A Convenient Untruth

Towards a lighter agricultural footprint

Sustainability Council of New Zealand

Contents

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** Incorporates a minor change to point 17 of the summary to reflect the main text.*

Summary

Agriculture has the potential to substantially reduce the nation's greenhouse gas emissions. At a profit, the sector could meet its share of New Zealand's emission reduction target under the Kyoto Protocol. As livestock accounts for half the nation's total emissions, this would in turn meet about half the total excess emissions currently projected. This potential can be achieved through abatement of nitrous oxide emissions alone and is considerably greater than has generally been acknowledged.

1. Livestock emissions are expected to account for over 40% of the growth in emissions above 1990 levels that are the baseline for measuring compliance under the Kyoto Protocol. New Zealand's emissions in excess of this are currently projected to cost around $600 million on the Government's pricing assumptions, or about $1.2 billion at a price of $30/tonne for the carbon credits required to be purchased. The taxpayer is liable for this cost unless it is passed through to emitters.

2. In 2004, the Government entered into a Memorandum of Understanding (MOU) with the agriculture industry so as to "shield the agriculture sector … from the cost New Zealand will incur due to growth in agricultural greenhouse gas emissions". In recent announcements, the Government has signalled it will make some movement away from this position and has signalled it will review the MOU.

3. Yet the rationale for that agreement is still widely cited. It states that the sector will be exempted from any charges on livestock emissions prior to 2012 because "there are currently no proven, practical and cost-effective farm practices and technologies to reduce agricultural emissions". To the extent this ever was true, it is not now.

Saving Nitrous Oxides Emissions at a Profit

4. A third of livestock emissions are the nitrous oxide N_2O and these can be substantially reduced very cost-effectively. Research on how to cut the other two thirds of emissions that is methane is at an earlier stage so the costs of abatement are less well understood, though there are clear prospects there.

5. Research on reducing N_2O emissions has focused on the dairy industry. The leading tool that has emerged is a product capable of inhibiting the release of N_2O when applied to pasture as a spray or in granules. Recent results from trials of a nitrification inhibitor across four major New Zealand soil types shows an average 70% reduction in emissions arising from pasture land. Significantly, inhibitors also retard leaching to a similar degree and thus protect waterways and lakes from nitrate runoff.

6. A further important benefit is that by assisting to retain nutrients in the soil, inhibitors increase pasture growth by 10% to 15% or more. These gains, and the savings resulting from less fertiliser use, mean that it is generally

profitable to use inhibitors before even taking account of the value of reduced N_2O emissions and reduced nitrate runoff.

7. Another technique that research indicates more than pays for its costs is the use of what are termed “standoff pads”. By ensuring that cattle spend three quarters of their time on such pads during winter months, N_2O emissions can be reduced by 10% - or rates up to double this if the effluent collected is not immediately sprayed on the land.

8. Feeding cattle a diet less rich in nitrogen is another mechanism. Using maize silage as supplementary feed reduces N_2O emissions by 22% while holding milk production constant. This technique’s cost-effectiveness varies depending on maize prices. Other techniques include: improving soil drainage (reductions of 7% to 10%), soil liming, and breeding new grasses (reductions of around 6%).

9. A number of these measures are also applicable to sheep and beef farming, which account for most of the nation’s other N_2O emissions. Trials to date indicate nitrification inhibitors will perform similarly effectively on these farming systems. The extent to which they will be cost-effective remains to be clearly determined.

Meeting Half the Current Kyoto Liability

10. To explore the national significance of these techniques, the extent of emission reductions available were modelled under a range of scenarios. The high level assumptions used for the modelling are derived from the most recent government projections and the technical assumptions are either those used by the Lincoln University team that has led research into the relevant inhibitor formulation, or assumptions used by MAF.

11. The baseline scenario is the application of nitrification inhibitors alone to all relevant pasture. For the dairy sector, this would reduce emissions by 3.7 megatonnes (Mt) of carbon dioxide equivalent in the year 2010, or 9.3% of then expected total agricultural emissions.

12. This scenario shows total dairy N_2O emissions are abated about 57% after allowance for various limiting factors. If the effectiveness of the inhibitor is reduced, this proportionately lowers savings. However, if farmers apply other techniques at the same time as inhibitors, the overall level of savings will not be restricted to inhibitors. There has been very limited study of the effects of emission reduction measures in combination. Indicatively however, combining a standoff pad with inhibitors at their baseline rate of effectiveness could raise dairy N_2O abatement to around 60%. If maize feeding is also added, the effective abatement could be as high as 67%. Importantly, combining other techniques with use of an inhibitor does not meaningfully alter its economics.

13. For the beef and sheep sectors, the use of inhibitors alone has the technical potential to save a similar quantity of N_2O emissions as is available from the

dairy sector. Thus overall, there is the ability to abate some 19% of total agricultural emission, though the cost-effectiveness of the sheep and beef component remains to be determined.

