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Report to

The Ministry of Agriculture and Forestry

Climate Change Policy

Measures to address

Agriculture Sector GHG Emissions

July 2006

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Acknowledgements: I have received helpful input and comment from many people, from within the Ministry of Agriculture and Forestry, and from other agencies. However, responsibility for the views expressed, and for any errors of fact or analysis, is the author's alone.

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1. Executive summary

In December 2005 the Government rolled back its climate change policy framework and commissioned further work ahead of re-visiting the subject later this year. This paper contributes to a work programme on agriculture sector GHG emissions. The focus is on policy instruments that could be implemented for or during CP1, but also with a view to possible longer-term strategies.

1.1 Broad classes of policy instrument

There is a number of alternative general approaches that can be drawn on to address agriculture sector emissions. The main 'economic' instruments are:

- **Government pricing of emissions** (and emission reductions), that is, applying a charge on emissions and/or paying a credit for emission-reducing activities. Central to whether pricing should take the form of a charge (tax) or credit (subsidy) is whether or not emitters are regarded as having an 'existing use right' (to emit). Either approach results in emitters facing a price; either a charge, or the opportunity cost of a compensation payment forgone. Pricing emissions results in efficient outcomes as it tends to equalize the marginal cost of abatement across all emitters: each emitter faces an incentive to reduce emissions up to the point where the marginal cost (of emission reduction) is less than or equal to the emission price.

- **Cap-and-trade arrangements**, under which tradable emission rights are allocated by the Government. Under this approach a cap is set on the amount of emissions permitted, and the price is determined in a market. If emission rights can be traded internationally, then the local cap is no longer binding, and price converges on the world price. An internationally 'open' cap-and-trade arrangement corresponds, in economic substance, with a pricing regime in which the government charges for emissions above a threshold level (corresponding with the cap) and compensates emission reductions below that threshold, in both cases at the world price. The main difference is that under a government pricing regime, the government plays a central intermediary role, whereas under a cap-and-trade arrangement, the government steps back and transactions occur directly amongst those who emit and who reduce emissions.

- **Offset schemes**. These are essentially a constrained form of a cap-and-trade arrangement. They may involve an 'internal exchange' whereby an emitter offsets the emissions of one activity by undertaking another which has emission-reducing properties. Or there may be an 'external' exchange, in which an emitter contracts another party to reduce emissions, and may fund that other party to undertake an emission-reducing activity, or pay a sum of money equivalent to the value of the emission reduction.

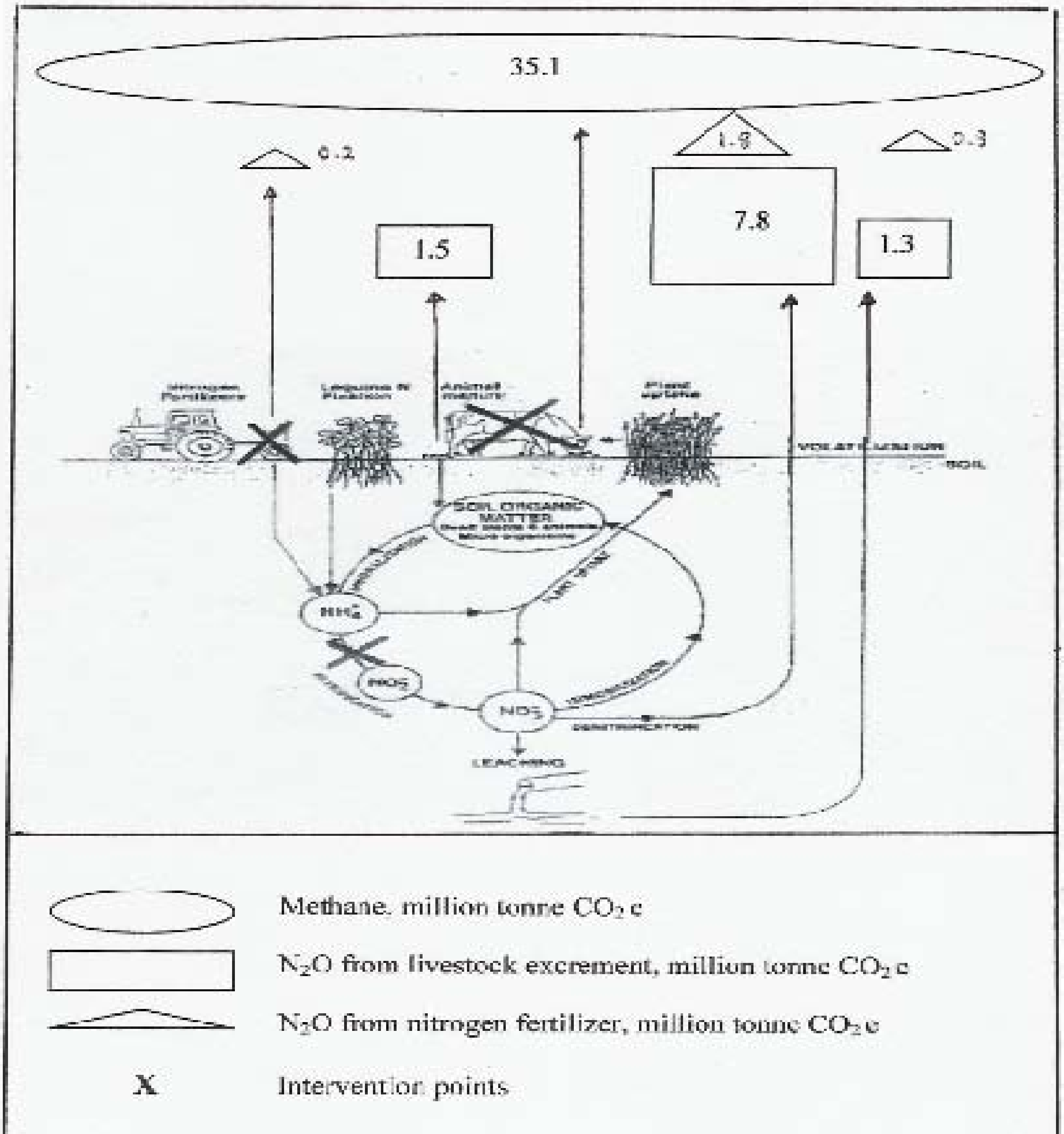
- **Mandatory emission standards** or emission-reducing practices. Embedded in these also are prices and costs, but these are implicit rather than explicit.

- **Voluntary emission reduction and reporting programmes**, extension and advisory services, and publicly funded research on emission-reducing technologies, also have roles to play. These elements of policy are most effective when they are aligned with and complement the framework of economic incentives facing emitters, rather than when used as substitutes for economic incentives.

1.2 New Zealand's agriculture sector emissions

The nature and sources of agriculture sector GHG emissions are illustrated in figure 1.

Figure 1: The emissions cycle[1]



[1] Adapted from McLaren and Cameron, 1996

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Key points to note are:

- that 65 per cent of agriculture sector greenhouse gas (GHG) emissions comprise enteric methane (CH_4) emissions, and 35 per cent nitrous oxide (N_2O) emissions.

- that of the N_2O emissions, a little less than 20 per cent are directly attributable to nitrogen fertilizer, with the remainder (over 80 per cent) stemming from livestock excrement. "Directly attributable" means stemming from the fertilizer itself, and not including the additional livestock excrement that results from the additional pasture growth that the fertilizer promotes. The latter is included in the 80 per cent figure. Emissions attributable to nitrogen fertilizer, therefore, can be thought of as those that would result from applying nitrogen fertilizer to pasture that does not carry livestock.

- the three points of intervention identified: reduced application of nitrogen fertilizer, reduced livestock numbers, and the use of nitrification inhibitors.

Latest central projections for Commitment Period One (CP1) are that N_2O and CH_4 emissions, combined, will be in the vicinity of 38 million tonnes (CO_2 equivalent), which would contribute to Crown's Kyoto liability over that five-year period of between $570 million (assuming a price of $15 per tonne) and $955 million (assuming a price of $25 per tonne.[1]

1.3 Specific instruments: possible candidates

Some specific possibilities for addressing agriculture emissions in CP1 are outlined below. These are intended to be illustrative only. Some go beyond current government policy but are included for comparative purposes, and to enable near-term measures to be considered in the light of what may be longer-term (post-CP1) possibilities.

A nitrogen fertilizer 'Kyoto' charge

- This would be a specific (excise-like) charge on nitrogen fertilizer, calibrated to cover its N_2O emissions (as included in New Zealand's GHG inventory, and at the world price for emissions).

- Indicatively the rate of charge would be about 10 per cent on the existing price of urea, assuming a world price for emissions of $15 per tonne. This would raise revenue of about $38 million per annum during CP1, or $190 million over the five-year period.

- The effect on rates of nitrogen fertilizer application and hence GHG emissions would likely be small. N_2O emissions attributable directly to nitrogen fertilizer account for no more than about 5 percent of New Zealand's agriculture sector GHG emissions. Also, the available evidence indicates that, at the rate of charge envisaged, paying the charge would be a lower cost option in most situations than curtailing nitrogen fertilizer application.

[1] All emissions prices in this paper are quoted in terms of an equivalent tonne of carbon dioxide, that is, as a 'carbon price'.

- Confining a Kyoto charge on nitrogen fertilizer to its direct emissions only would be largely consistent with maintaining a stance of not wishing to implement policies aimed at penalizing farm production. (Any reduction in application rates, and hence 'collateral' reductions in pasture growth and production, could be expected to be small.)

A broad-based 'Kyoto' charge on livestock numbers/production

- This would be a charge per head of livestock, or unit of livestock production (at the dairy/meat processing company level), calibrated according to the emission factors used in calculating the agriculture N_2O and CH_4 emissions in New Zealand's GHG inventory, and at the world price for emissions.

- The charge could be zero-rated for up-to-1990, or existing (2006), levels of emission. Each point of obligation would be allocated a base level of throughput that would be free of charge, determined according to by how much aggregate livestock numbers/production have increased since the reference year.

- Revenue estimates for the five-year CP1 period, assuming a price of $15 per tonne, are $570 million if emissions above 1990 levels were charged (this would cover the full amount of the Kyoto liability attributable to agriculture emissions), and $115 million if charging commenced for emissions in excess of 2006 levels. These revenue estimates assume that the charge mainly would raise revenue rather than curtail production, at least in the short term. Over the longer run, the charge could act as a more significant counter-weight to production growth.

A compensation payment for use of a nitrification inhibitor

- This would involve payment by the government of a credit, calibrated according to qualifying nitrification inhibitors' properties in reducing N_2O emissions, at the world price of emissions.

- Nitrification inhibitors initially were developed to boost the production efficiency of nitrogen, but more recently there has been an additional focus on how inhibiting the nitrification process can also reduce N_2O emissions. Inhibitors come in at least two forms; as a coating to nitrogen fertilizer, and in a fine-suspension form that is applied separately from nitrogen fertilizer. The later, manufactured by the Ravensdown Fertilizer Co-op Ltd, and marketed as ***eco-n^{TM}***, has been the subject of most research in the GHG context. Research to date suggests it can reduce N_2O emissions from animal excrement and nitrogen fertilizer by 50 per cent to 70 per cent (depending on conditions), and nitrate leaching into water bodies by 35 per cent to 50 per cent. However these results are not (yet) taken into account in New Zealand's GHG inventory calculations.

- Payment of a Kyoto credit would increase uptake of inhibitors, possibly significantly given that they already are marginally economic as a nitrogen efficiency booster alone.

- If (or when) inhibitors are recognized in the GHG inventory, each dollar of credit paid would be offset by a corresponding diminution in the Crown's Kyoto liability. In effect, paying a Kyoto credit would amount to buying emission credits locally rather than abroad under the Kyoto

Protocol's flexibility mechanisms.

Mandatory use of nitrification inhibitor

- This would involve mandatory use of nitrification inhibitor, either in conjunction with nitrogen fertilizer, or on prescribed (dairy) pasture. Under the latter approach, the requirement to treat pasture could extend beyond that to which nitrogen fertilizer is applied, and include any pasture subject to intensive stocking. (Although limitations would apply in the case of the ***eco-n***^TM^ product, which has to be sprayed from a vehicle, little hill-country is intensively stocked.)

