7 Greenhouse gases and nutrients: the interactions between concurrent New Zealand trading systems

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Abstract

Emissions trading and nutrient trading interact in critical ways. The agricultural sector is a major emitter of both nutrients and greenhouse gases in New Zealand. Thus the simultaneous implementation of such systems will have a large impact on the farmers in affected catchments. Many of the mitigation options that are available to farmers, for example reducing animal numbers, will reduce both nutrient loss and greenhouse gas emissions. Thus the combined cost of control could be much less than the sum of the costs of the separate systems. The allocation of units under each system will also affect the same people. Monitoring systems for each pollutant could have common elements, but could also impose a double burden. The interactions between the two systems will complicate the decision-making process for farmers and need to be considered when the policies are designed so that they are as complementary as possible.

7.1 Introduction

New Zealand authorities are considering market-based instruments as a way of dealing with pollution externalities including greenhouse gas emissions and nutrient loss causing water pollution. Nationally, an emissions trading scheme (ETS) is in development to assist in meeting our Kyoto obligations. In some catchments, nutrient-trading systems are being considered, or implemented, to control nutrient loss into waterways where water quality is declining. A nutrient trading system is already in place for the Lake Taupo catchment and Environment Bay of Plenty is actively considering the use of a nutrient trading system for the Lake Rotorua catchment.

The two types of system interact in critical ways. The agricultural sector is a major emitter of both nutrients and greenhouse gases in New Zealand. Thus the simultaneous implementation of such systems could have a large impact on the farmers in affected catchments. If the ETS is implemented at farm scale, some farmers would be required to determine and report both pollutants leaving their property, and buy and sell allowances as their land-use and management practices change. They will face compliance costs (understanding the systems and reporting), will need to change land use and management in response to their new economic circumstances, and will face financial costs to the extent that they mitigate and need to purchase allowances.

The cost of responding to both systems may be lower than the sum of the costs of each individual system. For example, many of the emission reduction and mitigation options available to farmers will reduce both nutrient loss and greenhouse gas emissions. This is not always the case, however. Enhanced wetlands decrease nutrient loss off farmland, but do not decrease — and in some cases may even increase — greenhouse gas emissions. In addition, monitoring systems for each pollutant could have common elements but could also impose a double burden. Interactions between the two systems will complicate the decision-making process for farmers and need to be considered when the policies are designed so they are as complementary as possible.

This paper surveys interactions between one specific nutrient trading system, that proposed for the Lake Rotorua catchment, and the agricultural component of the New Zealand emissions trading system. We discuss issues of price, reporting and verification, scope, mitigation costs, motivations for free allocation, and externalities over time. While we offer only a brief outline of each of these issues, the paper draws on our extensive policy research and integrated modelling work in each system.[1]

Nutrient trading

Nutrient trading applies market-based instruments to the problem of water pollution. Our work looks specifically at nutrient trading in the Lake Rotorua catchment, but it could be applied in a wider range of places. The system we propose is cap and trade: it has a cap on the total amount of nutrients coming into the lake and tradable allowances equal to the cap. The cap is equal to the level of nutrients required to meet an agreed environmental goal.

[1] www.motu.org.nz/nutrient_trading and www.motu.org.nz/climate

Each year, farmers report the nutrients leaving their property using a computer-based model, and surrender allowances to match. If farmers hold more allowances than they require, these can be sold to farmers with insufficient allowances. The trading process will determine market price for these permits.

Nutrients reach the lake through groundwater and surface flows. They cannot be seen or measured, and instead must be monitored using a model. The particular model being developed in New Zealand is called OVERSEER, though alternatives exist. Farmers input their activities and the farm's geophysical characteristics, and the model estimates the amount of nutrients leaving the property each year. In particular, farmers must report animal numbers and fertiliser use.

Emissions trading

Agricultural emissions trading is very much in development as a core component of New Zealand's ETS. The New Zealand government has an allocation of Assigned Amount Units (AAUs) under our Kyoto obligations, which equates to New Zealand's allowable tonnes of carbon emissions. We can supplement these with carbon sequestration, and we can also buy units on the international market.

The national cap-and-trade system is similar to that described for nutrient trading, but differs in that it is essentially embedded within a bigger cap-and-trade system. The national system is an attempt to devolve responsibility for emissions to individual actors who are capable of behavioural change. To do this, private sector actors will be required to acquire NZ units through free allocation or by purchase. Private actors are responsible for reporting information that can be used to model greenhouse gas emissions from their chain of production. The sum of individual actors' emissions across all sectors and gases (plus any small sources excluded from the system) should sum to the national obligation. For agricultural emissions trading, the default point of obligation for emissions is the processor, though assessing emissions at farm level also remains under consideration. These details of the scheme are yet to be determined.