14. To put these figures in context, emission reductions available from just the dairy sector can almost halve the nation's currently projected excess emissions. Under baseline assumptions for the application of inhibitors alone, the potential savings equate to 18.5 Mt over the Protocol's first five-year commitment period – as against an excess currently estimated at 39.3 Mt. At a carbon price of $30/tonne (well below the current EU exchange price), this has a value to the nation of about $550 million.

15. By way of cross-sector comparison, dairy industry baseline savings are equal to cutting around half the nation's current emissions from electricity generation.

Dairy Industry Subsidies?

16. Major agricultural industry representatives argue however that inhibitors have a very limited role to play in that first commitment period. Federated Farmers and Fonterra in particular take this view, and Fonterra further states that it would be unfair to expect the dairy sector to take responsibility for its growth in emissions from 1990. As the industry's business strategy is focused on growth in output, it has an incentive to reserve the emission reductions it can make for that additional growth, while leaving the taxpayer to pay for its past growth since 1990.

17. The Government has stated that it is investigating a tradeable permit regime as a means of pricing "all gases, to all sectors". However, it has also floated the idea that the dairy sector could take responsibility for the growth in its livestock emissions only above 2005 levels. While this approach was suggested before Fonterra announced a significant rise in its expected payout for 2008, the principles at stake are clear. If the agricultural sector were granted a holiday on emissions growth before 2005, this would equate to a taxpayer subsidy on its excess emissions of between 68% and 85%, on current projections. It would mean that only 3% to 6% of the sector's total emissions were priced. At a carbon price of $30/tonne, such an exemption would be worth at least half a billion dollars to the sector, with values ranging from $529 million to $742 million assuming all the nation's forestry credits are used to offset the Kyoto liability, and more if not.

Business as if Sustainability Were Central

18. The New Zealand economy needs an agriculture sector with environmental sustainability at the core of its business planning, and so fully embracing responsibility for emissions. The best response to the sustainability challenge is for it to position at the premium end of overseas markets, where less volume can be sold at higher prices, and take leadership in delivering the environmentally sustainable products they increasingly value. It is about

turning threat to opportunity and getting ahead of the competition, not being "shielded" from change that is needed for the country as a whole.

19. Emission reductions available from the dairy industry are clearly a part of the nation's package of least cost abatement options. Further, these savings are large in relative terms and can be brought on quickly. The availability of a cornucopia of cheap and rapidly adoptable agricultural options is a remarkable break.

20. As a result, agriculture should be the first, not the last sector, to have its excess emissions priced. There is a range of ways a price can be set for 2008, including establishing a tradeable permits regime. Government can however assist the sector at no cost to the taxpayer by ramping the introduction of the obligation – so that less savings are required in earlier years than in later years.

21. If the dairy industry is to further significantly expand, then business cannot be as usual any more. It has to be business as if sustainability were a core business requirement. That means full pricing of environmental services for at least the additional growth. Only then are environmental costs in the new investor's equation, instead of being implicit subsidies.

22. Should the Fonterra price forecast result in dairy industry expansion beyond what current projections allow for, agriculture would then be expected to meet the cost of all its growth, regardless of whether it has the ability to cost-effectively mitigate all of those new additional emissions.

Moving Forward

23. The potential for reducing agricultural greenhouse gas emissions is much greater than has generally been acknowledged. The repeated shorthand that these livestock emissions are methane, and that methane cannot be abated without culling herds has proven a powerful but false message: a convenient untruth.[1] As an apparent justification for not passing through to agricultural producers the fiscal and environmental costs of their activities, its time has well expired.

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[1] The Oxford Concise Dictionary gives one definition of 'untruth' as "the quality of being false", and it is used in this sense.

1. Agriculture's Special Place in the Firmament

In recognition of New Zealand's responsibility to act with the international community to abate greenhouse gas emissions, and so limit adverse climate change, the Government has taken the following steps over the past 15 years.

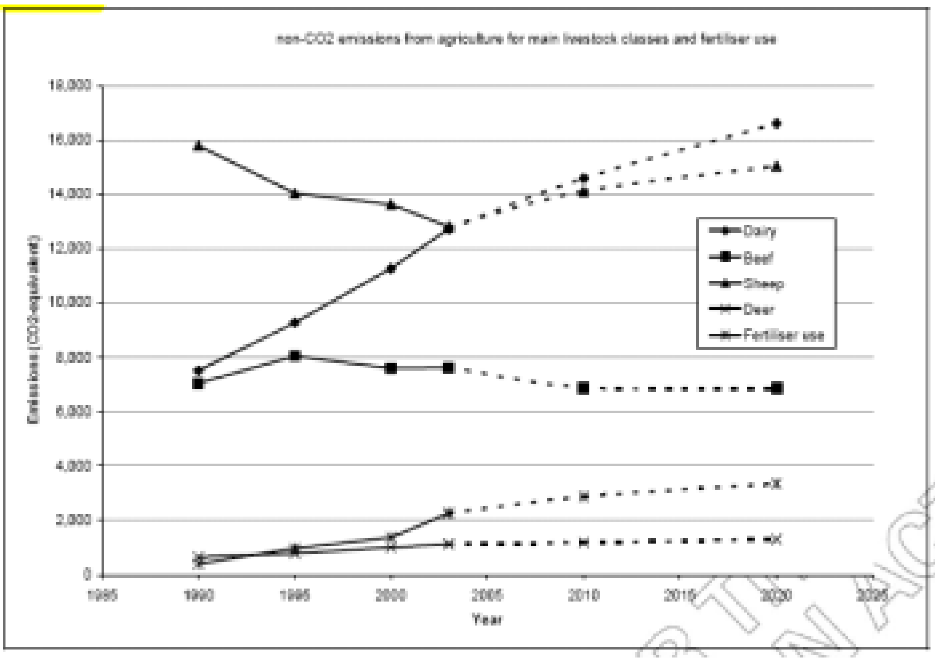
- In 1992 it signed and ratified the Framework Convention on Climate Change (FCCC) that emerged from the United Nations Earth Summit. This set up the legal structure for international co-operation on emissions reductions and places legal obligations on parties to act in their own right.