- A nitrogen fertilizer and inhibitor co-use requirement could apply at the wholesale level, by making it a requirement that nitrogen fertilizer be sold only jointly with the inhibitor. In this case, compliance monitoring would be straightforward. If the requirement, however, was to apply an inhibitor to prescribed pasture, compliance monitoring would need to be at the farm level, and could be more difficult.

- Compulsion may result in less efficient outcomes than if the emission reduction value of the product was priced, bearing in mind that their effectiveness varies with conditions. For example, compulsion could result in inhibitor having to be applied in situations where there would be little boost to nitrogen efficiency, thus making the treatment a high cost means of mitigating emissions. Conversely, in other situations, the mandated level of application may fall short of that which would have occurred if the full, including emission mitigation, benefit of the product had been factored into farmers' cost-benefit assessments.

- Making use of inhibitors compulsory could give suppliers pricing power and hence a possible need for price regulation.

A cap-and-trade approach – an allocation of N_2O emission rights to the dairy sector

The idea here would be to make a free allocation of N_2O emission rights to the dairy sector, specifically to dairy processing companies (Fonterra and the 'independent' dairy companies). Those entities then would be able to sell emission credits if emissions were reduced below the level allocated, and correspondingly be responsible for emissions above that level.

In this way dairy companies would be incentivised to work with their shareholder-suppliers to minimize emissions, for example, through more efficient use of nitrogen fertilizer and nitrification inhibitors (leveraging of Fonterra's existing promotion of nutrient budgeting), and adoption of on-farm practices that reduce N_2O emissions, eg, use of feed-pads, and optimal spreading of cow-shed effluent. The dairy companies would assume the compliance-monitoring role, in which they could leverage off their supply relationships. They would also face incentives to promote the research and extension activities required to maximize mitigation potential, including with respect to promoting the research required for emission-reducing on-farm practices to be recognized in the GHG inventory calculations.

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1.4 An illustrative package

The above kinds of intervention could be 'mixed and matched' in a number of ways, including to achieve different combinations of 'sticks' and 'carrots'. Desirably, extension, voluntary and research programmes would be integrated and aligned with a framework of economic incentives so as to be mutually reinforcing – such that the 'whole' might come to more than the sum of the parts.

A packaged, mutually reinforcing, approach comprising elements of give and take, might comprise:

- A 'Kyoto' charge on nitrogen fertilizer to cover its direct emissions; combined with

- Payment of a 'Kyoto' credit on nitrification inhibitors (subject to the inhibitor being recognized for GHG inventory calculation purposes);

- Some co-financing of the research required for use of inhibitors, and on-farm practices such as the use of feed lot pads, to be taken into account in the GHG inventory;

- Co-funding of extension and demonstration farm programmes that promote adoption of emission-reducing practices and technologies on-farm, as well as to provide a base for applied research.

A package along these lines would:

- Represent a significant step toward pricing N_2O emissions, but with only a handful (perhaps three or four fertilizer company) points of obligation/entitlement;

- Offset the Crown's Kyoto liability by about $190 million during CP1, that is, by about one third of that attributable to agriculture. Some of this financial benefit could be recycled to fund targeted research, extension and demonstration farm programmes;

- Leave the way open to introduce pricing of livestock-attributed (N_2O and CH_4) emissions at a later stage; and

- For the meantime, at least, preserve a stance of not wishing to introduce policy measures aimed at penalizing farm production.

Such a package for agriculture would be broadly consistent with an (assumed) forestry sector package involving payment of a Kyoto credit for new afforestation, and a charge (or corresponding cap-and-trade arrangement) for deforestation in excess of a 21 million tonne CO_2 e cap. The fiscal cost of such an approach for forestry would be up to $315 million (assuming deforestation reaches the 21 million tonne cap, and a CO_2 price of $15 per tonne), compared with, say, about $400 for agriculture.[2]

The package outlined would also overlap with policies directed to achieving water quality goals in

[2] The $400 million figure is a 'round figure' derived as $573 million - $190 million, plus an allowance for outlays on research, extension and demonstration farm programmes.

sensitive catchments. Soil nitrates are a common source of both N_2O emissions and nitrate contamination of water bodies; hence GHG measures focused on nitrogen would have co-benefits for water quality. However, the overlap is far from complete. There is a material difference in focus as between climate change and water quality policy. For example, climate change policy has a global context, whereas water quality is a local issue. Hence, while an ‘open economy’ approach is preferred in designing price, or cap-and-trade, regimes for addressing GHG emissions, a local or ‘closed economy’ approach needs to be adopted if water quality goals are to be met. (Buying emission credits abroad to meet the Crown’s Kyoto obligation, for example, does nothing to help improve water quality in the Taupo catchment.)

The present direction of water quality policy has been to adopt a cap-and-trade model for managing nutrient inputs in sensitive catchments (notably the Taupo catchment). By contrast, a more incremental approach to pricing and mitigating agriculture GHG emissions is envisaged, with comprehensive pricing or a cap-and-trade arrangement seen as a possibility only in the longer-term. There would appear to be scope to bring these two areas of policy on to more parallel, though not necessarily identical, tracks, and in a way that would enable each to more effectively leverage the other. For example, the research, extension and voluntary programmes envisaged for addressing GHG emissions could also strengthen the foundations for introducing nutrient cap-and-trade arrangements in sensitive catchments. Conversely, local initiatives to achieve water quality objectives could pave the way for more broad-based measures directed to reducing GHG emissions.

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2. Background

2.1 Policy background

In November 2005, officials reported to Government on a *Review of Climate Change Policies*. A key conclusion identified by that *Review* was a need to reconsider the appropriate mix of price-based, regulatory and support-based measures to achieve New Zealand's climate change policy objectives.

The policy framework under review comprised:
- a carbon charge on the transport and energy sectors;
- Projects to Reduce Emissions (the PRE mechanism);
- exemptions from the carbon charge for:
  - large emitters whose economic viability would be at risk from the carbon charge and that entered into Negotiated Greenhouse Agreements (NGAs);
  - agriculture, but with government/industry co-funding of a Pastoral Greenhouse Gas Reduction Research Consortium (PGHGRR consortium).

Officials assessed this package of measures would not have been effective in:
- reducing GHG emissions to the extent previously envisaged; nor
- enabling New Zealand to meet its Kyoto Protocol CP1 obligations at least economic and fiscal cost.

This changed assessment, from when the policy framework was developed in 2002, appears to have stemmed from at least two factors:
- changed economic circumstances, notably in the forestry and dairy sectors, where there has been a sharp reduction in afforestation, a shift from (lower emissions) sheep farming to (higher emissions) dairying, and, potentially, significant deforestation, in favour of dairy farming;
- downward revisions to assessed contributions to GHG reductions from the PRE mechanism, from NGAs, and from the PGGRC (which now appear likely to make little contribution to reducing GHG emissions in CP1).

A further consideration appears to have been a concern that the carbon tax was insufficiently broadly-based to play the pivotal role envisaged for emissions' pricing. Exemptions for agriculture, which contributes 50 per cent of New Zealand's GHG emissions, and for NGA emitters, which contribute a further 20 per cent, meant that only about 30 per cent of total emissions would have been subject to the carbon tax. Loading those remaining emissions with a carbon charge potentially would have caused significant economic distortion.

Looking ahead, the *Review* concluded that in a situation where New Zealand has binding emissions targets, the more closely a domestic GHG emissions charge approximates the international price of emissions, the less rationale there is for additional regulatory or supporting measures in the sectors of the economy subject to the charge. The Review also pointed to four strategic options for going forward:
- A low level broad-based charge, implemented in the near future, and gradually increased over

time;
- A broad-based charge at the world price, with targeted re-cycling of revenue (eg, energy efficiency, structural adjustment);
- Deferral of any decision on a price-based measure;
- A charge on (individual) large industrial emitters that do not meet (ie, are worse than) world-best practice emissions intensity.

In December 2005, in response to the officials' *Review*, Cabinet, inter alia:
- Agreed that the government will not introduce the current carbon tax model or any other broad-based greenhouse tax before the end of the first Kyoto commitment period (2012), but noted that this would not preclude putting in place a more narrowly based tax on large emitters if that was deemed appropriate (nor, implicitly, from moving to a broad-based pricing regime after 2012);

- Noted that a programme of work was required to provide further analysis to inform government decisions in the light of the *Review*, and would include work on land-use and the links between forestry and agriculture policies and on the treatment and reduction of agricultural emissions including research. (The *Review* had noted on agriculture that cost-effective emission reduction options were currently limited and were likely to remain so, at least over the next decade, and that the price measures that appeared most feasible and practical during CP1 were a tax or other controls on nitrogen fertilizers and/or incentives for the uptake of technologies to reduce emissions.)

2.2 Agriculture emissions

The main sources of GHG emissions from agriculture are illustrated in table 1 and figure 2 (reproduced from section 1.2).

Table 1: Agriculture emissions[3]

	1990		2004		2010 (estimate)		CP1 emissions > 1990 level	
Emission category	**$MtCO_2$**	**$m**	**$MtCO_2$**	**$m**	**$MtCO_2$**	**$m**	**$MtCO_2$**	**$m**
Enteric methane	22.2	355.2	23.7	355.5	26.0	390.0	19.0	285.0
Nitrous oxide	10.0	150.0	12.3	184.5	13.8	207.0	19.0	285.0
Total	32.2	505.2	36.0	576.0	39.8	597.0	38.0	570.0

[3] The data in this table are taken from inventory calculations for 2004, whereas those shown on figure 1 are for 2003. Hence some of the data do not exactly correspond. All $ amounts in Table 1 are based on a CO_2 price of $15 per tonne.

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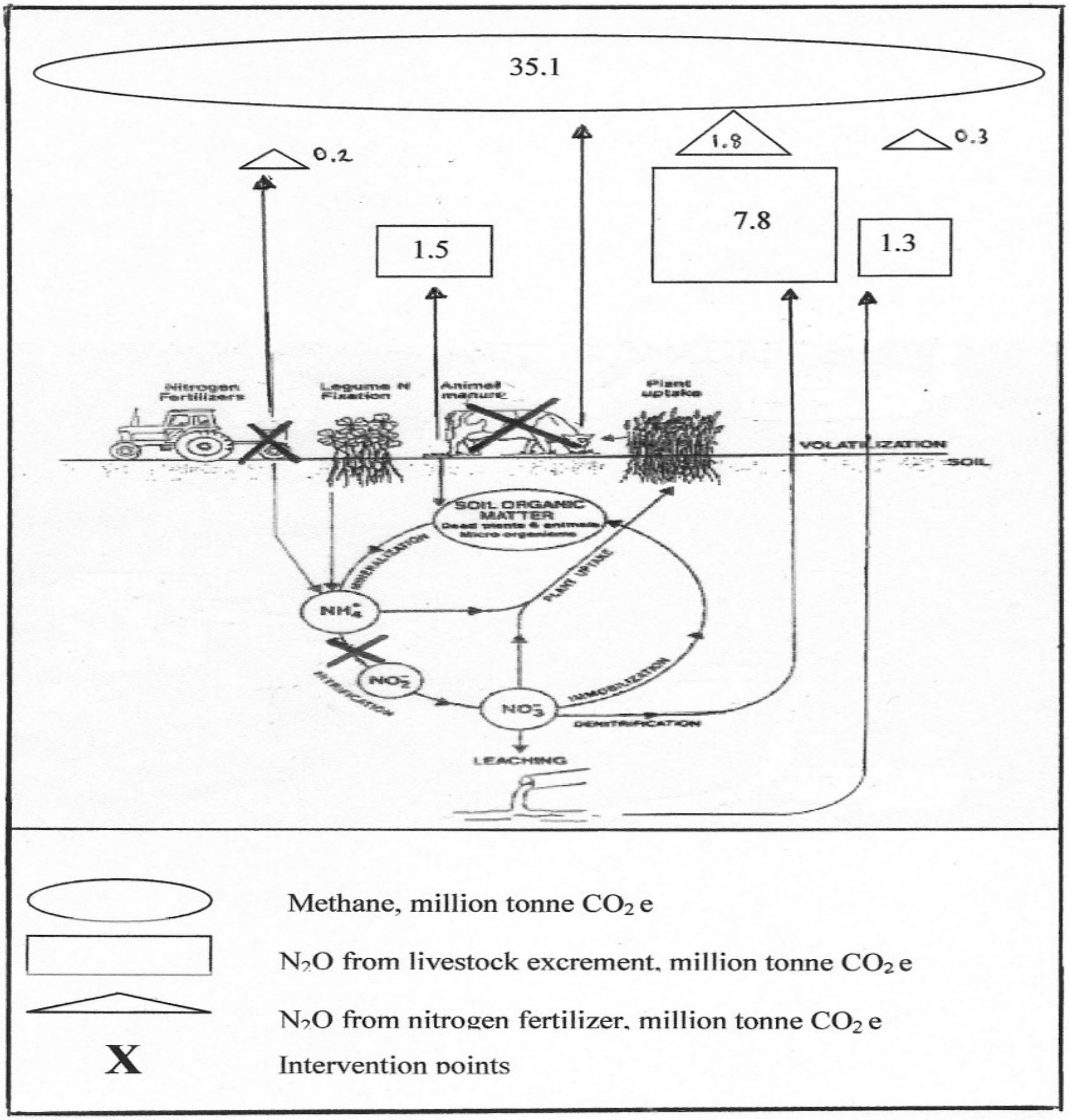
Figure 2: The emissions cycle[5]



