



Why do New Zealanders Care about Agricultural Emissions?

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Abstract

The question of how to effectively address agricultural greenhouse gas emissions is of critical importance for New Zealand and the world. Ensuring that our responses are effective requires us to first consider what we aim to achieve: why do we care about agricultural emissions? This paper responds to this fundamental query, and argues that New Zealanders' diverse individual motivations can be grouped under three headings: one, concern about the direct impacts of climate change on New Zealand and the world; two, pressure from others based on their concern about climate change; and three, environmental or social goals that are complementary to reducing emissions. This framework is useful in setting out how our underlying motivations should shape our responses, and highlights the importance of choosing responses that will be robust to future uncertainties.

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1. Introduction

In 2007, agricultural emissions accounted for more than 48% of New Zealand's total greenhouse gas emissions (Ministry for the Environment, 2009) and 13.5% of global greenhouse gas emissions (IPCC, 2007c).¹ The question of what response will effectively address these emissions is therefore of critical importance to New Zealand and the world. However, ensuring that our response is effective requires us to first ask a different question: why do individuals, communities, companies, and government in New Zealand care about agricultural emissions? This paper responds to this fundamental query.

Different New Zealanders will be motivated to address agricultural emissions for different reasons and to differing degrees; indeed, some will not be interested in addressing agricultural emissions at all. This paper does not attempt to present a consensus view of why New Zealanders should address agricultural emissions, or aim to present any specific group's or individual's motivations. Instead this paper aims to set out all of the possible motivations to act that different New Zealanders might hold, and how these different motivations may affect the sort of responses that we should make.

New Zealanders may want to control agricultural emissions for three main reasons. We may be concerned about the impacts of climate change on New Zealand and the world. A second possible motivation may be that we are interested in controlling greenhouse gas emissions due to international pressure and a desire to take up opportunities offered by climate-conscious consumers. This international pressure could be felt from two distinct sources: as diplomatic pressure from countries and international organisations, or alternatively in the form of commercial pressures and opportunities for domestic producers. A third motivation may be that we are interested in complementary goals that can be achieved by targeting agricultural greenhouse gas emissions, such as improving water quality or improving farm efficiency. This paper elaborates on the nature of these non-mutually-exclusive motivations and presents relevant evidence on each issue from current research.

Even if New Zealanders are motivated to address agricultural emissions, a number of considerations will limit the intensity with which we will want to respond. We discuss a number of these considerations including expense, New Zealanders' possible impact on climate change, and the issues of emissions leakage and food security. We also discuss the issue of timing, and whether we are motivated to act now to address current concerns, to delay our response, or to act now in anticipation of future pressures.

The motivations New Zealanders have for addressing agricultural emissions should determine the way that the emissions are addressed; that is, the why should determine the how. This paper considers how visible and verifiable our response to agricultural emissions will need to be, what sort of technological development will be desirable, and the degree to which we will need to co-operate and communicate internationally to best address each of New Zealanders' possible motivations for addressing agricultural emissions.

A final issue that this paper addresses is how to ensure that our response is robust to the many different possible futures. While we can control and influence some factors around agricultural emissions, there are also a number of factors over which we have little or no control. These will have a large effect on the actual outcome of any agricultural emissions response we make. These uncontrollable factors include climate issues and international responses. We need to ensure that whatever responses we choose to make are robust to these many uncertainties.

¹ In 2009, agriculture was the source of 46.5% of New Zealand's emissions (Ministry for the Environment, 2011).

1.1. Current responses

New Zealanders have already begun to formulate and implement responses to agricultural emissions. One key New Zealand government response has been to begin the process of including agriculture in New Zealand's Emissions Trading Scheme (ETS). Agriculture is slated to be fully included in the ETS from 2015. Under this scheme agricultural processors will be liable to cover all emissions associated with the production of the meat or milk that they process. Farmers (along with other "trade-exposed" participants) will receive free allocation based on their output at a rate equal to 90% of baseline emissions.² New Zealand is also heavily involved in national and international research efforts investigating methods to mitigate agricultural emissions, such as through the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC)³ and as key participants in the Global Research Alliance on Agricultural Greenhouse Gases.⁴

Many industry and non-governmental groups have also begun to privately address agricultural emissions. Fonterra has invested (along with the government and other industry participants such as Beef + Lamb New Zealand) in the Pastoral Greenhouse Gas Research Consortium (PGgRC) to investigate methods that will reduce emissions per unit of product.⁵ Non-governmental groups such as Greenpeace and Forest and Bird,⁶ among many others, have worked to raise public awareness about the risks of agricultural emissions and climate change, and groups such as the New Zealand Landcare Trust and the Carbon Farming Group⁷ are providing practical information to farmers to reduce the carbon footprint of their production. Moreover, many individual farmers are acting to decrease the carbon footprint of their operations.⁸

2. Motivations for Addressing Agricultural Emissions

2.1. Motivation one: climate change is likely to cause serious damage and reducing agricultural emissions will help to reduce the risk.