For the purposes of this paper we consider agricultural emissions trading at the farm level of obligation. As for nutrient trading, private actors surrender emission units to match emissions inferred using a model. Under a separate component of the ETS, if farmers have the benefits of post-1990 forestry or native regeneration on their land, they can claim emission units to match sequestration.

Scientific background

We are concerned with two related sets of emissions. Agricultural emissions trading controls the greenhouse gases, nitrous oxide and methane. Nutrient trading controls nitrates and phosphorus, which cause hazardous algal blooms in waterways in New Zealand. Both pollutants are produced predominantly by pastoral agriculture.

Farm management designed to reduce greenhouse gases can also reduce nutrient loss. Reducing stocking rates reduces methane and nitrous oxide roughly in proportion to the consequent reduction in feed intake and can reduce nitrate loss even further. If you are already controlling gas emissions, by felicity you can also control nutrient losses, and vice versa.

In some instances, the effects will not be so felicitous. For example, using straw bales to catch run-off reduces nutrient loss, but may increase nitrous oxide. This is because capturing nutrients creates more opportunity for them to escape into the atmosphere.

In many cases, however, greenhouse gas regulation may not be a significant extra burden for farmers who already control for nutrient loss. Introducing an emissions trading system effectively reduces demand for nutrient allowances, leading to a price drop in the nutrient market. In effect, farmers will pay less for nutrients and will instead start paying for greenhouse gases.

7.2 What are the similarities and differences between nutrient trading and emission trading?

The burden of nutrient trading and emissions trading depends on a number of potential interactions between the two proposed schemes. This section sets out issues of price, reporting and verification, scope, mitigation opportunities, motivations for free allocation, and externalities over time.

Price

For nutrient trading, the Regional Council sets the nutrient cap, and the price is determined entirely by what happens within the catchment.

By contrast, New Zealand has very little control over greenhouse gas emission prices. The Kyoto cap is set internationally through negotiations in which we are a very small player. For the global ‘carbon’ market we are price takers and therefore exposed to international changes.

In both systems, the council or government could choose to protect farmers from extreme prices and volatility by providing a 'safety valve' or price at which they will provide additional units.

Reporting and verification

If agricultural emissions are reported at farm scale, reporting and verification is very similar for both systems. Both involve pollutants that cannot be directly measured, but can be modelled through OVERSEER.

The challenge is to design a model with verifiable data inputs that accurately reflect nutrient losses and greenhouse gas emissions. The data must be verifiable or it would be impossible to determine compliance. The data inputs should also enable a range of mitigation options. Farmers want to be able to respond to both systems in ways that will not cost too much.

For both systems there is a real issue about the acceptability of regulation based on uncertain, inaccurate science. You can hear murmurings about nutrient trading and also emissions trading, saying 'Why are we bearing cost when you're not even really sure what's going on?' There is quite a lot of resistance on this basis. Traditionally, resistance where science has been uncertain has been beneficial to farmers because it has allowed them to avoid regulation. In this case, however, once the inevitability of Kyoto obligations or nutrient targets is accepted, acceptance of some of the uncertainty in modelling of mitigation options would allow farmers more flexibility and lower the burden on them.

This raises an economic question: what is the value of extra information? Perfect accuracy is not possible in this situation, but how valuable is it to be more accurate? This question is a transactions cost versus accuracy trade-off. There is an economic cost if negative perceptions lead to the system working inefficiently.

Scope

Another issue that arises in both systems is determining who should participate. For nutrient trading there are arguments for higher participation and arguments for lower participation. Applying the same arguments to emissions trading suggests that direct participation in the latter scheme should be somewhat lower overall.

To maximise environmental benefit from a nutrient trading system, it is desirable to have as many sources monitored and covered by the regulation as possible. It can also be difficult to monitor the activities of those who are not included. This has been seen in New Zealand fisheries, where commercial fishing is tightly controlled and recreational fishing has very few controls. Those not included in the system as direct participants have less incentive to mitigate their nutrient losses, which leads to loss of efficiency. Nonparticipants may not use low-cost mitigation options because they do not lead to economic advantage through the sale of allowances. A greater number of participants might increase market liquidity, which could be an issue if the number of projected participants is really low. More participants might also avoid some market power problems.