[5] Adapted from McLaren and Cameron, 1996

Methane emissions

Methane emissions are generated from the process by which cellulose plant matter is digested by ruminant livestock; mainly cattle, sheep, and deer. Currently no animal technologies or farm management practices to materially reduce methane emissions from these livestock are available, although improvements in animal genetics have resulted in improved livestock productivity, which is reflected in a trend decline in emissions per unit of output (milk solids, meat). That is, enteric methane emissions have been growing less rapidly than output, as output per head of livestock has increased, and this trend is expected to continue. Longer term, there is potential for the rate of growth of enteric methane emissions to be slowed further, through adoption of more specific methane emission-reducing animal technologies, but these remain at a very early and uncertain stage of development.

Nitrogen emissions

The main sources of N_2O emissions (with quantities, measured in the equivalent Mt CO_2, 2003 inventory data, in parentheses):

- Livestock (10.6 Mt): Nitrogen taken from the atmosphere into plant matter by way of the nitrogen fixing process and from nitrogen fertilizer is recycled back the soil as livestock excrement, mainly in urine deposits. The urine interacts with soil to form nitrates, which volatilize from within the soil and from water bodies into which the nitrates have leached. (The nitrate formation process is muted considerably, however, if the urine is spread over a large area of pasture, rather than being deposited in concentrated patches.)

- Nitrogen fertilizer. This generates N_2O emissions as the result of:
    - volatisation of the fertilizer on application (0.2 Mt);
    - volatisation of nitrates formed directly from the interaction of the fertilizer with soil compounds, in essentially the same way as urine deposits generate N20 emissions (1.8 Mt); and
    - the additional pasture growth promoted by nitrogen fertilizers, and hence additional N20 emissions via increased livestock urine deposits, as above (0.3Mt).

In New Zealand's GHG inventory, N_2O emissions attributable to nitrogen fertilizer exclude those from the livestock excrement that can be traced back to the additional pasture growth promoted by fertilizer; these instead are counted as livestock-attributed N_2O emissions. One way to think about nitrogen fertilizer emissions is as the N20 that would be emitted if nitrogen fertilizer was spread on pasture that is, and remains, un-stocked.

N_2O emissions can be reduced by breaking the nitrogen cycle at a number of points (identified in figure 2). These are by:

- reducing application of nitrogen fertilizer;
- reducing stocking rates and hence excrement deposits;
- increasing application of nitrification inhibitors.

Nitrification inhibitors are products that reduce the extent to which both fertilizer and animal excrement form soil nitrates and hence N_2O emissions from both within the soil and from nitrates leached into water bodies. Moreover, they increase the production efficiency of the nitrogen cycle, with more nitrogen being available for, and hence taken up in, pasture growth. Also, to some extent, nitrification inhibitors, besides contributing to emission reductions, can additionally serve as a substitute for nitrogen fertilizer, and in this way make a dual contribution to emission reduction goals.

Nitrification inhibitors come in two forms, either as a coating to nitrogen fertilizer, or as a separate product (***eco-n**™* , manufactured by Ravensdown Co-operative Fertilizer Company Ltd) which is applied in a fine suspension form. The latter appears to have greater, or at least more established, N_2O emission mitigation properties, although neither is yet recognized as having such properties for GHG inventory calculation purposes.

Reducing rates of application of nitrogen fertilizer similarly contributes to emission reduction goals in two ways. Emissions attributable to the fertilizer itself are reduced, as are livestock-attributed emissions, of N_2O and methane, owing to the reduced pasture growth. The lower level of livestock-attributed emissions, however, is achieved only at the expense of less livestock production.

The third means to reduce N_2O emissions is directly to reduce stocking rates, but that too, of course, results in less production.

2.3 Policy objectives

A prerequisite for the design of any policy is clear definition of policy objective(s). With respect to agriculture emissions, a number of – overlapping and complementary, but not identical – objectives can be identified. These include:

- an absolute emissions reduction objective, that is, achieving a specified reduction in emissions in New Zealand, as a contribution to the global climate stabilization objective in its own right.

- a qualified emissions reduction objective, that is, achieving emission reductions in New Zealand but subject to the cost of that not exceeding the cost of purchasing emission credits abroad (that is, paying for emission reductions abroad rather than in New Zealand). This objective dovetails with the Kyoto Protocol framework, which has been designed to enable global emission reduction targets to be achieved wherever they can be achieved at least economic cost.

- a strategic 'national interest' objective, in effect, positioning New Zealand to best advantage for post-CP1 Kyoto Protocol negotiations.

Alternative general classes of policy instrument for achieving emission reductions, including at least economic cost, are outlined in section 3 below. The broader strategic context is discussed next.

Strategic considerations

The strategic context for maximizing New Zealand's national interests in relation to climate change policy has at least two, inter-related, elements.

First, New Zealand has a strong interest in an effective international response to climate change, given the potential costs of climate change to New Zealand and given that, as a small economy, there is next to nothing New Zealand itself can do to avoid those costs (even if New Zealand was to totally eliminate its

GHG emissions, that would make virtually no difference to the climate facing New Zealand).

We also have a strong interest in seeking to ensure that the international response does not result in the imposition, directly or indirectly, of an undue burden on New Zealand.

Managing uncertainty

Another complicating factor is uncertainty. Leaving aside the scientific uncertainties – which now appear to be more about when and by how much, rather then whether, GHG emissions will result in climate change – the international policy environment is highly uncertain. To be sure, a policy framework for CP1 is in place, but there remain uncertainties about how it will be applied. These and other uncertainties, in turn, cloud the outlook both for the evolution of emission credit prices and for the development of the markets in which those emission credits are expected to be traded. Faced with these uncertainties, short-term policy needs to be sufficiently flexible to leave open a range of options for the future and, in particular, avoid locking-in what could turn out to be high-cost policy interventions.

Co-benefits

Related to, but different from, climate change policy objectives are concerns about water quality, particularly in ‘sensitive’ catchments, and soil conservation in erosion-prone hill-country regions. These environmental issues overlap with climate change policy objectives, although by no means completely. The main overlaps are with respect to soil nitrates, which are both a GHG emissions source and a water contaminant, and with respect to land-use choices for hill country, where livestock farming can contribute both to emissions and erosion, while afforestation helps on both fronts.

For the purposes of this paper, the main co-benefit of interest is that relating to water quality. This corresponds with its primary focus on N_2O emissions. But also to be noted is that nitrate leaching is only one of the sources of contamination to water bodies, the principal others being phosphate and microbial contamination, neither of which are linked to GHG emissions. Also, water quality objectives have a strong regional, of not local dimension, whereas the focus of climate change policy is national if not global.

These overlaps of climate change and water quality objectives give rise to policy opportunities and risks. The opportunities arise from the potential to capture co-benefits – to ‘kill two birds with one stone’. Risks arise because policy objectives can end up becoming muddled and hence compromised. It is unusual for a single policy instrument designed and calibrated for one purpose also adequately to meet the needs of another, different, purpose. For example, it is possible that certain policy instruments could be effective in meeting Kyoto obligations at least economic cost, but fall well short of achieving the reduction in nitrate leaching required to meet water quality objectives. A general principle in policy design is that there should be at least as many policy instruments as there are objectives.

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3. General classes of policy instrument

3.1 Pricing emissions

The pricing of emission rights enables emitters to evaluate the cost of emitting relative to the cost of achieving emission reduction. In this way, environmental outcomes can be achieved in a way that is also economically efficient, provided of course that emissions are priced appropriately. If, as is envisaged by the Kyoto Protocol, emission rights will be internationally tradable, efficient national interest outcomes would be achieved by pricing local emissions at their world price. New Zealand emitters would then be incentivised to reduce emissions up to the point that the cost of doing so is less than or equal to the cost of New Zealand buying emission rights on the world market.

A charge or a rebate?

There are always two ways in which the government can price an activity, in this case emitting GHGs: either by charging a tax (or fee or levy) on emissions, or by paying compensation (a subsidy, rebate or credit) to those who reduce emissions. Both establish a cost for emitting compared with not emitting. But obviously who pays is different under the two approaches – whether it is the emitters or the wider community.

Whether pricing should take the form of an emissions charge or payment of compensation for emission reductions depends on the view one takes about who holds the right to emit. If emission rights are viewed as belonging to society, then it follows that 'society' has a right to charge those who emit. This is the “polluter pays” principle. But if it is considered that emitters have an ‘existing use’ right, then arguably emitters should be compensated for giving up some or all of that right. This approach is consistent with a view that because it is wider society that benefits from emission reductions, wider society should bear the cost.

While both approaches are equivalent in terms of establishing a price for emitting relative to not emitting, the difference in who pays can have economic efficiency implications. If compensation is paid for emission reductions, the compensation payments have to be funded from general taxes. And taxes amount to a price distortion and hence result in an economic efficiency cost. This efficiency cost does not arise if emitters are charged for the cost of their emissions, since that serves to internalize the cost of emissions directly and in a way that corrects, rather than distorts the overall structure of prices. But the efficiency cost of making a compensation payment may be still be justified where emitters could reasonably regard themselves as holding a long-established right to emit. In that circumstance imposing a charge may not fairly and equitably acknowledge that property right. Over-riding property rights can give rise to economic costs over the longer term. Having said that, property rights, even if long-held, do not necessarily last forever. As circumstances change, what had been an unqualified right to emit may appropriately be modified or curtailed, to reflect the changed situation. It follows that, once notice has been given of a change in circumstances, the policy justification for paying compensation for emission reductions, rather than charging for emitting, may be confined to a transitional period.

Pricing emissions or emission proxies?

In the case of agriculture emissions there is a further, practical, matter. Because most agriculture emissions are not ‘point-source’ emissions, it is difficult for them to be attributed, and hence priced, directly to individual emitters. Rather, they can be priced only by imputing emissions to inputs and activities that are known to result in emissions, or emission offsets. These include nitrogen fertilizer, livestock (or production proxies for livestock, eg, milk solids and meat), and nitrification inhibitors. An average emission, or emission offset, factor for each of these can be determined scientifically, which, in turn, can be given a monetary ($) value, for a given a emissions price.