Climate change could affect New Zealanders either directly (through physical changes brought about by global temperature rises) or indirectly (through flow-on effects from physical changes in other countries that are then transmitted to New Zealanders, for example through trade). We might also be concerned about the negative impacts that climate change will have on others in the world. This motivation is predicated on the accepted likelihood that, globally, climate change will cause damage and that reducing agricultural emissions will help reduce this damage. Key references for the science of climate change and its likely global effects are the latest Intergovernmental Panel on Climate Change (IPCC) reports on the physical science of climate change (IPCC, 2007a) and its likely impacts (IPCC, 2007b).

² This free allocation will phase out at -1.3% per annum from 2016. Baseline emissions are set equal to the industry average emissions per unit of output for a given year or years (which year (or years) has not yet been decided). See www.climatechange.govt.nz/emissions-trading-scheme for more information on New Zealand's ETS.

³ The NZAGRC has been established by the New Zealand government to investigate agricultural greenhouse gas mitigation. More information on its work can be found online at www.nzagrc.org.nz.

⁴ More information on the global research alliance can be found online at www.globalresearchalliance.org.

⁵ More information on Fonterra's responses to climate change can be found online at www.fonterra.com.

⁶ Greenpeace New Zealand's climate change work can be found online at www.greenpeace.org/new-zealand/en/campaigns/climate-change; Forest and Bird's can be found at www.forestandbird.org.nz/saving-our-environment/climate-change.

⁷ More information about Landcare Trust's work can be found online at www.landcare.org.nz. Information on the Carbon Farming Group can be found at www.carbonfarming.org.nz.

⁸ Farms with outstanding approaches to environmental sustainability are recognised at the Ballance Farm Environment Awards. Previous winners can be found online at www.ballance.co.nz/community/ballance+farm+environment+awards.

Direct impacts on New Zealanders

A recent summary of science assessing the likely direct physical impacts of climate change on New Zealand is given in a report prepared for the Ministry for the Environment (Ministry for the Environment, 2008). The authors find that the physical effects on New Zealand over the next half century are expected to be mild, particularly when compared with other countries. Average temperatures across New Zealand are expected to increase by approximately 1°C by 2040 and 2°C by 2090 (relative to average temperatures in 1990). Rainfall is expected to decrease in the north and east of the country and increase in the south, although there is large variability across specific locations and seasons in these estimates. Extreme events (droughts and floods) will become more common and more serious. McMillan et al. (2010) explore the climate change impacts on two regional New Zealand flood catchments and find that, under reasonable future climate scenarios, serious floods are likely to become more serious; for example, “30-year floods” will be 1.2–2 times as large as current discharges. On the positive side, New Zealand would face significantly fewer days with frosts, and improved pastoral productivity over much of the country (Renwick, 2011). These are all predicted impacts, but actual impacts are highly uncertain and could be much larger or smaller than these.

Indirect international impacts on New Zealanders

New Zealanders could also be affected by global climate change through international effects that are transmitted to New Zealand through trade. These indirect effects would result from physical climate change effects on other countries, their responses to these effects, and the flow-on effects on the goods and services that New Zealand imports and exports. A recent paper by Stroombergen (2010) looks at one possible path: international agricultural prices. He finds that, in 2070, New Zealanders are likely to benefit economically from these indirect impacts on agriculture⁹. Reduced international agricultural production and higher prices for New Zealand exports are likely to occur under most reasonable climate scenarios, which would in turn lead to increases in New Zealand real gross national domestic income. These benefits could be somewhat muted if agriculture production worldwide increases due to increased carbon fertilisation. Stroombergen (2010) also finds that these indirect effects are likely to significantly outweigh any direct economic impacts on New Zealand agriculture.

Climate change may also lead to economic and political instability, and is likely to affect migration flows. These could all have large indirect effects for New Zealanders, though the size of these impacts is impossible to assess accurately. Burson (2010) is a collection of papers discussing the implications of climate change for Pacific migration.

International impacts

Current research shows that the negative effects of global climate change outside New Zealand are likely to be widespread and serious (IPCC, 2007b); we may be motivated by altruism and a sense of justice to minimise these effects.