Transaction costs are the primary reason to limit involvement. It costs to comply with this sort of system, to determine and report farm nutrient losses and to learn how to gain the most benefit from trading. Dealing with many participants is also costly to the regulator who needs to verify reports and enforce compliance. In the prototype nutrient trading system, we propose that very small properties are simply made the responsibility of the district or regional council, which has the choice to pass on a nominal cost, potentially in combination with regulation to lower nutrient losses. This ensures that all activity is included within the overall cap, but avoids considerable effort from individual landowners. For the same reasons, we remain undecided about whether to create tradable permits for phosphorus alongside those for nitrous oxide. Nevertheless, both gases would be monitored as part of the nutrient cap.

The emissions trading system differs in two areas: liquidity is not an issue and nor is comprehensiveness of coverage of gases.[2] This is because we are working within an international market, whose associated regulations define all sources that are monitored and how monitoring is done. Actions in New Zealand will not affect the liquidity of the global market, and that would argue for lower participation in the trading system. In the short run, while the international market is relatively underdeveloped, the development of brokers who specifically deal with NZ units, and the Kyoto units that will be accepted in New Zealand, would help local liquidity. A system with lower participation would exclude sources with higher transaction costs and low emissions.

Cost bearing and mitigation

The major financial impact of both systems is on farm profitability, and, as a consequence, land values. Landowners are likely to bear the majority of the cost because lower land values will lead to a loss of equity. In the short run, if capital markets are relatively inflexible, introducing the trading systems could lead to

[2] The New Zealand government is choosing not to regulate sources that are not covered by Kyoto and are closely mirroring the international rules in domestic legislation.

possible bankruptcy even of farms that will be viable in the long run, particularly for people who bought farms recently and have large debts.

Initial costs are likely to be higher than ongoing costs for a given cap or price, because farmers will gradually begin to reduce and mitigate emissions. We lack robust empirical evidence on how much they can mitigate and the costs of doing so. We do know that greenhouse emissions per unit of output vary considerably across farms, which indicates scope for mitigation. This is the case even for methane, where it is possible to change the efficiency with which grass (dry matter) is used to produce meat and milk. The question is to what extent it will be possible for farmers to manipulate this variation, improving their productivity and hence mitigating their emissions.

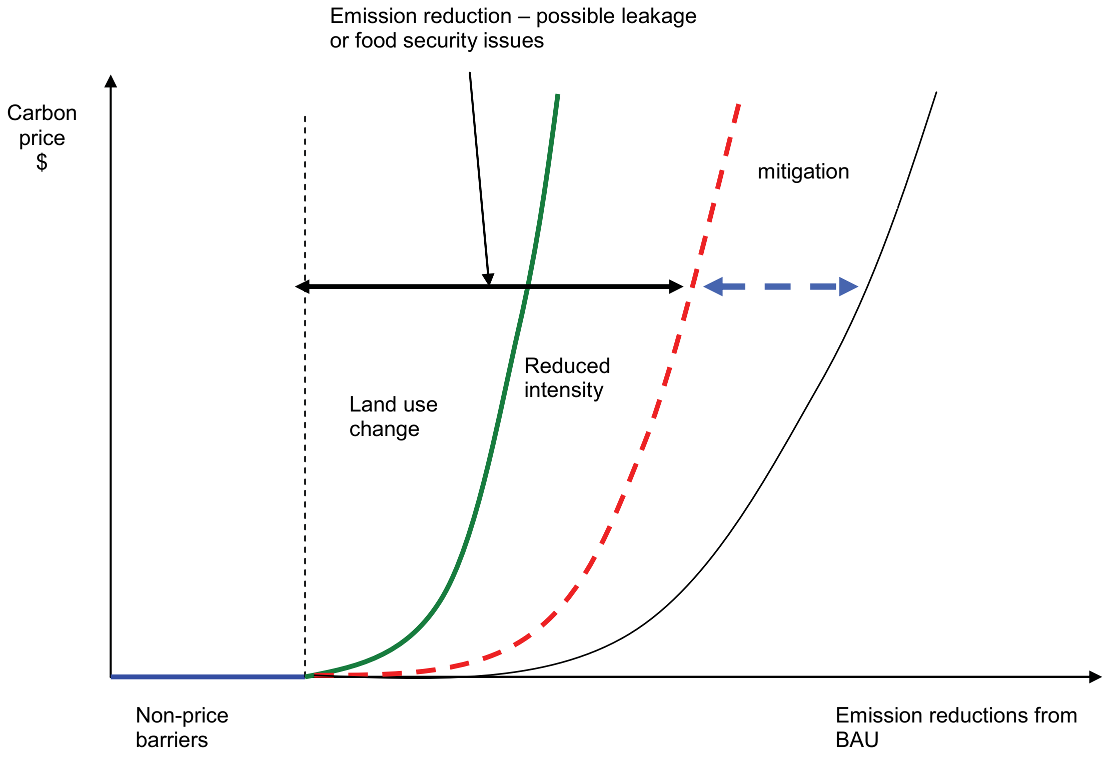
We use two farm models, FARMAX (for sheep and beef farms) and UDDER (for dairy farms) combined with OVERSEER, to explore these questions. These models do not involve explicit optimisation algorithms. Skilled users must try different options that they consider physically feasible to find an optimal outcome for the specific farming situation. Based on the inputs, farm geophysical characteristics and management practices defined by the user, and using a set of production functions for the farm and animal type, the model will produce predictions of output as well as farm profit.