If emitters face a charge on the causes of emissions, or a credit for emission reductions, they face an incentive to manage those particular inputs and activities in ways that achieve emission reductions efficiently. However, the effect of the pricing incentive is confined only to the particular variable to which it applies. For example a charge on nitrogen fertilizer has no influence on decisions about whether or not to apply nitrification inhibitor. By contrast, if N_2O (and/or methane) emissions could be measured on a farm-by-farm basis, attaching a charge directly to them (or paying a credit for reductions) would result in emitters facing an incentive to mitigate across the full range of possibilities, and the ability to trade off amongst them according to which is most efficient for their particular situation. Absent that possibility, the next best approach for achieving emission reductions with maximum efficiency is to attach a price – either a charge or a credit – to as wide a set of sources and offset proxies as possible.

Pricing all emissions or 'excess' emissions?

Under the Kyoto Protocol, emission rights up-to-1990 levels are allocated to the government for free: it is only emissions above that level that give rise to a 'Kyoto responsibility'. Hence, if the government was to apply a zero-based charge to emissions[4], including for up-to-1990 levels, that would be fiscally positive: emitters would be charged for more emissions that the Government would be liable for.

One way by which an emissions charge can bring about a shift in relative price, without resulting in a fiscal impost greater than the corresponding Kyoto liability, would be to charge, at the world price, but for emissions only above 1990 levels ('excess emissions'). A pragmatic approach would be to designate a proportion of today's emissions as the pre-1990 level, to be charged at a zero price, with that proportion for each emitter, or emission source, based on by how much the aggregate level has increased since 1990. Indeed, if the government considered it appropriate for itself to bear some of the cost of the post-1990 increase in emissions, the charging threshold could be set higher, perhaps at today's level in which case only future increases in emission levels would be charged. Of course, under such a regime, emissions below the chosen threshold would then not face any incentive for reduction, even if some of those emissions could be reduced at lower cost than others above the threshold. That would be inefficient.[5]

An alternative, that would also avoid a fiscal impost greater than the Crown's Kyoto liability, would be to set the rate of charge (applied to a zero base) below the world price. However, that would mean marginal emissions would no longer be priced at their marginal cost, and the regime would be even less economically efficient. Almost certainly, some emitting that it would be economic to curtail at the world price would continue.

The counterparts to these two approaches under a compensation (rather than under a charging) regime would be to compensate emission reductions only down to a threshold level, or to set the rate of compensation below the world price of emissions. Both would result in a smaller fiscal outlay than compensating all emission reductions in full (which mirrors how part-charging would avoid an unnecessarily large fiscal impost). But they would also be inefficient in terms of establishing the appropriate marginal price for the marginal emission. Setting a floor below which emission reductions would not be compensated would mean, as in the case of charging only above a threshold, that some emission reduction possibilities may not be taken up even though they could be achieved at relatively low cost. And if the rate of compensation was set below the world price, emitters would not be incentivised to reduce emissions down to the point where marginal cost equals the value of the emission reduction achieved.

The most efficient approach overall – that would result in all emissions facing their full price, while also maintaining fiscal balance – would be to charge above the 1990 threshold and compensate reductions in

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[4] Or, practically, to emission proxies.

[5] Although it it is a scenario that may be more theoretical than real, at least in the case of a 1990 threshold. In that case, with emissions today mostly well above the 1990 level, there may be few emitters with low cost options for achieving what would have to be deep cuts in emission levels.

emissions below that threshold. Fiscal balance ensues because the government's liability for any emissions that continue above 1990 levels would be funded by the charge, and the fiscal cost of compensating emission reductions below 1990 levels would be offset by the corresponding diminution in the Crown's Kyoto liability.

3.2. Cap-and-trade models

An alternative to the government being the pricing intermediary in an emissions pricing regime is for it to allocate a quantity of emission rights and to enable those rights to be traded, and hence priced, in a market – a so-called 'cap-and-trade' regime. Under such an approach, those for whom reducing emissions are most costly are prepared to pay the most for the emission rights that are available, and those who can reduce emissions face an incentive to do so and thus make emission rights available to the market, up to the point that marginal cost equals the price at which an emission right can be sold.

Under a cap-and-trade regime, the quantity of allowable emissions is set by the government, and the market determines the price. Cap-and-trade approaches, therefore are more apt either when the policy objective is to achieve a quantitative outcome in its own right (for example, a quantitative limit on leaching to a water body, or an absolute cap on GHG emissions), and/or where the government wishes to be able to take something of a step back from on-going direct involvement in the process.

On open or closed market?

The cap-and-trade approach just outlined relates to where the market is "closed" and emission rights cannot be bought or sold outside of it. But if emission rights can be bought and sold internationally, then, given that New Zealand is small relative to the world market, there is no longer any cap on New Zealand's emissions. In that case, the ability to trade emission rights internationally results in the domestic price of emissions converging on the world price. Thus, an 'open' cap-and-trade regime would deliver emissions pricing and hence emission levels essentially the same as would result from the government directly pricing emissions at the world price. The main difference between a cap-and-trade regime and direct government pricing that would remain concerns the role of government: whether it plays an intermediary role, or having once allocated emission rights, steps back from the process and leaves market participants to interact directly.

Emission right allocations

A key issue in the design of any cap-and-trade model is the allocation of initial rights. These can be allocated either for free, typically on the basis of existing use rights, or at a price, for example, through a tendering process. The latter implies that existing use rights are society-owned, and the former that emitters have existing use rights. The issue here is essentially the same as that concerning whether to charge or to provide a credit under an emission pricing regime. Requiring those receiving an initial allocation of emission rights to buy those rights is the economic parallel of levying emitters with an emissions charge (the emission rights can be thought of as being either bought outright, or alternatively as rented and thus subject to a user charge). And a free allocation of emission rights (which can be sold) is the economic parallel of paying compensation to emitters who reduce emissions.

Because, under the Kyoto Protocol, up-to-1990 emission rights are allocated to governments free of charge, there may be a presumption in a cap-and-trade regime that rights up to the 1990 level would also be devolved for free, with only allocations above that level having to be bought. That would be the equivalent, under a government pricing regime, of the government charging for emissions only above a 1990 threshold and compensating emission reductions below that threshold (as described above).

Offset schemes

Offset schemes can take a variety of forms but generally entail a requirement that an emitter take actions to offset an increase in emissions with a corresponding reduction in emissions elsewhere. Those actions may be taken by the emitter itself, or might involve a bilateral arrangement under which an emitting activity undertaken by one party is subject to an emission reducing activity being undertaken by another, or might involve one party funding the emission reducing activities of another.

An offset scheme under which the emitter itself is required to undertake emission reducing activities is inherently constraining, and hence economically inefficient compared with broader-based arrangements. To some extent a bilateral offset arrangement, which in effect is a barter transaction, is also constraining. Nonetheless, allowing an emitter to offset emitting activities in these ways is less inefficient than a rigid restriction that allows no such flexibility.

Broadening the scope of an offset scheme to allow required offsets to be funded with money further relaxes the constraints inherent in offset schemes. If full funding of the offset project is required, the remaining constraint would be a financial rather than physical. Greater flexibility still could be achieved if just the value of the offsetting emission reduction had to be funded or, in other words, if an emitter could purchase the emission credits required to offset its own increased emissions. That, of course, in effect, would be a cap-and-trade model.
For any kind of offset scheme to operate, the emission properties of the activities within its scope would need to be determined so as to establish the ratios at which one activity would be accepted as offsetting another, eg, how many trees would offset an additional head of livestock. And in many respects similar administrative machinery as required for a cap-and-trade arrangement also would be required, including for example, a registry of emissions and of their offsets, and of the contracts that tie one to the other. As will be evident, an offsets scheme in which emissions could be offset by purchasing emission credits for money would be little or no different from an emissions cap-and-trade arrangement.

3.3 Mandatory emission standards

Setting mandatory emission standards may be preferred over price-based measures where a quantitative outcome is the overriding objective, and/or the transaction and administrative cost of a cap-and-trade regime would be excessive.

The major shortcoming of a mandatory standards approach is that it is more difficult to take account of the cost of achieving the standard mandated. Implicit in quantitative regulation is always a ‘shadow’ price. Without that price being made transparent, there is a risk of interventions that impose costs that are greater than the benefits they deliver. Nonetheless, direct regulation is often considered appropriate. For example, lead compounds in petrol are now prohibited, not priced. In that case the health consequences have been assessed to be sufficiently severe that we can be confident that the benefit from eliminating lead outweighs the cost – without the need for any assistance from a market-based price discovery process.

Direct setting of standards can also be more appropriate where the costs are reasonably uniform across all users, for example, the cost of a catalytic converter for one vehicle is much the same as for another. Hence, there is limited scope for the desired outcome to be achieved more cost-effectively by some agents responding more than others. By contrast, within the agriculture sector, and across different industries, conditions vary substantially from one situation to the next, and generally it will be possible for some firms to reduce GHG emissions at lower cost than others.

3.4 Voluntary approaches

There are many examples internationally of programmes that support, or promote, 'voluntary' emission reduction efforts. These can draw on firms seeking to establish social responsibility credentials, eg, by way of 'triple bottom line' accounting, or wishing to establish baselines should charging, or cap-and-trade regimes, be introduced at a later date. They can also play a role in developing the infrastructure required for cap-and-trade arrangements, for example, by enabling reporting of emissions to emissions registries to be piloted as a forerunner to emission rights becoming a tradable right.

The international evidence indicates that voluntary programmes, at least by themselves, generally have little discernible effect on emission levels without a credible threat of pricing or regulatory action if 'voluntary' targets are not met. On the other hand, it is also apparent that over extended time frames, societal norms and expectations can change; what people and firms might have done only under compulsion or threat of penalty a decade ago they may do voluntarily today. It is not difficult to think of examples in other areas of policy where a combination of instruments directed at changing incentives and at shifting societal norms have had a significant impact, eg, drink-driving, and smoking.

3.5 Extension activities

In a similar vein to the role that can be played by voluntary emission reporting programmes, extension and information dissemination activities can reinforce price- and market-based instruments. For incentives, whether positive or negative, to be effective, there needs to be market awareness of them, and of the costs and benefits of emission-reducing options and opportunities. Put more generally, for markets to work well, they need to be well informed.

Dissemination of authoritative and unbiased information can have a role in hastening the uptake of new technologies. Specific examples might include productivity gains that can be achieved from the use of nitrification inhibitor (quite apart from GHG benefits) and from nutrient budgeting by farmers. Such extension activities can be expected to be most effective when designed to support other interventions and/or to bolster industry-based extension-like activities, for example the activities of the field officers of the fertilizer manufacturers and Fonterra's programme of encouraging its suppliers to use nutrient budgeting.[6]

3.6 Agriculture sector GHG related research

[6] A nutrient budgeting tool, such as Overseer™ accounts comprehensively for nitrogen inputs (eg, fertilizer and bought-in feed), and outputs (animal protein), and hence provides the information required to achieve maximum nitrogen efficiency, as well as estimation of the nitrogen 'surplus' retained in the soil, but eventually leached/emitted.

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Authoritative research is critical if GHG emissions from agriculture are to be:

- accurately measured (for GHG inventory purposes);
- managed and mitigated.

A number of factors point to New Zealand playing a significant research role with respect to agriculture GHG emissions:

- The relative absence of existing mitigation technologies for agriculture emissions, other than by curtailing production;
- New Zealand's agriculture sector-dominated GHG emission profile;
- The uniqueness of that profile amongst Annex 1 countries, which means that the incentives for research in this area outside of New Zealand are not strong.

If emissions (and emission reductions) were priced, the sector itself would be incentivised to fund research that has a reasonable prospect of payoff. But there can be a 'catch 22'. For example, if nitrification inhibitors are to be taken into account in the calculation of New Zealand's GHG emission inventory, further research will be needed. But the incentives for private research will be lacking unless there is some degree of assurance that if the research is successful and establishes the means by which agriculture emissions in New Zealand's GHG inventory can be reduced, the resulting economic value will flow back, either directly or indirectly, to those who provided the research funding.

Co-ordination problems can also result in less private research than is optimal. These can stem from the decentralized nature of the New Zealand agriculture sector, which comprises a large number of small, independent, farm units. This appears to be one of the reasons why a significant amount of agriculture research in New Zealand is publicly funded, although private research is also funded by fertilizer manufacturers and the dairy and meat processing companies.