2.2. Motivation two: pressure from others based on their concern about climate change

Another possible motivation for addressing agricultural greenhouse gas emissions is that we face pressure from others outside of New Zealand who are concerned about climate change. This international

⁹ Stroombergen (2010) predicts a 2.4% increase in New Zealand’s RGDNI (real gross national domestic income) by 2070, relative to 2005 levels. This result assumes no change in extreme events such as floods, droughts, or extreme human responses (such as financial crises or war).

pressure could come from two distinct sources. We might be motivated to act due to pressure from national governments or international organisations such as the UN. Additionally or alternatively, we might be motivated to act because of pressure or opportunities that we face as a result of climate-concerned international consumers or markets. We will want to address agricultural emissions differently depending on which of these sources of international pressure motivate us. The timing of our response will also depend on what motivates us.

2.2.1. Pressure from other national governments or international organisations

New Zealanders are likely to face the cost of agricultural emissions whether or not we have a domestic policy that accounts for them. New Zealand is a signatory to the Kyoto Protocol and has committed to taking responsibility for any emissions above 1990 levels over the period 2008–12; that is, to either have net emissions that are on average no higher than our gross emissions in 1990, or buy carbon allowances on the international market to make up the difference. While future Kyoto commitment periods are not yet certain, it is highly likely that there will continue to be an international carbon price and carbon market of some form going forward (Emissions Trading Scheme Review Panel, 2011). Regardless of the state of these international agreements, the New Zealand government has made commitments to take responsibility for New Zealand's emissions going forward. These commitments include a obligation to take responsibility for a 10–20% cut in emissions relative to 1990 emissions by 2020,¹⁰ and a long-term undertaking to be responsible for a 50% emissions cut below 1990 emissions by 2050 (Smith, 2011). New Zealand will face international pressure to meet these commitments regardless of whether a formal global agreement is reached.

If New Zealand continues to take on international obligations to reduce our emissions, addressing agricultural emissions may be an efficient way to achieve our targets. Agricultural emissions make up almost half of New Zealand's gross emissions. Under our current commitments, and at a conservative carbon price of NZ\$25, by 2020 New Zealand agricultural emissions will have an annual opportunity cost of \$1 billion.¹¹ If New Zealanders could halve emissions from agriculture we would benefit annually by \$500 million. This benefit could come as a result of decreased costs of buying international allowances to cover our emissions, or of increased incomes from the sale of surplus allowances to international emitters.

Alongside these formal external pressures to “pull our weight”, New Zealanders may be motivated to address agricultural emissions because we desire to be seen in a good light by the rest of the world. New Zealanders generally like New Zealand to be seen as a responsible and principled country that overachieves on the world stage: addressing agricultural emissions and committing to bear some cost to avoid climate change may be motivated by this desire. A favourable international image also has benefits at the macro level; New Zealand is likely to enjoy increased tourism and economic opportunities as a result.¹² As a small country New Zealand is heavily dependent on good will from other nations, for trade, investment, security, cooperation on bio-security, and many other issues, so we have a strong incentive to model cooperative international behaviour. This positive global image will also be important to ensure that New Zealand maintains some credibility around climate issues. This credibility around climate issues

¹⁰ This commitment came as part of New Zealand's association with the Copenhagen accord. This commitment is conditional on a number of issues, such as commensurate efforts by other countries; an acceptable global agreement; effective rules governing land use, land use change and forestry (LULUCF); and access to an international carbon market (Smith and Groser, 2010).

¹¹ Projections for 2020 agricultural emissions come from the Ministry for the Environment (2009). They project that agricultural emissions in 2020 will be equal to 39,072,000t of CO₂ equivalent, an 8% increase on 2010 agricultural emissions.

¹² The value of New Zealand's clean green image is discussed by the Ministry for the Environment (2001).

may be crucial in allowing New Zealand to have real input into future international agreements and decisions, for example, around current international carbon accounting rule negotiations.

2.2.2. Pressure from international consumers and markets

We also face pressure from international markets and consumers. This pressure, and the future opportunities and risks that climate-concerned consumers pose, may motivate us to address agricultural emissions.

This pressure could be felt in a few different ways as is discussed in Saunders (2011). There is a risk that if we do not adequately address agricultural emissions we may be closed out of international markets or lose our position as a favoured supplier to large buyers. Consumer demand for New Zealand products may also fall if we are seen as emissions-intensive producers. This is a risk whether or not we truly are high emissions producers; poorly- or misinformed international consumers' perceptions are more important than reality. The "food miles" debate demonstrated that even when New Zealand's produce is relatively emissions efficient, if this is not made abundantly clear to consumers then our producers will not benefit, and may suffer (Saunders and Barber, 2008). Proactive and effective communication of the environmental sustainability of New Zealand products internationally will be of increasing importance.