A difficulty with this modelling approach is that, in general, farmers do not currently optimise their activity in accordance with this type of model. Some of this may be due to rational differences between a farmer's decision problem and that actually modelled; part may be due to non-price barriers to more efficient farm operation. Different farmers may have different preference for average returns relative to risk as well as across management options that require their input. Although models may appear to offer cheap (or negative cost) mitigation opportunities, these barriers may be real and certainly won't be addressed solely through the ETS.

Figure 7.1 illustrates the empirical question. We would like more robust numbers about how much farmers would optimally pursue each of the three broad types of activity — land use change, reduced intensity and mitigation — at different carbon prices. The more flexible farmers responses are, the lower the individual and aggregate costs of the system will be.

If farmers' responses are to change land use or reduce intensity and hence output, this could have negative effects in three ways. First, 'leakage' could lead to higher global emissions as a result of the ETS. Leakage arises when, as a result of carbon regulation in New Zealand and an incomplete global agreement, production falls in

Figure 7.1 **Emission reduction/mitigation cost curves**



New Zealand and rises in a country that is not covered by the Kyoto cap. Regardless of New Zealand's relative GHG efficiency in production, a movement of production to an uncovered country will raise their emissions above business as usual (BAU), while the sum of emissions under the Kyoto cap will be unchanged. Thus, global emissions will rise relative to BAU. Offsetting this somewhat, there may be local environmental benefits from reduced production. These could include improvements in water quality, biodiversity and reduced erosion.

Second, the fact that we are competing with unregulated countries in the short term may lead to production going offshore, something which in the long run we would regret when (or if) there is a global agreement. If New Zealand is relatively GHG-efficient in livestock production, we will have a long-term comparative advantage in production and we will want a strong livestock sector in the long term. Losing efficient production in the short term could lead to long-term regrets if New Zealand loses key skills, if infrastructure (including processing capacity) and the quality of herds decline in ways that are hard to reverse quickly or, if land moves into forestry or indigenous regeneration which is relatively costly to reverse in the short term. Short-term reductions in output could also lead to unnecessary social pain as small rural communities struggle to adjust to lower local economic activity.

Third, if the fall in New Zealand's food production is not replaced by increased production overseas, it will exacerbate the current global problem of food insecurity and high food prices. The less emissions leak, the more we contribute to food shortages. The challenge is to trade off the lower burden in New Zealand from allowing production to fall (also avoiding the costs of protecting production) against the emissions leakage, long-term regret, and food insecurity effects.