Research is inherently risky and, where publicly funded, mechanisms are needed to establish a reasonable prospect of pay-off. Co-funding requirements can play an important role in this regard. Subjecting research projects to the test of whether firms with a direct commercial interest in their success are willing to contribute risk capital can provide a good indication of the prospect of success.

4. Selected specific instruments – an evaluation of some options

Against the backdrop of the policy context and analytical frameworks outlined in sections 2 and 3, this section outlines some specific measures that might be considered for addressing agriculture emissions in CP1. These are provided to illustrate in a more tangible way how alternative approaches might be implemented, rather than as policy recommendations.

The possibilities outlined cover a wide spectrum to facilitate comparison amongst the different classes of instrument. Some may go beyond current government policy, but are included for comparative purposes, and with a view to what could be longer term (post-CP1) policy possibilities.

4.1 Evaluation criteria:

There is a number of criteria against which policy instruments can be evaluated. These include:

Emission mitigation

Achieving a reduction in emissions is not the only measure of an instrument's effectiveness in achieving climate change policy outcomes (cost also matters), but it is an important consideration. In particular, being seen to be making some progress in containing emissions may be important for New Zealand's credibility in international negotiations.

Fiscal implications

The Kyoto Protocol allocates GHG rights and obligations to governments. As outlined in section 2, how and whether those rights and obligations are allocated (devolved), or priced, besides having important implications for economic efficiency, also has important fiscal implications.

Allocative efficiency and sector production

The choice of policy instrument to address GHG emissions will influence the level and efficiency of production in the agriculture sector. Production levels concern the aggregate level of output, while efficiency of production, that is, productivity, is concerned with optimizing production relative to the cost of that production.

The efficiency of production is maximized at the point where the economic value of a marginal unit of production just covers its marginal cost. A new element of production cost in agriculture (and other GHG emitting industries) is the cost of GHG emissions. These carry a marginal cost equal to their world price. For productivity to be maximized, the cost of GHG emissions needs to be factored into production decisions. All other things being equal, the efficient level of agriculture production with GHG emissions taken into account will be lower than was the case in the absence of a cost for emissions.

Consistency with long term

Desirably policy actions taken in the short-term should be consistent with intended long-term policy direction. Cabinet in its December 2005 decisions did not indicate a long-term strategic direction, pending further work and reporting back to Cabinet. The working assumption adopted for the purpose of this report, therefore, is that the desired long-term direction is as signaled in the Officials' *Review of Climate Change Policies*. That was to move to more broadly-based pricing of GHG emissions, including possibly by developing cap-and-trade arrangements. Short-term policy options, accordingly, are evaluated in terms of their consistency with that policy direction for the longer term.

Sector responsibility for emissions

New Zealand has a long history of a "right to farm" as including an unlimited right to emit GHGs. Emerging concerns about climate change, and other environmental impacts, however, bring into question the unqualified nature of that right. Pressures already exist to address the unintended environmental effects of farming, whether by way of constraints imposed on the sector, or through structures that better "internalize" environmental impacts into land-use and production decisions. The former tend to work 'against the grain' of the incentives faced by emitters while the latter work more 'with the grain' and may engender a better embedding of environmental impacts into on-farm practices.

International influence

As noted, New Zealand has an interest in international climate change policy both because it is the only way we can influence the course of the climate changes faced by New Zealand, including by New Zealand agriculture, and because international policy will determine how much of the burden of global response New Zealand will shoulder. Domestic policy measures need to be evaluated in relation to whether they will help to bolster or undermine New Zealand's international negotiating objectives. Consistency with the position New Zealand is taking on securing a sectoral approach to country emission targets is particularly relevant, as is the need to position domestic policy for a range of outcomes from international negotiations.

Compliance issues

An objective of all the government's business regulation programmes is to avoid excessive compliance and administrative costs, for the firms involved as well as for the government. Generally this is easier to achieve with requirements that are simple rather than complex and that have an interface with a small rather than large number of points of obligation or entitlement.

Also, different categories of instrument can give rise to different types of compliance cost. Charges, mandatory standards and compensation payment/subsidy arrangements all require some form of compliance monitoring. Cap-and-trade arrangements require that tradable rights be defined, monitored and enforced, and additionally that mechanisms be established for recording transfers of ownership of those rights.

Cross-sector consistency

Consistency of approach across different economic activities and sectors is necessary to avoid introducing distortion to the allocation of resources. This is particularly relevant as between agriculture and forestry which are competing uses for significant areas of land.

A policy framework that provides for even-handedness across sectors can also help in building sector acceptance of the framework.

Equity

The implications of policy interventions for equity need to be taken into account alongside efficiency.

It is sometimes indicated that instruments that can achieve emission reductions only by curtailing the emitting activity are less equitable than for where (low-cost) technology responses are available.

An alternative, though perhaps related, aspect concerns whether a transition from one set of circumstances to another should be provided for; in effect, whether there should be a period during which 'existing use' rights are recognized, but with emitters on notice that those rights have a 'use by' date. The case for recognition of existing use rights during a transition may be stronger where technology-based low-cost responses are not available.

Co-benefits

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GHG emissions are just one of a number of overlapping effects that agriculture has on the environment. Climate change policy therefore needs to be integrated as one element of an overall policy framework. The degree of alignment of instruments designed to address GHG emissions with the other elements of a framework for sustainable agriculture needs to be taken into account in choosing amongst the alternatives.

Risks and implementation issues

All policy interventions involve risks. In relation to climate change policy and agriculture these include:

- Those arising from the inherent uncertainties associated with climate change, including in relation to the future world price of emission rights, and future developments in the international framework for addressing climate change. These could evolve in unexpected ways.

- Sector resistance to policy change – which can complicate policy implementation, eg, the passage of necessary legislation.

Trade policy/WTO obligations

New Zealand has a virtually unblemished record in terms of avoiding subsidies for agriculture. In the case of policy measures that involve paying compensation for agriculture sector emission reductions, there could be a question concerning consistency with WTO requirements to avoid input subsidies, and/or for meeting the conditions for such payments to be classified as an environmental ("green box") measure.

Treaty of Waitangi issues – land values

Cognizance of Treaty of Waitangi obligations is needed in respect of policy measures that have implications for land use rights and/or land values.

4.2 Some selected policy options

This section outlines and considers in some detail a range of specific possible policy possibilities for addressing greenhouse gas emissions in the agriculture sector. Five alternative economic instruments are canvassed, covering pricing emissions under charging, compensation, and devolution regimes, as well as a non-price, standards-based, approach. In each case a brief outline of the policy instrument is presented, followed by an assessment against the evaluation criteria outlined in 4.1 above.

4.2.1 A 'Kyoto' charge on nitrogen fertilizer

Instrument parameters

- A charge levied on nitrogen fertilizer calibrated to its emissions per tonne in New Zealand's GHG inventory, valued at the world price of those emissions. The emissions covered would be those generated only by the fertilizer itself, not those stemming from the additional pasture growth and hence livestock production it promotes. In this sense, the charge would not directly penalize production (although, to the extent that it resulted in less fertilizer use, it would still have that effect, indirectly).

- A zero based charge. This would be on the basis that the 1990 level of nitrogen fertilizer application was only about 15 per cent of today's level, that is, sufficiently close to zero that the complexity of an above-1990 marginal charging regime would be unwarranted.

- A wholesale point of obligation, that is, the manufacturer and, if applicable, importer. Currently there are only two (or three) principal manufacturing wholesalers of nitrogen fertilizer in New Zealand.

- The charge would be akin to an excise tax on nitrogen fertilizer and could be administered in a manner similar to the excises applied to, for example, motor spirits and alcohol. The rate of charge could be adjusted, say, annually to take account of changes in the world price of emissions.

Indicatively, assuming a Kyoto price for emissions of NZ$15 per tonne, such a charge would add about 10% to the current price of urea of about $550 per tonne. (Detailed workings are attached as an Appendix.) Assuming little reduction in application rates, the charge would raise about $38 million of revenue per annum during CP1, or about $190 million over the five years.

Overseas evidence indicates that the responsiveness of nitrogen fertilizer application to price is low and, although that evidence relates mainly to arable farming, best assessments are that the situation in New Zealand would be similar. The amount of nitrogen fertilizer applied in recent years has increased strongly, from about 50,000 tonne (nitrogen content) in 1988 to nearly 350,000 tonne in 2004/05. This increased rate of application reflects in part a structural shift from sheep to dairy farming and the increased incidence of clover root weevil (which diminishes clover nitrogen fixing). There also appears to have been increased farmer awareness of the contribution nitrogen fertilizer can make to pasture growth and hence production. To date the increased uptake has been mainly in the dairy sector, but increased application on sheep and beef farms remains a possibility. MAF has assessed that nitrogen fertilizer use could increase further, to between 408,000 and 433,000 tonnes by 2010.

Table 2: ***Assessment of a nitrogen fertilizer charge***

Criterion	**Overall assessment**	**Comments**
Emission mitigation	Favourable, but only slightly so.	The charge would be narrowly based (nitrogen fertilizer contributes less than 5% of agriculture emissions) and the available evidence, including from other countries where nitrogen fertilizers have been taxed, indicates that responsiveness to price would most likely be low.

Fiscal position	Moderately favourable.	The levy on nitrogen fertilizer emissions would fully offset the Crown's Kyoto liability in respect of this emission source – a source which accounts for a significant share of the growth in agricultural emissions since 1990. The offset to the Kyoto liability would be achieved both if, as expected, price responsiveness was low (in which case revenue would be raised to cover nitrogen fertilizer's Kyoto liability) or high (in which case emissions would be curtailed, and the Kyoto liability correspondingly reduced).
Allocative efficiency/productivity	Marginally favourable.	Incorporating the cost of nitrogen fertilizer emissions into the price of the fertilizer would enhance economic efficiency. Currently some fertilizer will be adding less to production than the all-up (inclusive of emission) cost of that production. In those situations, less fertilizer use would be associated with increased sector productivity, albeit at a slightly lower level of production. However, consistent with low price responsiveness, the productivity benefit would be only at the margin. Mostly the charge would be expected to result in a revenue flow to the government rather than reduced fertilizer application. Nonetheless it would be an efficient source of revenue, compared with the alternative of covering the fiscal cost of nitrogen fertilizer emissions from general taxes, which distort economic allocation and hence cause 'deadweight' costs. In sum, a Kyoto charge for nitrogen fertilizer would make a marginally positive contribution to sector, and economy wide, productivity. However the level of sector output would be slightly lower than otherwise.
Consistency with long term strategy (broad-based pricing)	A potentially significant first step toward broader-based pricing of emissions.	Introducing this charge would represent a significant, albeit narrow, step toward pricing agriculture sector emissions. Its value may lie as much in signaling future policy directions as in its direct emission mitigation, though the revenue raised would be material in relation to the sector's overall Kyoto liability.
Sector responsibility for emissions	Small favourable	The charge would result in the sector facing a price for one element of sector emissions, although it would be a charge imposed by the government rather than within a market. Hence the internalization of the cost of emissions into production decisions may face some resistance, certainly compared with if the government was to make compensation payments for reducing fertilizer use, and possibly also compared with a cap-and-trade structure. (Under the latter, once emission rights and responsibilities had been devolved, the government would cease to be an active participant in the process, unlike under a government charging regime.)