Climate-conscious consumers also offer opportunities. If New Zealand producers can meet the concerns of these consumers they may be able to access higher value markets. Saunders (2011) discusses the potential price premiums New Zealand producers could receive if our agricultural output is perceived as climate friendly or less emissions intensive by international buyers. These opportunities may be another motivation for New Zealanders to address agricultural emissions.

Economy-wide approach

We might also be motivated to mitigate agricultural emissions because we want to reduce emissions of greenhouse gases generally, and omitting agriculture would create inconsistencies and distortions. This desire to avoid inconsistencies might be based on equity grounds; if the New Zealand government regulates to internalise the cost of other industries' emissions (as is New Zealand's current approach through the Emissions Trading Scheme) then it seems reasonable that agriculture emissions too should bear the cost of their emissions.

This desire to avoid inconsistencies might also be based on an aversion to distorting incentives. If agricultural producers do not face the external costs of their emissions (but other industries do), the incentives to shift resources away from emissions-intensive industries will be distorted. Agricultural production will in effect be subsidised, and agriculture will artificially become more attractive than alternative industries within New Zealand.¹³

Ensuring that there are incentives for a movement to less emissions-intensive output, in agriculture and in other industries, will be essential if New Zealanders are to be able to take advantage of the many commercial opportunities presented by climate-conscious consumers worldwide.

¹³ Because agricultural emissions in other countries are currently unregulated, the appropriate incentives to invest in low-emissions agricultural production are distorted internationally, and the pricing of emissions in New Zealand may lead to leakage. The issue of leakage is discussed below in section 3.12.

2.3. Interest in complementary goals

A final possible motivation for addressing agricultural greenhouse gas emissions may be that the same actions that address agricultural emissions will also positively affect complementary goals. Along with the sometimes-competing concerns for environmental and economic outcomes (which drive the first and second motivations), New Zealand and New Zealanders may be concerned about other issues that will be affected by any decision to address agricultural emissions.

Complementary goals could include complementary environmental outcomes, such as improved water quality, increased biodiversity, or decreased soil erosion. These complementary goals could also include rurally focused aims such as long-term rural sustainability, resilience of rural communities, or increased farm profitability (through improved on-farm efficiency). It is unlikely that we would choose to address agricultural emissions solely to achieve a complementary goal, but recognising that some New Zealanders are motivated by complementary goals could alter the way that we choose to respond to agricultural emissions, and increase the constituency of New Zealanders who will support actions that address agricultural emissions.

Actions we make to address agricultural emissions that also positively affect these complementary goals should be enhanced to take into account their additional benefits. Likewise, any actions that are aimed at affecting some other issue, but also have positive agricultural emissions impacts, should be enhanced.

2.4. Relationships among the different motivations

These different motivations are related to and interlinked with each other. The relationship between motivations one (a desire to avoid climate change) and two (international and commercial pressure to reduce emissions) are of particular interest. They are especially closely related, and this relationship is liable to change as (or if) international agreements to limit greenhouse gas emissions become more stringent. These agreements could be formal and multilateral, or a loosely coordinated set of smaller agreements. The interplay between motivations one and two depending on international agreements, and how this relationship should influence our response, are explored below.

International agreements on climate change are an attempt to assign the external cost of greenhouse gases produced to the country that produced them. Governments of countries can then decide whether and how to pass the costs of emissions on to their own citizens and businesses. These global agreements are not currently stringent enough to limit greenhouse gas production to a globally optimal level. As a response, some consumers and markets are willing to pay a premium or offer preferred access to producers whose products are less emissions-intensive. These consumers and markets are implicitly pricing the emissions mitigation carried out by these producers that is not currently internalised by current global emissions agreements.

In the short run, acting optimally to influence long-run climate mitigation, acting to meet short-term international obligations, and acting to take advantage of commercial opportunities lead to somewhat different actions. For example, any actions that decrease emissions are useful to mitigate climate change. In contrast, appealing to climate-conscious consumers requires mitigation that is visible and marketable; effort needs to be expended on marketing and not just on the mitigation.

If, in the long run, international climate agreements become more stringent and approach an optimal level of emissions reductions, these motivations will overlap more and more. Countries will have to face the cost of emissions they produce. As a result, consumers and markets will be less willing to pay a premium for low emissions production: this previously external cost will instead be internalised to the country of origin by the more stringent international agreements. The motivations to reduce emissions to meet our

international commitments and avert global warming will align and increase, and the motivation to reduce emissions due to consumer pressure will decrease, and in the long run may be wholly captured by the international agreements. Consequently, when we make long-run investments or decisions with long-run implications, we should make them in accordance with the need to avoid global climate change and to meet our international emissions commitments (motivations one and two), and not to meet international consumer pressure.

