Karimi, Z., Dastgir, M. and Saleh, M.A. (2017), "Analysis of factors affecting the adoption and use of environmental management accounting to provide a conceptual model", *International Journal of Economics and Financial Issues*, Vol. 7 No. 3, pp. 555-560, available at: [www.econjournals.com/index.php/ijefi/article/view/4862](http://www.econjournals.com/index.php/ijefi/article/view/4862)
- Kazemian, S., Djajadikerta, H.G., Trireksani, T., Sohag, K., Sanusi, Z.M. and Said, J. (2022), "Carbon management accounting (CMA) practices in Australia's high carbon-emission industries", *Sustainability Accounting, Management and Policy Journal*, Vol. 13 No. 5, pp. 1132-1168, doi: [10.1108/SAMPJ-05-2021-0174](https://doi.org/10.1108/SAMPJ-05-2021-0174).
- Kielbasa, B., Pietrzak, S., Ulén, B., Drangert, J. and Tonderski, K. (2018), "Sustainable agriculture: the study on farmers' perception and practices regarding nutrient management and limiting losses", *Journal of Water and Land Development*, Vol. 36 No. 1, pp. 67-75, doi: [10.2478/jwld-2018-0007](https://doi.org/10.2478/jwld-2018-0007).
- Latif, B., Mahmood, Z., Mohd Said, R. and Bakhsh, A. (2020), "Coercive, normative and mimetic pressure as drivers of environmental management accounting adoption", *Sustainability*, Vol. 12 No. 11, p. 4506, doi: [10.3390/su12114506](https://doi.org/10.3390/su12114506).
- Lee, K.H. and Gunaratne, N. (2019), "An exploration of the implementation and usefulness of environmental management accounting: a comparative study between Australia and Sri Lanka",



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- available at: [www.cimaglobal.com/Documents/Thought\\_leadership\\_docs/Academic-research/an-exploration-of-the-implementation-and-usefulness-of-environmental-management-accounting.pdf](http://www.cimaglobal.com/Documents/Thought_leadership_docs/Academic-research/an-exploration-of-the-implementation-and-usefulness-of-environmental-management-accounting.pdf)
- Li, X. (2004), "Theory and practice of environmental management accounting", *International Journal of Technology Management and Sustainable Development*, Vol. 3 No. 1, pp. 47-57, doi: [10.1386/ijtm.3.1.47/0](https://doi.org/10.1386/ijtm.3.1.47/0).
- Marco-Fondevila, M., Moneva, J.M. and Llena-Macarulla, F. (2020), "Accounting for carbon footprint flows in wine production process: case study in Spanish winery", *Applied Sciences*, Vol. 10 No. 23, doi: [10.3390/app10238381](https://doi.org/10.3390/app10238381).
- Mathiyazhagan, K., Govindan, K. and Noorul Haq, A. (2014), "Pressure analysis for green supply chain management implementation in Indian industries using analytic hierarchy process", *International Journal of Production Research*, Vol. 52 No. 1, pp. 188-202, doi: [10.1080/00207543.2013.831190](https://doi.org/10.1080/00207543.2013.831190).
- Menon, R.R. and Ravi, V. (2021), "An analysis of barriers affecting implementation of sustainable supply chain management in electronics industry: a Grey-DEMATEL approach", *Journal of Modelling in Management*, Vol. 17 No. 4, pp. 1319-1350, doi: [10.1108/JM2-02-2021-0042](https://doi.org/10.1108/JM2-02-2021-0042).
- Ministry for the Environment and Stats NZ (2019), "New Zealand's environmental reporting series: environment Aotearoa 2019", available at: <https://environment.govt.nz/assets/Publications/Files/environment-aotearoa-2019.pdf>
- Ministry of Primary Industries (2019), "Climate issues facing farmers: sustainable land management and climate change research programme", available at: [www.mpi.govt.nz/dmsdocument/33747-Climat-Issues-Facing-Farmers-Sustainable-Land-Management-and-Climate-Change-Research-Programme](http://www.mpi.govt.nz/dmsdocument/33747-Climat-Issues-Facing-Farmers-Sustainable-Land-Management-and-Climate-Change-Research-Programme)
- Monaghan, R.M., Hedley, M.J., Di, H.J., McDowell, R.W., Cameron, K.C. and Ledgard, S.F. (2007), "Nutrient management in New Zealand pastures: recent developments and future issues", *New Zealand Journal of Agricultural Research*, Vol. 50 No. 2, pp. 181-201, doi: [10.1080/00288230709510290](https://doi.org/10.1080/00288230709510290).
- Orduño Torres, M.A., Kallas, Z. and Ornelas Herrera, S.I. (2020), "Farmers' environmental perceptions and preferences regarding climate change adaptation and mitigation actions; towards a sustainable agricultural system in México", *Land Use Policy*, Vol. 99, p. 105031, doi: [10.1016/j.landusepol.2020.105031](https://doi.org/10.1016/j.landusepol.2020.105031).
- Pangborn, M.C. and Woodford, K.B. (2011), "Canterbury dairying: a study in land use change and increasing production", Proceedings of the 18th International Farm Management Congress, *Methuen, NZ*, pp. 81-87, available at: <https://researcharchive.lincoln.ac.nz/handle/10182/3850>
- Pangborn, M.C., Woodford, K.B. and Nuthall, P.L. (2016), "Development of a dairy industry in a new area: land use change in Canterbury, New Zealand", *International Journal of Agricultural Management*, Vol. 5 Nos 1/2, pp. 20-24, doi: [10.5836/ijam/2016-05-20](https://doi.org/10.5836/ijam/2016-05-20).
- Parliamentary Commissioner for the Environment (2013), "Water quality in New Zealand: land use and nutrient pollution", available at: [www.pce.parliament.nz/media/1275/pce-water-quality-land-use-web-amended.pdf](http://www.pce.parliament.nz/media/1275/pce-water-quality-land-use-web-amended.pdf)
- Puntsagdorj, B., Orossoo, D., Huo, X. and Xia, X. (2021), "Farmer's perception, agricultural subsidies, and adoption of sustainable agricultural practices: a case from Mongolia", *Sustainability*, Vol. 13 No. 3, p. 1524, doi: [10.3390/su13031524](https://doi.org/10.3390/su13031524).
- Qian, W., Hörisch, J. and Schaltegger, S. (2018), "Environmental management accounting and its effects on carbon management and disclosure quality", *Journal of Cleaner Production*, Vol. 174, pp. 1608-1619, doi: [10.1016/j.jclepro.2017.11.092](https://doi.org/10.1016/j.jclepro.2017.11.092).
- Schaltegger, S. and Burritt, R.L. (2000), "Contemporary environmental accounting issues, concepts and practice", *International Journal of Sustainability in Higher Education*, Vol. 2 No. 3, pp. 288-289, doi: [10.1108/ijshe.2001.2.3.288.1](https://doi.org/10.1108/ijshe.2001.2.3.288.1).
- Schaltegger, S. and Burritt, R.L. (2010), "Sustainability accounting for companies: catchphrase or decision support for business leaders?", *Journal of World Business*, Vol. 45 No. 4, pp. 375-384, doi: [10.1016/j.jwb.2009.08.002](https://doi.org/10.1016/j.jwb.2009.08.002).