International influence	Moderately favourable	Charging for the emissions attributable to nitrogen fertilizer is an obvious candidate for demonstrating New Zealand's willingness to take agriculture emissions seriously. (A number of Annex 1 countries already have measures in place to address the adverse environmental effects of nitrogen fertilizers.) At the same time, confining pricing to just the emissions attributable to the fertilizer itself, and not the additional production it supports, would be consistent with maintaining a position that New Zealand does not favour emission-reducing measures that penalize farm production.
Compliance issues	Favourable	A wholesale level point of obligation would mean that there would be only a handful of entities subject to the charge (possibly no more than 3 or 4). Determining the amount of obligation would also be straightforward if, as proposed, it was linked directly to the relevant GHG inventory emission factors and world price for emissions. The charging regime could be very similar to the specific duties payable on, for example, motor spirits and alcohol.
Cross-sector consistency	Slightly - moderately favourable	The charge would act as counter-weight to existing incentives to deforest land capable of dairying (eg, Central North Island), for which significant application of nitrogen fertilizer may be required to maximize early pasture growth.
Equity	Favourable	Much of the increase in nitrogen fertilizer application has occurred post the commencement of Kyoto negotiations – the sector has been on notice.
Co-benefits - water quality - soil erosion	Small favourable	A charge on nitrogen fertilizer would be consistent with policies aimed at addressing both climate change and water quality problems. Soil nitrates, to which the fertilizer adds both directly and indirectly, are a common source of both N_2O emissions and nitrate contamination of water bodies. However, achieving water quality goals in sensitive catchments may require stronger policy action than would be consistent with meeting Kyoto Protocol responsibilities at least cost. A charge on nitrogen fertilizer at the rate envisaged would be a step toward achieving water quality goals, but perhaps only a small one.
Risks	Potentially significant	The main risk relating to a nitrogen fertilizer charge might be sector resistance. The argument might be made that the carbon tax was rolled back because the base became too narrow, but that a charge on nitrogen fertilizer would be much narrower still. That indicates the importance of such a charge being introduced as part of a well-explained and comprehensive package (possibly including 'carrots' as well as 'sticks').
Implementation issues	Legislation required.	
Trade- policy/	No issues	

WTO compliance		
Treaty of Waitangi	Need to consult with the Office of Treaty Settlements	Prima facie, a charge on nitrogen fertilizer would be akin to the government introducing or varying the rate of tax on, for example motor spirits or alcohol. However, as it may also have implications for land use, albeit at the margin, the Office of Treaty Settlements may need to be consulted.

4.2.2 A broader based Kyoto charge on sector emissions

Instrument parameters:

- A broader charge to cover above-1990 (or a more recent year, eg, 2006) level emissions of:
  - N_2O fertilizer emissions (as above); and
  - N_2O livestock-attributed emissions; and
  - Enteric methane emissions.

  Cumulatively, these amount to about 5%, 32% and 100% of New Zealand's agriculture sector emissions.

- A wholesale point of obligation, that is, the charge would be applied to dairy and meat processing companies on the basis of production throughput; with

- The charge calibrated to the Kyoto factors for each emissions source, at the world price of emissions.

Assuming a Kyoto price for emissions of NZ$15 per tonne, and again relatively low responsiveness to price, such a charge on > 1990 level emissions would raise about $570 million per annum. (This amount is only about three times that from the nitrogen fertilizer charge, notwithstanding that nitrogen fertilizer accounts for only 5 per cent of sector emissions, because in this case only emissions > 1990 levels would be charged.) The same charge if applied only to > 2006 emissions, of course, would raise no revenue initially, but would be expected also to raise about $115 over the five-year term of CP1, or $23 million per annum on average.

The assumption that responsiveness to price would be low is based on there being no more – indeed even less – scope to mitigate enteric methane emissions without reducing production than is the case for N_2O emissions. However, a broader-based charge could result in a larger financial impost on the sector, and this could act as more of a counterweight to future production growth than a narrow fertilizer-only charge.

Devising a broad-based charge to apply to incremental emissions with a wholesale point of obligation would present some design issues. These include:

- whether the charge should apply to units of livestock or units of livestock production (eg, milk solids, meat, etc); and
- how to allocate 1990 base levels (up to which there would be a zero rate of charge), given industry structural and ownership changes that have occurred since 1990.

However, in principle, such an approach should be feasible. For example, one way of coping with post-

1990 structural change would be to allocate current processing companies a 1990 base level of through-put as a percentage of current through-put, the percentage being based on by how much industry through-put has increased since 1990. Going forward, 1990 base level emissions could also be adjusted to take account of changes in market share, so as not to penalize successful companies that grow their market share, to the benefit of those that lose market share.

Table 3: ***Assessment of a broader-based Kyoto charge on agriculture sector emissions***

Criterion	**Overall assessment**	**Comments**
Emission mitigation	Slightly-moderately favourable	Given that the limited scope to curtail N_2O, and more particularly enteric methane, emissions without curtailing production, emission reduction would occur mainly only at the point that farming (at existing levels of intensity) becomes an uneconomic land use, relative to alternatives. At a Kyoto price of $15 per tonne Mt CO_2 e, the impact on production, given current meat and milk-fat prices, would likely be slight to moderate. (For an 'average' dairy farm, for example, the cost has been estimated at about $2,500 to $4,500 per annum, relative to annual milk solid proceeds of about $400,000 (assuming 100,000 kg of milk solids @$4 a kg).
Fiscal position	Favourable	A broadly-based levy on sector emissions above the 1990 level would fully offset the Crown's Kyoto liability in respect of those emissions. This would be the case whether the responsiveness was low (in which case revenue raised would cover the liability) or high (in which case emissions would be curtailed and the liability would be correspondingly reduced). However, if the charge applied only to > 2006 emissions, the Crown would be left responsible for sector emissions from the 1990 level up to current levels. The fiscal cost of that would amount to about $114 million per annum ($570 million over the five-year term of CP1).
Efficiency/productivity	Favourable	Under this option, virtually all sources of emissions from agriculture would be priced at the margin. This would result in emission costs being factored into production decisions in away that results in economically efficient outcomes.

Consistency with long term (broad-based pricing)	Favourable	Under this option, virtually all sources of emissions from agriculture would be priced at the margin, ie, it would bring broad-based pricing of emissions to the agriculture sector.
Sector responsibility for emissions	Medium	Though sector emissions would be priced, the price would still be one imposed by the government, rather than established within a market.
International influence	Favourable	Implementing broad-based pricing of agriculture emissions at this stage could be seen as a strong response; one that might even place New Zealand 'ahead of the game'.
Compliance issues	Favourable	Despite the breadth of the pricing, compliance costs could be kept low if the point of obligation was to be at the wholesale level (processing companies and fertilizer manufacturers/wholesalers). This could limit the points of obligation to a relatively low double-digit number.
Cross-sector consistency	Favourable	Applying a charge to agriculture sector emissions over and above current levels would be broadly aligned with compensating new afforestation, and charging for deforestation. A policy shift from the status quo, which is skewed in favour of agriculture, toward neutrality.
Equity	Favourable	The charge would apply only to above-1990 level, or "new" emissions, hence a moderate, or no, burden would be imposed on the 'existing' level of farming.
Co-benefits : - water quality - soil erosion	Slightly favourable	A broad-based charge on agriculture emissions would be consistent with, but not targeted at, water quality and soil erosion objectives. It could result in small-modest changes in land-use at the margin.
Risks	Significant risks	Sector resistance could be significant, particularly if the charge was not accompanied with similarly broad-based pricing of other sector emissions – which Cabinet decisions have ruled out.
Implementation issues	Legislation would be required.	
Trade-policy/WTO compliance	No issues	
Treaty of Waitangi	Need to consult with the Office of Treaty Settlements	Prima facie, a charge on (ruminant) livestock farming could be seen as having implications for land use/land values, albeit at the margin; hence the Office of Treaty Settlements may need to be consulted.

4.2.3 A 'Kyoto credit' for use of nitrification inhibitors

Instrument parameters

- Payment of a credit for treating pasture with an approved nitrification inhibitor;
- For the duration of CP1 (with a sunset clause);
- Calibrated to the Kyoto value of the inhibitor's emission reduction properties;
- Approval being subject to recognition of the inhibitor's emission reduction properties in Kyoto inventory calculations.

Nitrification inhibitors are products that reduce the extent to which both fertilizer and animal excrement form soil nitrates, and hence N_2O emissions from both within the soil and from nitrate contaminated water bodies. They correspondingly increase the extent to which nitrogen taken into the soil is taken up in pasture growth (and initially were brought to market as products to improve nitrogen efficiency rather than to mitigate emissions). To some extent nitrification inhibitors, besides contributing to emission reductions, can serve as a substitute for nitrogen fertilizer, and in this way make a dual contribution to emission reduction goals.

Currently nitrification inhibitor products are being marketed by two companies, Ravensdown Fertilizer Co-operative Company Ltd, and Balance Agri-Nutrients Limited, and in two forms. One form, know as ***eco-n***^{TM} and marketed by Ravensdown, comes in a fine suspension (slurry) form, and is applied by spraying on to pasture. If applied in the correct manner under the correct conditions, it is assessed as being capable of reducing N_2O emissions by 50 per cent – 70 per cent and leaching of soil nitrates into water bodies by 35 per cent – 50 per cent. (Given that correct application is critical for the product to be fully effective, it is made available to farmers only through applicators approved by Ravensdown; the product and the cost of application are purchased as a package, at a price per hectare of treated pasture.)

Other inhibitors take the form of a coating to nitrogen fertilizer and are applied in combination with the fertilizer. The emission reduction properties of these products are less well established.

Ravensdown has proposed that the government pay a credit for the ***eco-n***^{TM} product at the rate of $30 per hectare (compared with the current cost of $124 per hectare). This rate of credit has been based on a carbon dioxide price of $25 per tonne. If applied to all dairy pasture, the fiscal cost in CP1 has been assessed by Ravensdown at about $200 million, or $40 million per annum. The corresponding figures at $15 per tonne are $120 million and $24 million per annum. Ravensdown has also sought additional government funding of $650,000 over three years for research that is required for ***eco-n***^{TM} to obtain GHG inventory recognition.

The option outlined below broadly corresponds with the proposal being advanced by Ravensdown.
Table 4: ***Assessment of a 'Kyoto credit' for use of nitrification inhibitors***

Criterion	**Overall assessment**	**Comments**

Emission mitigation	Favourable (subject to confirming research)	The ***eco-n***^{TM} inhibitor is slated to reduce N_2O emissions by 50% - 70%, depending on soil and other conditions. However questions remain about the permanence of the mitigation effect. It also promotes pasture growth and hence potentially increased CH_4 emissions, but could offset some nitrogen fertilizer use and hence emissions from that source. Responsiveness to price could be significant given that production benefits already put inhibitors on the margins of economic viability.
Fiscal position	Neutral relative to status quo; but no inroad into the underlying Kyoto liability.	Credit payments, if calibrated to the value of the emission reduction of the product (at the world price of emissions), would be offset dollar-for-dollar by a diminution in the Crown's Kyoto liability (subject to inhibitors being recognized in the GHG inventory calculation). But those payments would have to be funded; hence no inroad would be made into the Crown's underlying Kyoto liability.
Allocative efficiency and productivity	Partly favourable, partly unfavourable	Introduces a price for nitrogen emissions. Hence least-cost reductions in nitrogen emissions, from both fertilizer and livestock sources, would be promoted. Also, production would be supported rather than penalized. But a fiscal cost, which would have to be covered by (distorting) general taxes would remain.
Consistency with long term (broad-based pricing)	Favourable	Introduces a price for emitting N_2O, albeit a credit payment forgone. The pricing would be broader-based than a charge on nitrogen fertilizer alone, as it would address all N_2O emissions (from livestock excrement as well as from fertilizer).