The relationship between motivations one and two is representative of the underlying, potentially conflicting, goals that are inherent in any decision to address agricultural emissions: maximising environmental outcomes and maximising economic outcomes. In the short run these two goals are often substitutes, and maximising one goal comes at the expense of the other. For example, minimising the greenhouse gas production of New Zealand's farms will require costly mitigation; maximising environmental outcomes comes at the expense of economic outcomes. However, as described above, in the long run, New Zealand's economic and environmental outcomes are inextricably intertwined. While the short term may invite a different response for each goal, in the long run the ideal response to each is far more similar. New Zealand's future economic outcomes depend heavily on the future environment; significant global warming will restrict future economic outcomes, and, as discussed above, in the long run the emissions content of production is likely to be internalised and faced, if not by the producer, at least by the country of origin. Consequently, maximising long-run environmental outcomes is crucial for both the environment and the economy.

3. Factors influencing the intensity of response

The intensity with which we should address agricultural emissions will depend heavily on the number of motivations to act that we hold, and how strong each is. It will also depend on a number of other factors, including how effective we expect our response will be at addressing our motivations, the opportunity cost of acting, and the potential of counterproductive outcomes such as emissions leakage or decreased food security. The timing of our response is also of importance: when should we begin to act? This is discussed, with reference to the three motivations, below.

3.1. New Zealanders' possible impact on climate change

Any greenhouse gas emission reductions that we do in New Zealand will have a very small direct effect on global emissions because of New Zealand's scale. This is of course true of any small country or region's actions. Our reduction efforts could still be important for controlling global emissions for two reasons: technology and policy transfer, and building global cooperation.

3.1.1. Technology and policy learning and transfer

If New Zealand can learn how to effectively and efficiently design policy to control agricultural emissions without excessive social cost, and we are able to effectively communicate this to other countries, we will be able to reduce the cost of emissions reductions in other countries. This could lower other countries' emissions by reducing their resistance to policies that control agricultural emissions, ensuring that they pick up policies that we have shown to be effective. While this could potentially be achieved through research alone, demonstration of technologies and policies that observably reduce emissions without unacceptable costs or other consequences is likely to be much more compelling. We are also likely to learn by doing in ways that we cannot replicate through research alone, meaning the solutions we offer will be stronger.

3.1.2. Building global cooperation

Achieving global cooperation on an issue that affects all sectors and individuals, involves considerable uncertainty, and is likely to be costly, presents a particularly recalcitrant problem. The core challenge is that every individual, sector, and country has an incentive to “free ride”, as no one has a large individual impact on the problem and people face significant direct costs of action for an infinitesimal decrease in their own risk of facing climate change costs. Even those who are willing to contribute to the common good often fear being made a “sucker” if they contribute and others do not. Rational, purely self-interested humans would achieve very little or no cooperation.

Fortunately, there is evidence that humans do quite often manage to cooperate even where it seems inevitable that they will not. Elinor Ostrom won the 2009 Nobel Prize for Economics for empirical work demonstrating this (Ostrom, 1990). Her work and that of many others, applying the tools of repeated game theory, help us to identify the conditions that facilitate cooperation. Reducing the cost of contributing is one key approach. Creating a reputation for cooperation, which encourages others to also cooperate in anticipation that they are part of a wider effort, is also very valuable. New Zealand has disproportionate visibility in the climate space. Our efforts will likewise have disproportionate impact on others’ willingness to act.

3.2. Risks from action

The cost of reducing emissions will limit the extent to which New Zealanders will want to respond to these motivations. One factor will be the expense of decreasing emissions: the cost of contributing may be perceived as high relative to the gains that would result. The opportunity cost may also limit action: New Zealanders may want to spend their money addressing other issues. Some may believe New Zealand is still too small to matter – that our impact on technology change and trust building are not justified by the cost to us. Others may believe that our best response is to focus only on adaptation rather than emissions control.

Along with these reasons to limit our response, there are two interrelated reasons why acting may be counterproductive: emissions leakage and food security. These may result in New Zealanders choosing not to act on agricultural emissions, even if we are concerned about climate change.

3.2.1. Emissions leakage

One possible concern is that any New Zealand efforts to reduce emissions will be ineffective because of “emissions leakage”. When agricultural emissions are reduced, the resulting increase in production costs may mean that some exported products are no longer competitive, or that products imported from countries with less stringent climate policies are substituted for domestic products. This may cause certain production activities to relocate to countries without any climate policies. This leakage could potentially lead to job losses in New Zealand but no change in global GHG emissions. This problem will be greater still if the international production is more emissions-intensive than the New Zealand production it is replacing. Kerr and Zhang (2009), however, summarise existing empirical evidence on the responsiveness of livestock production in New Zealand to changes in profit and find that, although there would be significant hardship for farmers, there is unlikely to be significant leakage at carbon prices of around \$25 per tonne CO₂. While some land is likely to transition into forestry, it will tend to be low productivity land (Todd et al., 2009). Woods (forthcoming) is unable to find evidence that New Zealand influences international commodity prices. This means that New Zealand is unable to pass on carbon costs, but also that international production is unlikely to increase significantly in response to price rises driven by a

reduction in New Zealand production. It could still increase if human or financial capital that is specific to the livestock industry leaves New Zealand.