- In 1997, New Zealand negotiated an emissions reduction target along with most other developed nations under what became the Kyoto Protocol to the FCCC. It signed the Protocol that year and once ratified, this would commit the nation to either itself achieve a reduction in emissions back to 1990 levels, or else purchase credits from others who have achieved qualifying reductions elsewhere in the world.

- In 2002, New Zealand ratified the Kyoto Protocol and thus became legally bound to deliver on the commitments specified.

Agriculture accounts for 49% of New Zealand's total greenhouse gas emissions. The sector is also expected to generate over 40% of the growth in emissions above 1990 levels. Nearly all of that increase has resulted from dairy industry growth, with a good part of it caused by conversion of forested land to dairy – a true lose-lose in climate change terms.

Emission Shares for Dairy, Sheep and Beef Farming[2]



2 New Zealand Government, *Review of Climate Change Policies*, November 2005, p 140.

At a point in 2002 or before, a plan was set for managing agricultural emissions by using the credits arising from forestry plantings to offset these for the purposes of the Protocol.[3] This plan was structured to operate whether the credits are all held by Government (as later transpired) or whether they are shared with forest owners (as Government originally indicated would be the case, and may yet eventuate).[4] MAF outlined the approach in the following terms:

> The Government has agreed to shield the agriculture sector … from the cost New Zealand will incur due to growth in agricultural greenhouse gas emissions.
> …
> Government has access to [forestry] credits to cover New Zealand's greenhouse gas liabilities arising from growth in emissions, including from agriculture.[5]
>
> Current policy is to exempt the agricultural sector from a tax on methane and nitrous oxide for at least the first Commitment Period of the Kyoto Protocol (2008-2012). The excess emissions from agriculture above 1990 levels over the first commitment period have a value of $600 million at $15 per tonne carbon dioxide equivalent.[6]

The position was formalised between Government and the major agriculture players in a Memorandum of Understanding (MOU) announced in February 2004 that specified:

> The Crown … will bear the cost of the agricultural sector's non-carbon dioxide emissions, provided that the sector contributes to research[7] into ways to reduce greenhouse gas emissions from agricultural activities.[8]

However, by May 2005[9] it was well apparent that even after counting all the credits for forests planted post 1990, there was no longer the ability to simply cross-subsidise

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3 The Cabinet minute of 7 October 2002 stated that Cabinet had "agreed that so long as an adequate research effort is undertaken, the non-CO_2 emissions from the sector will not face any additional price measures prior to or during the first commitment period".

4 "Cabinet has already: - agreed in principle that *all or most* of the sink credits would be tradable within an international emissions trading system and that some proportion of the credits would go to those undertaking sink activities;
- noted that making sink credits tradable internationally would reduce the risk of such sink credits being used to shield emitters from having to face the cost of their emission reduction responsibility, and this would enhance New Zealand's credibility." Source: *Climate Change: Domestic Policy Options*, Paper to Cabinet Policy Committee, 8 October 2001, para 17.

5 MAF, *Forestry: Briefing for incoming Ministers*, October 2005, p10.

6 MAF, *Agriculture: Briefing for incoming ministers*, October 2005, p 14.

7 The research contribution was unspecified but has been mush lower than the $8.4 million a year the Crown originally sought to level from the sector.

8 MOU clause 1.3, 2004, Memorandum of Understanding between the Crown and the following parties: Fonterra Co-Operative Group Limited, Fonterra PGGRC Limited, Dairy Insight Incorporated, Dairy Insight (PGGR Consortia) Limited, Meat New Zealand, Meat NZ Emissions Company Limited, Deer Industry New Zealand, Deeresearch Emissions Mitigation Company Limited, New Zealand Fertiliser Manufacturers' Research Association Incorporated, Wrightson Limited, and Wrightson Consortia Research Ltd. Announced 5 February 2004. Available at www.maf.govt.nz.