Sector responsibility for emissions	Unfavourable	The agriculture sector would face a price for nitrogen emissions, but as a compensation payment rather than a charge. This would imply an "existing use right" to emit, and would still leave for the future a shift of responsibility for emissions to the sector itself. (The 'sunset' provision would terminate the compensation payment, but if nitrogen emissions were to continue to be priced thereafter, a new charge on those emissions would then need to be put in place.)
International influence	Somewhat favourable	Could be regarded as a meaningful response to agriculture emissions (though it could be viewed less positively than would a charge on nitrogen emissions, as above, or a compulsory requirement to use nitrification inhibitor, as below).
Compliance issues	Favourable	Low compliance costs if the credit was paid at the wholesale level.
Cross-sector consistency	Favourable	While a compensation payment to agriculture, it would be paid only to the extent that the sector reduced its GHG emissions. It can be viewed as the equivalent of a compensation payment for new afforestation.
Equity	Favourable	Recognizes transitional 'existing use rights'.
Co-benefits - water quality - soil erosion	Favourable	Widespread use on dairy pasture could materially reduce the nitrate element of water contamination by agriculture (subject to outstanding questions about the permanence of the effect). Little if any implication for hill country erosion. The required method of application of the ***eco-n***^{TM} product at least precludes its use on hill country.
Risks	Some policy risks	The main risk is that the performance of nitrification inhibitors cannot be sufficiently proven to count towards reducing New Zealand's GHG inventory. However, partial recognition would be a possibility if full recognition cannot be obtained. No sector resistance should be encountered to a credit payment, but there could be resistance to its termination at the end of CP1.
Implementation issues	Budgetary appropriation required.	
Trade policy/WTO compliance	Issues would need to be managed.	Prima facie a credit payment for use of nitrification inhibitors could be seen as an input subsidy; hence a need to structure the credit so that it meets WTO requirements to qualify as a "green" measure.
Treaty of Waitangi	No issues.	

4.2.4 Mandatory use of nitrification inhibitor

Instrument parameters

- A farm level point of obligation.
- Compulsory application of an approved (GHG inventory-recognized) nitrification inhibitor product either:
    - In conjunction with the application of nitrogen fertilizer; or
    - To prescribed pasture, for example, dairy pasture that carries more than ‘x’ cows per hectare.

Table 5: ***Assessment of mandatory use of nitrification inhibitor***

Criterion	**Overall assessment**	**Comments**
Emission mitigation	Favourable	The ***eco-n***^{TM} product marketed by Ravensdown is slated as reducing N_2O emissions by up to 50%-75%. Compulsory application could result in more certain and (depending on the details of the compulsory requirement) greater uptake of nitrification inhibitors than under the option to pay a Kyoto credit. Compulsory co-use with nitrogen fertilizer would result in less broad-based emission mitigation, since it would not address emissions attributable to livestock on unfertilized pasture.
Fiscal position	Favourable	Fiscally positive as the Crown’s Kyoto liability would be reduced (by the amount of inhibitor applied times its emission reducing factor), at no fiscal cost.
Allocative efficiency/productivity	Unfavourable for allocative efficiency. Favourable for the level of sector output.	Optimal use of inhibitors depends on soil and other conditions. Thus, a compulsory requirement to achieve full uptake in some situations would result in over- (wasteful) use. On the other hand, a compulsory requirement at a relatively low level would result in situations where the required rate of application would be less than what the combined production and emission reduction benefits would warrant. Nonetheless, a low-level compulsory requirement would boost rather than reduce production, just not as efficiently as under a pricing approach.

Consistency with long term (broad-based pricing)	Unfavourable.	Imposing a compulsory requirement would run counter to a strategy to move toward broad-based pricing of GHG emissions.
Sector responsibility for emissions	Unfavourable.	Compulsion is less likely than pricing to engender acceptance by the sector of responsibility for GHG emissions.
Compliance issues	Unfavourable if a farm level point of obligation. Favourable if a co-use requirement with a wholesale point of obligation.	A compulsory requirement applied at the individual farm level would involve compliance having to be monitored and enforced at a very large number of points of obligation. Compliance issues would be less problematic in the case of a nitrogen fertilizer/nitrification inhibitor co-use requirement, at least in the case of inhibitor that takes the form of a coating to nitrogen fertilizer. However, that is not the case for the ***eco-n****TM* product, which is applied separately, and at different times, from nitrogen fertilizer.
Cross-sector consistency	Unfavourable	A compulsory standards approach has not been applied in other sectors – though may be with respect to vehicle emissions/ages.
Equity	Unfavourable	Compulsion implies imposition of uneven costs.
International influence	Moderately favourable	Requiring use of nitrification inhibitors could be regarded internationally as a moderately strong response to agriculture emissions (though still consistent with not penalizing production).
Co-benefits - water quality - soil erosion	Favourable	Inhibitors are slated as reducing nitrate leaching into water bodies by up to 35%-50%. Widespread use on dairy pasture could materially reduce the nitrate element of water contamination by agriculture. Little if any implication for hill country erosion. (The required method of application of the ***eco-n****TM* product at least precludes its use on hill country.)
Risks	Moderately unfavourable	The major risks relate to: - sector resistance to a compulsory requirement - the possibility that inhibitors fail to achieve recognition as reducing New Zealand's GHG inventory.
Trade policy/WTO compliance	No issues	

Implementation issues	Legislation probably required (or possibly capable of implementation under Resource Management Act legislation.)	Whether it would be possible to mandate use of nitrification inhibitors by way of a National Policy Statement under the Resource Management Act is uncertain; if so probably only as a water quality related measure. (The Resource Management was amended to exclude greenhouse gases from the scope of the environmental effects it is concerned with.)
Treaty of Waitangi	No issues	

4.2.5 Cap-and-trade allocation of (nitrogen) emissions to dairy companies

Instrument parameters

Under this option, a level of (N_2O) emission rights would be allocated to the dairy sector, with dairy processing companies being the point of allocation. Dairy companies would be responsible for any emissions above the level allocated and, correspondingly, able to sell any rights that become excess to requirements owing to emission reductions achieved by suppliers. Accordingly, the dairy processing companies – principally Fonterra – would face an incentive to work with their farmer suppliers to contain or reduce emissions, with financial benefits expected to flow back to farmers by way of a higher price for milk solids supplied. (A full flow-back of benefit to farmer suppliers could be expected in the case of the co-operatively-owned Fonterra and other companies could be expected to follow suit in order to maintain a competitive position vis-à-vis Fonterra.)

A number of pre-conditions, however, would need to be met before such an arrangement could be established. One relates to the availability of means – that are recognized for GHG inventory purposes – by which dairy farms can manage-down or contain N_2O emissions. Currently the only such means is to reduce application of nitrogen fertilizer. Others, yet to be recognized in inventory calculations, but which potentially could be (on their emission-reducing properties being confirmed by further research) include use of nitrification inhibitors and of stand-off and feed-lot pads.

Importantly, such an arrangement would need to be negotiated rather than imposed: it does not appear possible to make one party (a processing company) responsible for the actions of others (farm suppliers). And the processing companies could be expected to enter into such an arrangement only on terms that would be advantageous to them, possibly, for example, by seeking allocations of emission rights above existing levels.

Table 6: ***Assessment of a cap-and-trade allocation of (nitrogen) emissions to dairy companies***

Criterion	**Overall assessment**	**Comments**

Emission mitigation	Moderately favourable	Emitters, via the processing companies, would face a world price for emissions – which depending on the extent of the emission allocation could be either a cost of having to purchase additional emission rights, or the cost of forgoing the opportunity to sell emission rights for financial benefit. Hence the emission mitigation effect, with respect to N_2O emissions, could be expected to be similar to that under option 2.1.2 above.
Fiscal position	Uncertain – would depend on the size of the emission right allocation.	The greater the allocation of N_2O emission rights, the less inroad would be made into the Crown's Kyoto liability. (Allocating emission rights for free, which recipients can sell on the world market, is equivalent to the Crown paying a compensation payment at the world price for emission reductions.)
Allocative efficiency/productivity	Mostly favourable	Emissions would be subject to a price, which could be expected to converge on the world price. This would be allocatively efficient. Under such the structure envisaged, processing companies could be expected to drive/fund the development of mitigating technologies (inhibitors, stand-off pads, nutrient budgeting etc). A qualification is that the Kyoto liability that remained with the Crown would need to continue to be funded from general taxes, which impose deadweight (efficiency) costs.
Consistency with long term strategy (broad-based pricing)	Favourable	The structure would result in pricing of marginal dairy sector N_2O emissions, and could pave the way for the development of broader trading of emission rights.
Sector responsibility for emissions	Uncertain	The sector would assume responsibility for emissions above the level allocated – but if the allocation was generous, eg, above existing levels, that would mean significant responsibility would remain with the Crown.

International influence	Favourable	Could be regarded as a significant response to, and useful signal in relation to, agriculture emissions.
Compliance issues	A possible impediment	Compliance monitoring and enforcement would be devolved to the dairy processing companies – something which they may see as sufficiently problematic as to make them unwilling participants.
Cross-sector consistency	Potentially unfavourable	A generous allocation of emission rights could set unhelpful precedents for other sectors.
Equity	Likely generous recognition of ‘existing use rights’	A generous allocation of emission rights could set unhelpful precedents for other sectors.
Co-benefits - water quality - soil erosion	Moderately favourable.	Co-benefits would parallel the extent of emission mitigation achieved.
Risks	Some policy risks.	The main risks that would need to be considered are: - sector resistance, the degree of which would be inversely related to the size of the allocation. - that if the allocation was generous, that other sectors would claim similar entitlements – a potential fiscal risk. - that mitigating technologies are not sufficiently proven to count as reductions to NZ’s GHG inventory (hence limiting the scope for on-farm reductions of emissions and correspondingly lessening sector interest in participation).

Implementation issues	Unfavourable	Such an arrangement would need to be negotiated. The Crown would need to have alternative arrangements available as a credible fall-back.
Trade policy/WTO compliance	No issues apparent	
Treaty of Waitangi	Need to consult the Office of Treaty Settlements	An allocation of a property right would be involved.

5. Bringing it together – short term options and longer term strategy

5.1 Possible package for CP1

Economic instruments

There are many ways in which elements of the options outlined in the preceding section could be brought together as a package for CP1. One possible combination might comprise the following:

- a charge on:
  - nitrogen fertilizer, calibrated to cover the cost of the N_2O emissions attributable to nitrogen fertilizer in the GHG inventory calculations; or
  - a more broad-based charge on all agriculture sector N_2O emissions (attributable to both fertilizer and livestock) and on enteric methane emissions, but only in respect of emissions above a (either >1990 or > 2006) threshold level; plus

- payment of a credit for uptake of nitrification inhibitor – subject to (a) the payment being committed for CP1 only and (b) the payment per unit of inhibitor not to exceed the amount by which its use reduces the Crown's Kyoto liability (hence inclusion of nitrification inhibitors in New Zealand's GHG inventory calculations would be a prerequisite);

Payment of a credit for use of nitrification inhibitors is proposed in favour of compulsion for two reasons.

First, nitrification inhibitors remain a relatively unproven product. To make use mandatory before their effectiveness is well-established would involve some risk, should it become apparent over time that their effectiveness falls short of expectations. Ravensdown recognizes, for example, that the effectiveness of its ***eco-n***^{TM} product is variable according to conditions, and that there is some uncertainty as to the permanence of its inhibitor properties. These uncertainties can be factored in to a pricing regime by discounting the credit paid, for example, by calibrating the credit to, say, half what might be suggested by the experimental results to date. (In any event, it seems likely that until nitrification inhibitors' emission reduction properties are more firmly established, they will be only part-recognized in GHG inventory calculations.) By contrast, a mandatory use requirement is, by its nature, an 'all-or-nothing' measure.

Secondly, pricing the emission-reducing benefits of nitrification inhibitors by way of a credit payable for use would be more efficient than a compulsory use requirement. To be sure, paying a credit would involve a fiscal outlay, and thus no inroads would be made into the Crown's underlying Kyoto liability, ie, the diminution in the Kyoto liability from the uptake of inhibitors would be offset by the cost of paying the credit. That may appear sufficient of a disadvantage to outweigh the economic inefficiency of a compulsory use requirement (bearing in mind that the taxes required to fund fiscal obligations generate their own efficiency, or dead-weight, costs). However, that disadvantage from paying a credit for use of inhibitors is more apparent than real.

While compulsion is one way in which to avoid fiscal outlay, another is to charge emission sources, eg, nitrogen fertilizer, and/or livestock. A charge applied to emission sources could raise the revenue required to cover the fiscal outlay arising from paying credits for use of nitrification inhibitors, and leave the

Crown with a net fiscal benefit (from the diminution of the Kyoto liability resulting from inhibitor use). The sector, on the other hand, would face a net zero fiscal position, with the fertilizer charge being cancelled out by the inhibitor credit. Such a structure, of charges and credits, based on the world price for emissions, would result in the economic cost of emissions, and benefit of emission reductions, being factored in to input and production decisions in a way that would result in economically efficient outcomes.