Even if emissions leakage is a significant potential result of controlling agricultural emissions in New Zealand, the risk of its occurrence and the magnitude of its impact can be minimised. Greenhalgh et al. (2007) provide a simple discussion of the issue and discuss policies that can minimise the risk of emissions leakage, such as border tax adjustment, or output-based free allocation of allowances to trade-exposed producers (such as farmers) in New Zealand's ETS.¹⁴

3.2.2. Food security

Another possible concern may be that decreasing agricultural emissions will reduce food security and may mean that more people go hungry. If the only response to agricultural emissions policy is a reduction in food production (e.g. stock numbers are decreased to reduce emissions) and this food is not replaced elsewhere (either as dairy/meat or something else of equal nutritional value) either in New Zealand or in another country, and richer people who have more than adequate food are not the only ones affected, then people could go hungry as a result of decreased agricultural emissions.

However, any decreases in food production as described above could be replaced in three basic ways. The first is through rises in the prices of food that New Zealand has previously provided (e.g. dairy, lamb or beef) which then induce an increase in production elsewhere. Second, investment capital that would have been deployed for food production in New Zealand may move to a food sector in another country. Third, if land that was used for food production is converted to forestry in New Zealand, the resulting increase in timber supply could lower global timber prices and hence reduce demand for land for plantation forestry elsewhere, thus freeing up agricultural land internationally. Obviously all these effects will be extremely small for any New Zealand policy, but we can expect them to be larger if we set a precedent for efforts by much larger countries.

3.2.3. Interrelation

There are clear contradictions between food security and emissions leakage fears. If food production decreases in New Zealand are directly replaced internationally with the same type of food (e.g. dairy or meat), then leakage will have occurred, but there will be no decline in food security. If, instead, decreases in New Zealand food production are not replaced overseas then there may be some decrease in food security, but no emissions leakage will have occurred.¹⁵ If leakage is a serious problem, then food security is not. Kerr and Zhang (2009) discuss the interrelation of these two issues and the role of free allocation of allowances to avoid their occurrence; they argue that it is unlikely that significant levels of emissions leakage or food insecurity will result from the introduction of New Zealand's ETS with a carbon price around \$25.

3.2.4. Timing of response

If we decide to respond and address agricultural emissions, then the question of when to respond becomes of interest. We may want to act immediately to address agricultural emissions, whether we face these pressures now or expect to face these pressures in the future.

¹⁴ Output-based free allocation is currently used to combat emissions leakage in New Zealand's ETS.

¹⁵ If dairy and meat are replaced internationally with different types of food that are not associated with high GHG emissions, then neither emissions leakage nor decreased food security will have occurred.

If we are motivated by currently held concerns about climate change, or expect to be motivated by them in the future, then acting soon is imperative: greenhouse gases emitted now stay in the atmosphere and contribute to global warming long into the future. While the most prominent agricultural greenhouse gas, methane, has a relatively short lifespan in the atmosphere (approximately 12 years), nitrous oxide has a lifetime of more than 100 years (IPCC, 2007a). Nitrous oxide makes up approximately a third of New Zealand's agricultural emissions, equivalent to 17% of New Zealand's total emissions (Ministry for the Environment, 2009). This may lead us to focus more on reducing nitrous oxide, as its effects are long lasting, and only focussing on mitigating methane emissions to meet short-term goals or to avoid climate tipping points.¹⁶ We might also be motivated to begin time-consuming processes immediately. Research, learning and adoption all take time to produce useful outputs; if we want to enjoy their benefits in the future we need to start these processes now.

If we are motivated by pressure from other national governments or international organisations then this too may motivate immediate action. The commitments made by the New Zealand government need to be met in the short term (Kyoto obligations), medium term (2020 targets), and longer term (2050 targets). Meeting these commitments will require action in the short term. Pressure or opportunities posed by international consumers with climate concerns, or the expectation of these in the future, may also motivate New Zealanders to act now. We may be able to decrease future costs (or take full advantage of future opportunities) if we begin to transition our economy to lower emissions now, rather than waiting for these pressures to arrive; that is, face short-term costs now in anticipation of long-term gains.