9 Government then declared the projected position had changed from a substantial surplus to a substantial deficit (31 megatonnes).

emitters with forestry credits and avoid a payment to offshore parties.[10] Instead of the surplus of credits to sell that had been projected when the Protocol was ratified in 2002, it was projected that the taxpayer would be facing a large Kyoto bill. This is currently officially estimated at about $600 million on the basis of a conservative price of around $15 per tonne of carbon dioxide equivalent.[11]

In spite of this projected taxpayer liability, the raft of documents Government issued in December 2006 to consult on climate change policy implicitly assumed livestock emissions would continue to be excluded from emissions pricing measures until after 2012.[12] Similarly, the second largest sector for growth in emissions, transport with 38% growth since 1990, was to be excluded – meaning the two sectors responsible for nearly 80% of the excess over 1990 levels would not face emissions pricing. The proposals for discussion were instead framed around just 23% of total current emissions being priced - those from stationary energy.

Government has since announced improved policy (detailed in Section 4) that clearly brings agricultural emissions into a proposed market for tradeable emission permits and has also begun a review of the MOU.[13] The questions this paper addresses are what scope for emissions savings does the agriculture sector possess, what are the consequences of this for climate change policy, and what part is agriculture to play in meeting New Zealand's Kyoto obligations?

10 If the numbers had been more rigorously compiled, then from April 2003 it should have been apparent that a surplus was not available. See Simon Terry, *Heat Treatment*, NZ Listener, March 24 2007.

11 While the Treasury updates the base forecast of $US9.65 per tonne of carbon periodically for exchange rate movements, it is convenient to use round numbers to make the type of comparisons brought forward in this report and allow for a very high exchange rate at present. So the $15/tonne and $600 million figures are used. See http://www.treasury.govt.nz/kyotoliability/calculation.asp for details of the Government estimates.

12 While agricultural emissions were technically an option for price action before 2012 in one of the five documents then issued (that on land use), there was no reference to agricultural emissions in the transitional measures document and statements by ministers at the time made clear the Government's thinking.

13 Personal communication, Julie Collins, 22 June 2007.

2. Options for Reducing Nitrous Oxide Emissions

2.1 The "No Abatement Options" Myth

The 2004 Memorandum of Understanding exempted agriculture from charges on all livestock emissions prior to 2012 specifically on the basis that:

> There are currently no proven, practical and cost-effective farm practices and technologies to reduce agricultural emissions whether by improving production efficiency for ruminant animals or otherwise. … The Crown has decided, therefore, that it will bear the cost of the agricultural sector's non-carbon dioxide emissions.[14]

Whether or not it was true in 2004 that there were "no proven and cost-effective" abatement options, it is not true now. Yet this has not stopped the myth continuing to be restated:

Federated Farmers in its March 2007 response to Government consultation documents:

> There are few steps farmers can take to reduce the methane and nitrous oxide emissions of their farm operations without severely limiting their financial viability. New technologies are a long way off yet. Although recent technologies like nitrification inhibitors have emerged it is clear their impact on reducing emissions is minimal at best and their uptake reliant on financial support.[15]

Climate Change Minister David Parker in December 2006:

> The agriculture sector has not got the technological alternatives that we have in the power sector for example. And so it would be unfair to impose upon them, a very stringent regime that they couldn't meet expect by killing off some of their livestock, which does not seem to be in New Zealand's interest to do.[16]

National Party leader John Key in May 2007:

> We're … realistic about the fact that right now the only way farmers can significantly reduce their emissions is by selling their stock.[17]

Fonterra in its March 2007 submission to Government:

> There is limited scope to bring mitigation technologies to commercialisation in sufficient time to significantly reduce emissions by the end of [the first commitment period].[18]

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14 Memorandum of Understanding between the Crown and agriculture sector parties, announced 5 February 2004, clauses 1.2 and 1.3.

15 Federated Farmers, *Sustainable Land Management and Climate Change Feedback*, March 2007, p 8.

16 David Parker, *Focus on Politics*, Radio NZ, 15 December 2006

17 *50 by 50: New Zealand's Climate Change Target*, John Key, speech to National Party Northern Regional Conference, 13 May 2007.

18 Fonterra, Submission to Government, March 2007, paragraph 5.2 (b)2.

One problem with such statements is that they mix two quite different abatement challenges. Agricultural emissions arise overwhelmingly[19] from livestock and are composed of two gases – methane and nitrous oxides. Methane accounts for about two thirds of these emissions and is essentially a result of fermentation inside the animals. Research into ways of reducing the amount of methane produced from livestock has indicated important strategies but has not progressed at the pace of research into solutions on the other emissions fraction.

The nitrous oxide N_2O that makes up the other third of livestock emissions, and 17% of total national emissions, arises dominantly (about 85%[20]) from excreted nitrogen deposited by grazing animals. While the amounts of gas released are small in volume, each N_2O molecule has an assessed atmospheric warming potential hundreds of times that of a CO_2 molecule. More importantly, there are proven and cost-effective ways of abating these emissions, as the following begin to describe.