- Setthasakko, W. (2010), "Barriers to the development of environmental management accounting: an exploratory study of pulp and paper companies in Thailand", *EuroMed Journal of Business*, Vol. 5 No. 3, pp. 315-331, doi: [10.1108/14502191011080836](https://doi.org/10.1108/14502191011080836).
- Solovida, G.T. and Latan, H. (2017), "Linking environmental strategy to environmental performance", *Sustainability Accounting, Management and Policy Journal*, Vol. 8 No. 5, pp. 595-619, doi: [10.1108/sampj-08-2016-0046](https://doi.org/10.1108/sampj-08-2016-0046).
- Stringleman, H. and Peden, R. (2008), "Sheep farming", *Te Ara: The Encyclopedia of New Zealand*, available at: [www.TeAra.govt.nz/en/sheep-farming/print](http://www.TeAra.govt.nz/en/sheep-farming/print)
- Tarighaleslami, A.H., Kambadur, S., Neale, J.R., Atkins, M.J. and Walmsley, M.R.W. (2019), "Sustainable energy transition toward renewable energies in the New Zealand dairy industry: an environmental life cycle assessment", *Chemical Engineering Transactions*, Vol. 76, pp. 97-102, doi: [10.3303/CET1976017](https://doi.org/10.3303/CET1976017).
- Tashakor, S., Appuhami, R. and Munir, R. (2019), "Environmental management accounting practices in Australian cotton farming: the use of the theory of planned behaviour", *Accounting, Auditing and Accountability Journal*, Vol. 32 No. 4, pp. 1175-1202, doi: [10.1108/AAAJ-04-2018-3465](https://doi.org/10.1108/AAAJ-04-2018-3465).
- Tatlıdil, F.F., Boz, İ. and Tatlıdil, H. (2009), "Farmers' perception of sustainable agriculture and its determinants: a case study in Kahramanmaraş province of Turkey", *Environment, Development and Sustainability*, Vol. 11 No. 6, pp. 1091-1106, doi: [10.1007/s10668-008-9168-x](https://doi.org/10.1007/s10668-008-9168-x).
- TBD Advisory Ltd (2020), "The dairy sector in New Zealand: extending the boundaries", *New Zealand Productivity Commission*, available at: [www.productivity.govt.nz/research/the-dairy-sector-in-new-zealand/](http://www.productivity.govt.nz/research/the-dairy-sector-in-new-zealand/)
- Walker, H., Di Sisto, L. and McBain, D. (2008), "Drivers and barriers to environmental supply chain management practices: lessons from the public and private sectors", *Journal of Purchasing and Supply Management*, Vol. 14 No. 1, pp. 69-85, doi: [10.1016/j.pursup.2008.01.007](https://doi.org/10.1016/j.pursup.2008.01.007).
- Wang, S., Wang, H. and Wang, J. (2019), "Exploring the effects of institutional pressures on the implementation of environmental management accounting: do top management support and perceived benefit work?", *Business Strategy and the Environment*, Vol. 28 No. 1, pp. 233-243, doi: [10.1002/bse.2252](https://doi.org/10.1002/bse.2252).

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