4. What Are the Implications of These Motivations for Our Responses?

When thinking about the best way for New Zealanders to address agricultural emissions we need to consider which one (or combination) of the motivations outlined in the section two is behind our actions. The nature of our response will be largely determined by our motivations: the why dictates the how. Depending on our motivation, we will require our responses to achieve different levels of verifiability or visibility, will have different priorities for technological change, and will focus more or less on communicating internationally. These dimensions are summarised in Table 1.

If we are motivated by concern about climate change (motivation one), then any actions that decrease emissions will be valuable. Our response will need to be visible to those carrying out the mitigation (so that they know they are making a difference), and will need to be verifiable and visible in ways that encourage others to also decrease their emissions. This motivation will require technological progress focused on developing new and improved agricultural emissions mitigation methods, and ensuring that these findings are accessible to New Zealand farmers. We will also want to cooperate internationally on mitigation development, and actively share the technologies and knowledge that we gain. New Zealand's participation in the Global Research Alliance on Agricultural Greenhouse Gases is an example of a response which addresses this first motivation.¹⁷

If instead our concern is assuaging international pressure from other countries or international organisations such as the UN, our response will need to differ. Addressing this motivation will require a

¹⁶ Tipping points occur when a relatively small change leads to large long term consequences. They are discussed by the Intergovernmental Panel on Climate Change (2007a).

¹⁷ The Global Research Alliance is a voluntary, collaborative international agreement that aims to “find ways to grow more food without growing greenhouse gas emissions”. More information can be found at <http://www.globalresearchalliance.org>.

focus on mitigation that meets internationally agreed-upon standards of verification.¹⁸ This will require technological progress that results in improved abilities to measure, monitor and verify mitigation, as well as new effective or improved mitigation methods. Demonstrating the rigor of these new mitigation methods to interested parties will require significant international communication.

Addressing international climate-conscious consumer pressure will require that our actions and effort are highly visible internationally. Developing effective ways to market our mitigation efforts to international consumers will be important. Our response will need to focus on mitigation methods that are visible and verifiable over those which have real but less verifiable environmental effects. International outreach will also be important in addressing this motivation; we will need to demonstrate to consumers that our mitigation effort is valid.

The verifiability and visibility of our impact on agricultural emissions will be less of a focus if we are aiming to achieve complementary goals (motivation three). Instead we will require real impacts on complementary goals. Technological development will need to focus on developing mitigation methods that have complementary impacts on other goals. For example, if our complementary goal is improving water quality, we should focus on mitigation methods that have positive effects on greenhouse gas emissions and water quality, such as nitrogen inhibitors. Different levels of international outreach will be required to achieve different complementary goals. Achieving a New Zealand-centric complementary goal such as improved New Zealand water quality or sustainable rural communities will not require significant international outreach, whereas a complementary goal with international interest, such as biodiversity, may benefit from international engagement.

If, as is likely, we are motivated to address agricultural emissions by some combination of these motivations, then our response should balance these different elements. Considering our response in terms of addressing our motivations in this way will be a useful way to consider appropriate policies.

Table 1: Choosing appropriate responses given our motivations¹⁹

	Responses		
	Visible/Verifiable:	Technology change:	External outreach:
Motivation One: Avoid climate change	Needs to be visible and/or verifiable to the farmer. Needs to be verifiable and visible to New Zealand regulators if national policy. Effort needs to be visible internationally to encourage others.	Mitigation technologies. Some measurement and monitoring technologies.	Cooperate on mitigation development. Share technologies and knowledge we develop. Actively disseminate knowledge.
Motivation Two: Meet international pressure	Must be verifiable by international organisations.	Verifiable mitigation methods.	Demonstrate to international parties that we are meeting commitments.

¹⁸ For example, our current ETS requires forests to be at least 30m wide to meet monitoring requirements, ignoring the benefit of riparian plantings, and does not allow pre-1990 forest to be cleared and replaced with new forests that will have identical storage capacity (Karpas and Kerr, 2010).

¹⁹ The extent to which New Zealanders will want to address agricultural emissions will depend on a combination of factors. Principally, it will depend on the intensity with which each motivation is felt, and the number of motivations we concurrently hold. This is discussed in more detail in section three.

• From countries or international organisations			
• From international consumers/markets	Must be visible to consumers.	Visible mitigation methods. Marketing technologies.	Show effort that is convincing to international consumers.
Motivation Three: Achieve complementary goals	Effect on complementary goals needs to be visible to communities of interest.	Technologies that positively affect our complementary goals.	None unless community of interest is international, such as biodiversity.