MAF in a December discussion paper:

> Options to reduce agricultural emissions focus primarily on nitrous oxide – not on methane produced by farm animals. This is because practical and cost-effective means of reducing emissions from livestock (other than by reducing stock numbers and/or production) have not yet been found.[21]

Fonterra in March 2007 in response to December discussion documents acknowledge:

> Fonterra agrees that measures relating to nitrous oxide provide the best prospect for tangible gains, in agricultural emissions reduction, in the transitional period.[22]

There are two broad ways to reduce nitrous oxide emissions:

- **Reduce the amount of nitrogen that is fed to the animals:** Current diets provide a considerable excess of nitrogen relative to what the animals can make use of and changing inputs can reduce the amount excreted.

- **Arrest the nitrogen that is excreted from converting to nitrous oxides:** This can be achieved by a variety of means.

Specific techniques include:
- The use of nitrification inhibitors;
- Replacement of nitrogen-boosted grass with low-protein feed such as maize;
- Breeding of grasses that have a better balance between energy and protein
- Keeping cattle on feed-pads during wet autumn and winter periods;
- Improving soil drainage.

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19 Horticulture also produces relatively small amounts of nitrous oxides arising from the use of nitrogen fertilisers. Agriculturally related CO_2 emissions are small in comparison to livestock emissions and are not classed as agricultural emissions for the purposes of Kyoto Protocol accounting.

20 H Clark, C Pinares-Pation and C de Klein, *Methane and nitrous oxide emissions from grazed grasslands*, 2005, p 283.

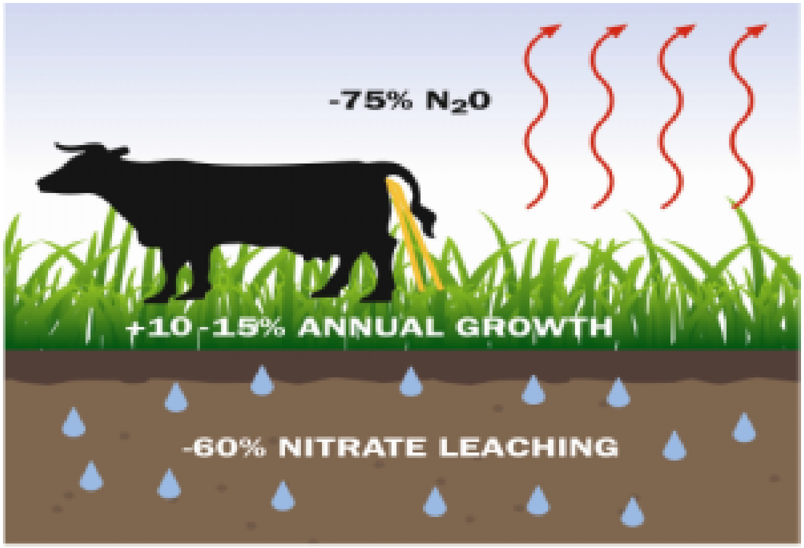
21 MAF, *Sustainable Land Use and Climate Change*, December 2006, p 32.

22 Fonterra, Submission in response to MAF December discussion document, March 2007, para 12 of summary.

2.2 N_2O Abatement Options for the Dairy Sector

The study of mechanisms to reduce N_2O has been concentrated on their application to dairy farms as these have the highest emissions per hectare and are easiest to abate. The studies summarised in this section are specific to dairy system application. While research has been taking place on this topic for some time, much of the more recent work is either funded through or linked into that directed by the Pastoral Greenhouse Gas Research Consortium (PGGRC). This consortium is in essence the parties that entered into the Memorandum of Understanding with Government noted above.

Nitrification Inhibitors



[23]

One technique that has demonstrated very significant abatement of emissions is the use of nitrification inhibitors. These products work by slowing the actions of soil bacteria that otherwise facilitate the production of N_2O.[24] Internationally, attention has focused on two chemical formulations – both of which demonstrate similarly startling effectiveness.[25]

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23 Graphic from: Pastoral Greenhouse Gas Research Consortium, *Third annual Report to the Crown on Progress*, July 2006 – credited there to Lincoln University/Ravensdown.

24 Nitrification inhibitors work by "addressing the main cause of nitrate leaching from the dairy farming system, being the urine patch. Nitrification inhibitors have previously been used as a coating on nitrogen fertilisers in cropping systems in an effort to reduce leaching but with limited success. However, in grazed pasture, the real issue is leaching from cow urine not fertiliser … . Nitrification inhibitors act by slowing the actions of a specific group of soil bacteria called *Nitrosomonas*. These bacteria convert ammonia (NH_3) or ammonium (NH_4^+) to nitrate (NO_3^-) in soil. Nitrogen from urine patches is rapidly converted from ammonium to nitrate. Plants can use either ammonium or nitrate for growth." Richard Christie, *The nitrification inhibitor (eco-n) and its potential to reduce dairying greenhouse gas emissions*, Primary Industry Management Journal, March 2006.

25 These are dicyandiamide (DCD) and 3,4-dimethyl pyrazole phosphate (DMPP). Source: Belastregui Macadam et al, *Dicyandiamide and 3,4-dimethyl pyrazole phosphate decrease N2O emissions from grasslands but dicyandiamide produces deleterious effects on clover*, Journal of Plant Physiology, 2003, p 1520.