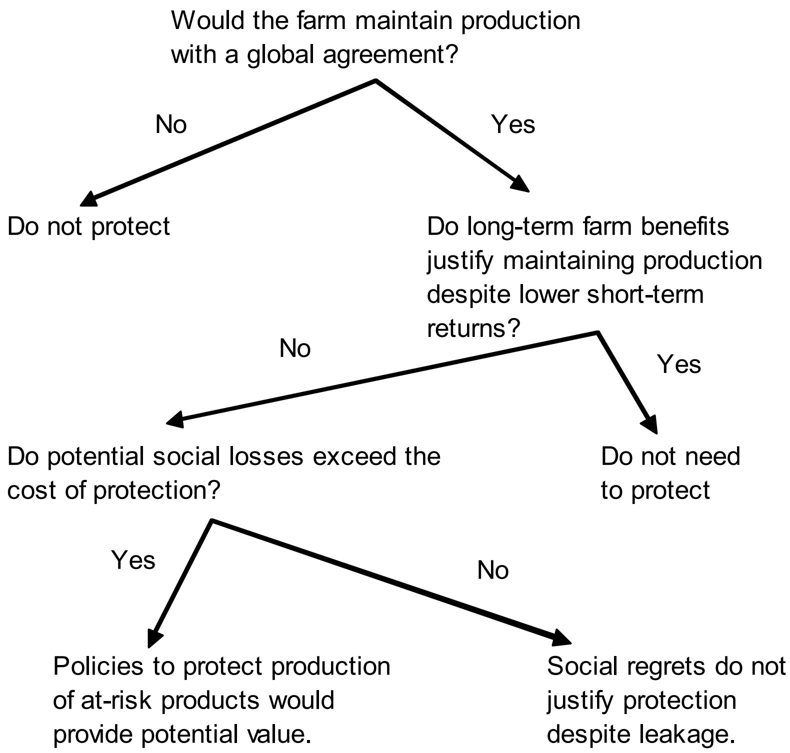
Motivations for free allocation

Allocating free allowances is a contentious issue in any trading system because of the high value of the allowances and the considerable costs that regulation can impose. For nutrient trading in Lake Rotorua, the key issues are fairness and smoothing transition into the new market regime. We propose that landowners initially receive allowances proportional to but lower than their current nutrient loss, so that landowners bear some of the costs of achieving the environmental target. Over time, our proposed allocation mechanism would transition to one based on potential nutrient loss on each land parcel. This avoids locking in current land use, or rewarding high nutrient-loss properties indefinitely. For example, land that is currently in forest, with very low nutrient loss, but that has high potential for sheep farming, or Maori land that is currently underdeveloped, would be penalised if allocation were entirely on the basis of current nutrient loss. A measure of potential nutrient loss is yet to be developed, but will need to incorporate land characteristics and potential stocking rates alongside a basic model of 'standard management practices'.

For agricultural emissions trading, where there are 33.7 million tonnes per annum of free units to allocate, the key issues are fairness, transition, and production falls leading to emissions leakage, long-term regrets and food insecurity. Free allocation is the only mechanism available to address leakage in the current scheme. Emissions leakage does not apply to nutrient trading, since the proposed scheme is self-contained within the Lake Rotorua catchment. The other effects on water quality elsewhere or food security are likely to be small and are not considered a critical local issue. There is no possibility of long-term regret because changes in profitability as a result of the scheme are not transitional or dependent on external agreements.

Figure 7.2 explores the decisions required to allocate to avoid leakage and economic regret in the ETS. The final question in this decision tree asks whether the potential social losses exceed the cost of free allocation, which is very expensive. This is another question requiring empirical evidence. We are working to collect evidence on potential production falls and emissions leakage in agriculture

Figure 7.2 **Decision tree for allocation to address leakage and economic regrets**



to give us a more robust idea of the sources and likely magnitudes and the effects of that leakage.

Timing of environmental effects

Another issue shared by the emissions and nutrient markets is that actions at one point in time can have environmental consequences at different times. In the Lake Rotorua catchment, nutrient loss can take between zero and 200 years to reach the lake, depending on a property's geophysical characteristics and location. Excess nutrients from some properties can go straight into the lake and cause water quality issues now; while nutrients from other properties will take 200 years to filter into the soil and through an aquifer before reaching the lake.

Our proposed nutrient trading system addresses this issue through vintage allowances. We propose creating a series of markets with their own targets, each related to a particular time period. Each property will have a groundwater lag associated with it, and landowners will purchase (or be allocated) allowances for the time period at which their nutrients reach the lake. For example, a property with a one- to five-year lag will surrender 2010–2014 allowances to match 2009 nutrient loss. A property with a sixty-year lag will surrender 2059–2069 allowances to match the same action on their farm. This allows authorities to meet water quality targets with greater confidence than would be possible with a single market.

For emissions trading, the comparison is not location but emissions type: carbon dioxide, methane and nitrous oxide each have different environmental outcomes over time. The NZ ETS converts each pollutant to CO_2 equivalents using global warming potentials (GWPs), following UNFCCC and Kyoto rules, but these rules do not distinguish medium- and long-term effects.

It is an open question whether the vintage approach can be applied to the global climate agreement. The relative treatment of different gases and the current use of GWPs is an important issue for New Zealand where we have high levels of emissions of methane, which has a very high global warming potential but whose current emissions will have little or no impact on the climate in 100 years. Two or more international markets for mid-term and long-term emissions targets would increase the accuracy of the environmental targeting and the economic efficiency of the global mitigation effort.

7.3 Conclusions

Emissions trading and nutrient trading are two related markets developing at the same time. We can take advantage of this situation by maximising complementarities and benefit from learning across markets. The markets have common challenges requiring innovative economic thinking and more empirical analysis.