Two options for charging emissions are listed above, that is, to charge for the emissions generated by nitrogen fertilizer, or to apply a marginal charge to all pastoral N_2O and CH_4 emissions above either a 1990, or 2006, threshold.

Of the two charging options presented above, the broad-based but marginal charge on all agriculture emissions has the advantage of introducing a price for all incremental pastoral emissions and would be neutral as between dairying and sheep and beef farming. If applied from a 1990 threshold, it would cover the full amount of the Crown's Kyoto liability in respect of pastoral emissions, not just credits paid in respect of use of nitrification inhibitors. If the same charge was applied only to above-2006 emissions, the revenue raised would still make a dent in that liability, perhaps to the extent of about $114 million out of $570 million projected for CP1. The narrower, but zero-based, charge on nitrogen fertilizer would make a larger dent, of about $190 million. In each case any outlay on an inhibitor credit would be offset by a dollar-for-dollar diminution in the Crown's Kyoto liability. Thus, combining either of the charging options outlined with payment of a credit for use of nitrification inhibitors would result in a net improvement in the Crown's fiscal position over CP1 of, $115 million and $190 million, respectively.

A possible advantage in adopting the option to charge nitrogen fertilizer is that it would be better attuned with a preference, including for strategic reasons, to avoid measures that directly penalize production. Compared with a marginal charge on livestock production above 2006 levels, it would also raise a greater amount of revenue (and sufficient to fund the inhibitor credit, if that measure also was to be adopted).

Complementary and supporting policy measures

While economic instruments may provide a core to an overall package, complementary research, voluntary and information dissemination activities can play an important mutually reinforcing role. Correspondingly, such activities by themselves may be of limited effectiveness.

With respect to research, the most obvious and immediate priority is to obtain confirmation of the mitigation properties of nitrification inhibitors so that their use can count as a reduction in New Zealand's GHG inventory. Ravensdown has identified a research funding need in respect of its ***eco-n***^TM^ product of $635,000. If the government was to signal its willingness to pass on the Kyoto credit value of the product, that may be sufficient for Ravensdown itself to make the necessary research investment, although some government co-financing could also be justified on the basis that inventory measurement is explicitly a government responsibility. Comparable co-funding of the research that could be required to also achieve inventory recognition for other forms of inhibitor product funding, including so as to maintain a "level playing field".

Less advanced is research into the emission mitigation value, in the New Zealand context, of other on-farm management practices with emission reduction potential, such as use of stand-off and feed-lot pads (in dairying). Introducing pricing for livestock emissions (and signaling potential broadening of that pricing in the future) would help to incentivise the research that will be needed for on-farm mitigation possibilities also to obtain inventory recognition. Co-financing of well-directed programs with the potential for an inventory recognition pay-off would appear warranted.

These areas of research may be at a more applied level than typically regarded as a government funding priority. (The case for government funding is generally regarded as strongest for pure research with a strong ‘public good’ character.) However, climate change is an area of policy where it is in the government’s own fiscal, as well as New Zealand’s international negotiating, interests, for positive applied research to be pursued. The government already has a significant investment in demonstration/research farm programmes, which provides a base for the applied research required for bringing new technologies to market.

To be effective, research needs to include tools and methods that foster engagement and uptake of new technologies at the farm level. Demonstration farms provide one such link. Voluntary reporting arrangements can also play a useful role in piloting the reporting and verification arrangements that would be needed under regimes in which tradable emission rights and obligations are devolved to the farm level, and/or if Kyoto credits are to be paid for adoption of emission-mitigating farm management practices.

In sum, a package organized around these – economic pricing and complementary – elements would:

- introduce (some) pricing of emissions to the agriculture sector;
- involve only a handful of points of obligation/entitlement (perhaps no more than three or four fertilizer companies);
- in a way that could be fiscally neutral to the sector, while fiscally positive for the government[7];
- reflect favourably on New Zealand in terms of being seen to take feasible steps to address agriculture sector emissions;
- preserve a position of being unwilling to adopt measures that achieve emission reductions only by curtailing farm production; and
- help to lay foundations for a range of future options (eg, cap-and-trade arrangements and the passing through of the Kyoto value of emission reducing on-farm management practices), and without closing off future options.

5.2 Cross sector integration – climate change, water quality and land use policy

The illustrative package outlined above has been framed with climate change policy mainly in mind. Concordance with water quality (and soil erosion) policy objectives, and cross-sector consistency, particularly as between the agriculture and forestry which are competing land uses, also needs to be considered.

Integration with water quality policy

The leading example of policy under development to achieve water quality objectives is that being developed for the Taupo/Waikato catchment by Environment Waikato and MAF. Its centre-piece is a proposed cap-and-trade arrangement in respect of nutrient inputs. The methodology proposed to be used in accounting for nutrient inputs is the Overseer™ nutrient budgeting programme.

[7] Of course the sector would bear the net of credit cost of the nitrification inhibitor, but would capture the productivity benefits it delivers (and presumably would not use inhibitors beyond the point that the net cost exceeded the production benefit).

The basic approach would be to allocate at the farm level a nutrient input entitlement (with the basis of allocation yet to be determined and subject to unresolved issues), with those entitlements being eligible for trading. This would enable property owners who reduce nutrient input, for example by adopting nitrogen-reducing dairy farm practices, to sell nutrient input entitlements to those wishing to increase nutrient input to above the level of their initial allocation.

While this proposal is well-developed in concept, it appears that much may remain to be done for it to become operational. The strategy being followed appears to have been "top down", with an operational cap-and-trade regime having been identified as an end-goal, and current efforts directed to developing some operational arrangements. However, it is unclear how advanced those arrangements are, for example, with respect to determining the basis on which initial allocations would be made, and developing the registry on which allocations and trades would need to be recorded. There may also be issues concerning the consistency of the nutrient accounting provided by the Overseer™ methodology across individual farms, and the procedures that would be required to verify/audit individual farm measurements. It is also unclear to what extent the accounting methodology incorporates allowance for variations in (existing and potential future) on-farm farm management practices, such as in the spreading of effluent, use of stand-off pads, wintering off, and use of nitrification inhibitors.

By contrast, the strategy outlined above for bringing the agriculture sector within the ambit of climate change policy is more "from the ground up". It envisages a pragmatic path forward, commencing with pricing that would operate at a wholesale, rather than individual farm, level. Further development is seen as being required before pricing at, and/or devolution of emission (trading) rights and obligations to, the farm level could be implemented.

It is therefore not obvious that the respective approaches to climate change and water quality are aligned in a way that would enable maximum co-leveraging. An alternative to the current quite different starting points might be to follow more parallel tracks.

A more integrated strategy might entail ensuring that the GHG research and extension activities incorporate a dual focus on water quality as well as climate change objectives. Nitrogen management issues are common to both areas of policy concern. The water quality focus could be used to spear-head some specific initiatives where sector buy-in to climate change policy has yet to become well established.

At the same time, the same research and extension programmes would serve to strengthen the foundations for implementing pricing and or/market based instruments in the water quality space, the foundations for which, currently, may be relatively weak. These programmes could provide a basis for vigorous promotion within the Taupo/Waikato catchment of on-farm practices that reduce water contamination, in conjunction with the introduction of voluntary reporting.

There could be advantage in getting some 'runs on the board' in these ways before progressing to a-cap-trade approach for managing water quality. Meanwhile the intention to move in that direction could be firmly foreshadowed for, say, 5 or 6 years time (incidentally, 2012 would correspond with the end of the Kyoto CP1). That would incentivise greater uptake of mitigating practices during the lead-up period, together with voluntary reporting to preserve future nutrient allocation entitlements. Such initial steps could set up a platform for a positive transition, with adjustment being fostered by a combination of 'sticks' and 'carrots'. Such an approach may also help to resolve the fraught issues that are inherent in making an initial allocation. The terms of allocation could be signaled well in advance and reward 'good' rather than 'bad' lead-in behaviours (possibly including some compensation for land that remains less intensively farmed, or forested).

An approach along these lines to progressing water quality goals would put climate change and water quality policies on more parallel tracks and provide greater opportunities for each to leverage off the other. For example, if government was able to indicate that there will be an economic benefit to farms that adopt GHG-reducing practices, based on the world price of GHG emissions, that could help ease the burden of achieving the water quality policy goals. (It seems that achieving desired water quality standards in sensitive catchments may be more significantly demanding than will be required of those regions in respect of climate change policy alone.)

Land use and land use change: forestry and agriculture

The frameworks for climate change policy under development for the agriculture and forestry sectors appear to be broadly congruent, at least in principle. The basic approach in both cases is to move toward pricing marginal emissions and emission offsets at their Kyoto value. That is, incremental emissions (from farming and from deforestation) would be subject to a charge and verified activities that offset emissions (application of nitrification inhibitors and afforestation) would be eligible for the payment of a Kyoto credit.

Table 7: Cross sector overview – agriculture and forestry.

Agriculture		Forestry	
Charge	Credit	Charge	Credit
Either: Nitrogen fertilizer emissions (Covers$190m of $573 CP1 liability, leaving a $383 m CP1 liability) **or** All N_20 and CH_4 emissions above: - 1990 threshold (Covers $573m of $573 CP1 liability), or - 2006 threshold (Covers $115m of $573 CP1 liability, leaving a $458 m CP1 liability)	Nitrification inhibitors (Fiscally neutral as cash outlay is offset by reduced CP1 liability)	Deforestation in excess of 21 million tonne CO_2 e. (Caps CP1 fiscal cost at $315 m)	Emission credits resulting from new (post 2006?) afforestation (Fiscally neutral, as cash outlay is offset by reduced CP1 liability)

The views expressed in this report represent those of the author and do not represent Government policy.

The symmetry of approach across both sectors is illustrated in table 7 (along with estimated CP1 fiscal implications). In each sector, emissions would be priced by way of a combination of charges and credits, in a way that would be broadly neutral with respect to land use choices as between agriculture and forestry.

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<u>Appendix</u>: What would be the rate of charge on N fertilizer calibrated to cover its Kyoto liability?

N_2O emissions (directly) attributable to N fertilizer

A. Emissions from fertilizer and excrement before entering the soil

Source: Table 4.5 (4 of 5) page 153 2005 Inventory.

Attributable to fertilizer: [33,153,333/(33,153,333 +.315,820,165)] X 5.484 = 0.521 Gg N_2O

Attributable to excrement: [315,820,165/(33,153,333 + 315,820,165)]X5.484 = 4.963 Gg N_2O

B. Emissions from leaching

Source: Table 4.5 (5 of 5) 2005 Inventory

Attributable to fertilizer: [331,533,333/(331,533,333 +1,579,100,824)] X 5.254 = .911Gg N_2O
Attributable to excrement: [1,579,100,824/ (331,533,333 +1,579,100,824)] X 5.254 = 4.343 Gg N_2O

C. Emissions from soil

Source: Table 4.5 (1 of 5, 2 of 5 and 3 of 5)

Attributable to fertilizer: 5.861 Gg N_2O
Attributable to excrement and other: 0.767+ 0.095 + 0,200 + 0.127 + 24.047 = 25.236 Gg N_2O

Total N_2O emissions attributable to fertilizer:

A + B + C = Total
0.521 + 0.911 + 5.861 = 7.293 Gg N_2O

X 310 to give CO_2 e = CO_2 e 2.261 Mt

Kyoto liability on emissions directly attributable to N fertilizer
@ $8 per Mt = $18.1 million
@ $15 per Mt = $33.9 million
@ $25 per Mt = $56.5 million

2003 Nitrogen fertilizer application:
331,533,333 Kg N /0.46 = 720,724,360 Kg Urea
@ $550 per tonne = $396.4 million

Kyoto charge as a percentage rate:
@ 8 per Mt CO_2 e = 4.6%
@ 15 per Mt CO_2 e = 8.6%
@ 25 per Mt CO_2 e = 14.3%