Across a series of research studies dating back to at least 1997, trials have shown these two inhibitors to be 60% to 70% effective in general, with some achieving gains as high as 80%.[26] Early studies in New Zealand confirmed this level of effectiveness for the version researched - dicyandiamide (DCD). Two companies, Ravensdown and Balance, have developed products for the New Zealand market – Ravensdown's based on spray application, and Balance using granule delivery. Recently, PGGRC-linked research was undertaken on Ravensdown's DCD formulation over four quite different soil types, with different climates and management conditions. These yielded effectiveness ratings from 61% to 73% with an average 70% reduction in emissions for the major soil types.[27]

Not only do inhibitors markedly reduce N_2O emissions, they also similarly retard leaching and thus the eutrofication of waterways and lakes – an environmental problem of serious proportions in a number of catchments. Their effectiveness in preventing such nitrate runoff is more variable but is generally 60% to 70%, with measurements ranging from 30% to 80%.[28]

The other significant bonus in this package of benefits is that inhibitors increase pasture production by retaining more of the nutrients in the soil and so allowing less frequent applications of fertiliser to achieve the same pasture gains. Estimates of this gain are generally stated to be in the range of 10% to 15%.[29] However, recent published research has recorded a 21% gain on a "whole paddock" basis.[30]

This last point is particularly important when assessing cost-effectiveness. Figures provided by Ravensdown Fertiliser argue that its inhibitor can be applied at a profit. For although application of its 'eco-n'[31] product costs $124 per hectare per year, farmers can count on a credit of $140[32] per hectare in avoided costs of fertiliser

[26] See citations immediately above and below along with: H J Di and K C Cameron, *Mitigation of nitrous oxide emissions in spray- irrigated grazed grassland by treating the soil with dicyandiamide, a nitrification inhibitor*, Soil Use and Management, 2003. Note that these values assume there is no increased stocking to pick up on the extra nutrients available as this has a feedback effect of raising methane emissions.

[27] Interestingly, while the rate of emission varied greatly between the sites, the effectiveness remained fairly constant. H. J. Di, K. C. Cameron & R. R. Sherlock, *Comparison of the effectiveness of a nitrification inhibitor, dicyandiamide, in reducing nitrous oxide emissions in four different soils under different climatic and management conditions*, Soil Use and Management, March 2007, p 8.

[28] Personal Communication, H J Di, Lincoln University, 1 June 2007.

[29] They have been reported as high as 21% and 28%. Pastoral Greenhouse Gas Research Consortium, *Third annual Report to the Crown on Progress*, July 2006, p 29.

[30] J Moir, K Cameron and H Di, *Effects of the nitrification inhibitor dicyandiamide on soil mineral N, pasture yield, nutrient uptake and pasture quality in a grazed pasture system*, Soil Use and Management, June 2007, p 17.

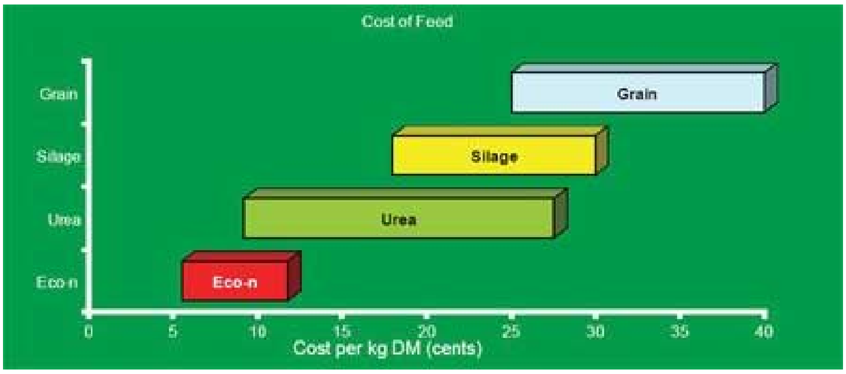
[31] This formulation is based on DCD with New Zealand research leading to the addition of other products to help it flow as a spray, rather than granules, and hence improve its effective coverage. Certain international patents are held in New Zealand on this formulation.

[32] This is based on the following: urea at $567/tonne, delivering 460 kg of nitrogen, making it $1.23 per kg of N purchased and $1.40 per kg once application costs are accounted for. At a response ratio of 1 kg of N generating 10 kg of dry matter, this equates to 14 cents spent per kg of dry matter grown.

application.[33] That is, a net savings of $16 per hectare to achieve the same level of pasture growth by a substitute mechanism.[34]

This calculation assumes less than an 8% gain in pasture production is available from eco-n, when the company is reporting gains from farmers using it in the field that are considerably higher and the research trials have recorded the 21% average gain. The greater the gains in pasture growth, the greater the relative benefits.

Ravensdown reports strong early growth in the product's use since it was introduced in 2004, and while uptake currently remains limited to about 5% of dairy pasture nationally, it has achieved a 25% uptake in the Canterbury and North Otago region this year.