4.1. Robustness

While we can control or influence many of the factors that will impact the success of our agricultural emissions response, some factors are beyond our control. We need to ensure that our response will be robust to the many different possible future realisations of these factors.

Uncontrollable factors can be grouped under two headings: climate factors, and international factors. Climate factors include the seriousness of the climate problem in the future, the existence and stringency of any binding global agreement, and the development of technologies for cheap and effective mitigation. International factors out of our control include world population growth, the global economy and agricultural prices (both partly driven by climate change itself), and the existence of trade barriers. Different possible outcomes (and combinations of outcomes) of these factors will greatly affect the implications of our response. We illustrate this point by examining the effects of two possible agricultural price and technological development scenarios, and discuss characteristics of a robust scheme below.

The level of future agricultural prices will have a huge impact on the actual outcome of New Zealanders' responses to agricultural emissions. New Zealand farmers are price takers, and as a result have little influence on the prices they face. Indeed, agricultural prices are affected by a multitude of outside factors, including international supply, changing consumer preferences, global income growth, international trade agreements, and international agricultural policy. As a result, we need to ensure that any response to agricultural emissions is robust to different possible future agricultural prices. To illustrate, we can imagine a future with either very high agricultural prices, or very low. The optimal response to address agricultural emissions would be very different under these two possible future scenarios. If we expect future agricultural prices to be very low and agricultural production (and emissions) to be lower in the future as a result, we may not be so concerned with addressing agricultural emissions now. We may want to focus less on reducing the emissions intensity of production, and focus more on policies which will help achieve complementary goals. Conversely, if we expect to face very high agricultural prices in the future, then a favourable policy may be one which allows agricultural production in New Zealand to continue to grow, and controls agricultural emissions intensity without unduly restricting future production. This simple illustration makes clear that we do not want to commit to any responses to agricultural emissions that would commit New Zealand to a path that was so inflexible as to penalise us in one of these possible scenarios. Public and private actors must consider these future uncertainties when deciding how to respond.

New Zealanders' responses will also have to be robust to different possible paths and speeds of technological development. Again, we can illustrate the importance of robustness using a simple example. We can easily imagine two possible future scenarios where there have been different paths of technological development: one, where we have no new mitigation options for agriculture emissions compared to what we have today; or two, where a "silver bullet" for agricultural emissions has been developed (for example, the NZAGRC is successful in developing a vaccine which cheaply and effectively stimulates anti-methanogen antibodies in cows and sheep, hugely decreasing the emissions intensity of our agricultural produce). Again, our responses will need to be robust to these distinct future scenarios, and particularly will need to avoid investing heavily in technologies or policies that will become rapidly obsolete. It is important to note that we do have some control over technological development: we can invest in research and development to increase the probability that a favourable realisation of technological development occurs.

4.1.1. Characteristics of a robust response

For a response to be robust it will need to be flexible, scalable, effective and cheap. The need to be flexible is made abundantly clear by the examples of agricultural prices and technological development above: we need to avoid locking ourselves into any set approach to addressing agricultural emissions, and to be flexible to take advantage or alter our approach as new mitigation options or opportunity costs of responding are faced. Our response will also need to be easily up- or downscaled: we need to be able to alter the intensity of our response in reaction to the seriousness of climate change and other countries' responses. Our response will also need to be high value, that is, effective at addressing our motivations and low cost.

5. Discussion

New Zealanders should think carefully about what exact motivations they hope to attend to when addressing agricultural emissions. These motivations should determine the characteristics of the response New Zealanders take. New Zealanders also need to be mindful of the many uncontrollable factors that will influence the success of any response we make, and attempt to ensure that our response is robust to likely future scenarios by building in flexibility, scalability and cost effectiveness.

Our discussion also suggests a few stronger conclusions. If we believe that New Zealand is likely to face a price on carbon emissions in the future, explicit or otherwise, then when making decisions with long-term consequences New Zealanders should focus on responses that will decrease agricultural greenhouse gas emissions. These responses will be characterised by significant international engagement and co-operation, and a focus on mitigation technology development. However, the key characteristic of these responses will be integrity; successful responses will focus on decreasing agricultural greenhouse gas emissions, rather than attempting to appeal to international consumers or regulators.

A second conclusion is also clear: there is an opportunity to broaden the consensus for addressing agricultural emissions by focusing on outcomes other than climate change. New Zealanders are motivated to address agricultural emissions for a wide range of reasons, and not only because they personally care about helping New Zealand meet international emissions commitments or reducing the risk of climate change. Focusing on responses that have positive complementary impacts on greenhouse gas emissions and also on issues that potentially resistant New Zealanders care about, such as water quality or on-farm efficiency, may be a productive way to make progress addressing agricultural emissions.

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