Ravensdown graph of relative costs of different feed sources for the North Island.
The figures for the South Island show Eco-n at an even lower relative cost.[35]

That inhibitors provide a net economic gain to dairy farms before any account is taken of reduced N_2O emissions appears to be generally accepted and an AgResearch study states:

> The economic analysis further showed that the use of nitrification inhibitors appeared to be a cost-effective mitigation strategy, as farm profitability was maintained or enhanced, while environmental losses were reduced.
> …
> In terms of financial performance, the nitrification inhibitor strategy appeared to increase farm profits by 10% to 34%.[36]

Ballance calculates that its DCD formulation, 'DCn', is generally more cost-effective than urea fertiliser once the additional pasture growth is 10% or more.[37]

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33 Personal Communication, Ron Pellow, Ravensdown, 9 May 2007. While the value of the credit is based on a conservative price for fertiliser application, this would change if fertiliser prices changed significantly.

34 If eco-n is assumed to produce 1000 kg of dry matter for $126/ha/per year, this would equate to a cost of 12.6c/kg of dry matter. Assuming a typical annual pasture yield of 12 to 15 tonnes of dry matter per hectare per year, an additional 1000 kg DM is equivalent to 7-8% increase in annual pasture yield.

35 www.ravensdown.co.nz.

36 C de Klein and R Mongahan, *The impact of potential nitrous oxide mitigation strategies on the environmental and economic performance of diary systems in four New Zealand catchments*, Environmental Sciences, June-September 2005, p 358 and 356.

37 Ballance assumes in common with Ravensdown a 10 to 1 response rate for urea as the benchmark.

While a long term European study of the use of DCD reported no adverse effects on soil microbial/enzyme activity when used in conjunction with fertiliser application,[38] and a four year New Zealand trial has shown concentrations of nitrogen, calcium magnesium and potassium to be unaffected,[39] study of the environmental effects under intensive and long term use in New Zealand remains to be completed and will inform its long term potential.[40] This work underway at Lincoln University includes assessment of any microbial impacts. DCD reportedly targets very specifically the enzyme that facilitates nitrification and the product biodegrades completely within two or three months (in moderate soil temperatures).[41] A Spanish study reported damage to clover leaves by DCD, possibly resulting from a change in mineral balances, but this was at a rate of application five times that used on local pasture and the same effect has not been evident in New Zealand applications.[42]

Effectiveness Rating: The most recent PGGRC sponsored study has measured an average mitigation effectiveness of 70%.

Cost-effectiveness: PGGRC research reports do not appear to have formally reported on the inhibitor's financial performance. However, based on an annual application cost of $124 per hectare per year, and a conservative $140 per hectare credit resulting from increased pasture growth and avoided fertiliser costs, N_2O emissions can be reduced at a profit. Thus the cost of abatement is negative.

Standoff Pads

A remarkably simple mechanism for considerably reducing emissions makes use of knowledge available from at least 2003[43] that when soils are wet, the production of N_2O is much greater. By creating a pad of bark and/or sawdust, and ensuring that cattle spend three quarters of their time on these pads during winter months, N_2O emissions can be reduced by about 10%.[44]

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http://www.ballance.co.nz/Education/Nitrification_inhibitors/More_pasture_growth.asp?PageID=4207&ID=9&CatID=2078&Level=1

38 Ravensdown, *Ecotoxicology Overview*, 2006, referencing: A Amberger, *Research on dicyandiamide as a nitrification inhibitor and future outlook*, Communications in Soil Science and Plant Analysis, 1989.

39 Pastoral Greenhouse Gas Research Consortium, *Third annual Report to the Crown on Progress*, July 2006, p 29.

40 Fonterra reports work along these lines has begun – Submission to Government, March 2007.

41 Personal Communication, H J Di, Lincoln University, 1 June 2007.

42 The damage to clover leaves and consequent reduced clover yield was observed with the use of the DCD formulation, but the effect was absent from the DMPP formulation. This difference was reported to also be consistent across lettuce and some other plants. Belastregui Macadam et al, *Dicyandiamide and 3,4-dimethyl pyrazole phosphate decrease N2O emissions from grasslands but dicyandiamide produces deleterious effects on clover*, Journal of Plant Physiology, 2003, p 1521.

43 C de Klein et al, *Potential mitigation options for reducing N2O emissions from pastoral soils in New Zealand*, Powerpoint presentation, 2003.

44 H Clark, C Pinares-Pation and C de Klein, *Methane and nitrous oxide emissions from grazed grasslands*, 2005, p 289, and de Klein et al, *Restricted autumn grazing to reduce nitrous oxide emissions from dairy pastures in Southland, New Zealand*, Agriculture, Ecosystems and Environment 112, 2006, p 198.

A recent AgResearch study for PGGRC has further confirmed that by grazing dairy cattle just six hours a day between late May and early August and keeping them on the pad for the remainder, a 10% abatement of emissions can be achieved while maintaining milk production levels.[45] The study also recorded a 25% reduction in nitrate leaching compared to the control.

While this work did not report an evaluation of cost-effectiveness, a separate AgResearch study considered this technique to have at least breakeven economics.

> Although the construction of a feed pad and associated effluent storage and effluent application facilities will require capital investment, a cost–benefit analysis by de Klein (2001) suggested that the potential increase in pasture production through a more efficient use of excreta N alone can off-set these costs. Any additional production gains due to reduced soil and sward damage would then be a direct cost-saving.[46]

An enhancement available under this technique is to not immediately spread the effluent collected from the pad back on to the land, as the study allowed for. One option reported on in another study is to store this and reutilise it during periods when emissions will be much lower - with an estimated 19% reduction in emissions overall.[47] If the effluent were instead fed to a biodigestor for the production of methane, from the details provided in the Agresearch study, it appears a total reduction in N emissions of about 20% could be achieved.[48] The methane produced by the biodigestor could then be directly harnessed to provide onsite energy for the milking shed, particularly water heating. The additional CO_2 resulting from this would be largely offset by reduced use of electricity, some 40% of which on average is generated by fossil fuel at less than 40% efficiency once delivered. The cost-effectiveness of this option depends on the cost penalty for emissions relative to the savings available from displacing electricity demand.

A more sophisticated version of the same concept is the “herd home”. This is a roofed pad, incorporating a slatted floor and effluent processing basement. In a bid to make “the most natural animal shelter / stand off pad possible”, systems have been developed to ensure effluent is broken down to 'bedding mix' by being exposed to the sunlight, the air and treading effect of the cows hooves.[49]

Effectiveness Rating: A PGGRC sponsored study has measured an average mitigation effectiveness of 10%. A separate AgResearch study indicates 19% mitigation is available at the additional cost of effluent storage facilities.

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45 Jiafa Luo, Stewart Ledgard and Stuart Lindsey, *Nitrous Oxide Emissions from Dairy Farm Systems*, AgResearch, reported in proceedings of the Massey FLRC Workshop, 2006, P.269-280.

46 de Klein et al, *Restricted autumn grazing to reduce nitrous oxide emissions from dairy pastures in Southland, New Zealand,* Agriculture, Ecosystems and Environment 112, 2006, p 198.

47 de Klein and Ledgard, *Nitrous oxide emissions from New Zealand agriculture – key sources and mitigation strategies,* Nutrient Cycling in AgroEcosystems, 2005, 81.

48 Interpolated from Table 4 of the study.

49 See http://www.herdhomes.co.nz/portal/

Cost-effectiveness: PGGRC research reports do not appear to have formally reported on the standoff pad's financial performance. However, in line with AgResearch's earlier assessment, PGGRC has indicated in its annual report that the standoff pad option at least covers its costs in terms of overall farm profitability.[50] Thus while the degree of overall savings appears to be lower than for the use of inhibitors, here too the cost of a 10% abatement at least appears to be negative.

Maize Feed Substitution

A further immediately available and significant source of reduced emissions is the use of supplementary maize silage feed. This technique takes advantage of the fact that "pasture plants require significantly higher concentrations of N_2O to grow at optimal rates than is needed by the grazing ruminant for protein synthesis".[51]

The replacement of grass feed that is high in nitrogen content with maize silage is estimated to abate N_2O emissions by about a quarter. A 2005 study reported a theoretical 27% reduction when substituting fertilised grass with maize grown with fertiliser along with a 19% reduction in CO_2 emissions, though these are a smaller proportion of system emissions.[52] PGGRC is also reporting that there is no resulting increase in methane – even with up to 37% feed replacement.[53]

A 2006 PGGRC funded study by AgResearch showed a 22% effective gain when comparing all inputs and sources of direct and indirect emissions.[54] This was based on the addition of about 5 tonnes of maize silage per hectare per year, at an average stocking rate of 3.8 cows per hectare.

Based on the AgReserach trial's input of 5 tonnes of maize silage per hectare per year, an average stocking rate of 3.8 cows per hectare and cost per tonne of dry matter at the lower end of the range, $180, the additional farm spend is $900 per hectare per year.[55] At the same time, the use of supplementary feed allows the stocking rate to be increased from 3 to 3.8 cows/ha and thus 21% less land is required for the same size herd.[56]

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50 "The stand off farm system gave slightly lower N2O emissions and total greenhouse gas emissions per $ of economic farm surplus, compared with the control farm system." Source: Pastoral Greenhouse Gas Research Consortium, *Third annual Report to the Crown on Progress*, July 2006, p 27.

51 de Klein and Ledgard, *Nitrous oxide emissions from New Zealand agriculture – key sources and mitigation strategies*, Nutrient Cycling in AgroEcosystems, 2005, 80.

52 de Klein and Ledgard, *Nitrous oxide emissions from New Zealand agriculture – key sources and mitigation strategies*, Nutrient Cycling in AgroEcosystems, 2005, 81.

53 Pastoral Greenhouse Gas Research Consortium, *Third annual Report to the Crown on Progress*, July 2006, p 21.

54 Note that while the study reported the results as a 22% gain in milk production relative to N2O emissions, it is equally the case that emissions could be reduced by 22% and leave milk production invariant by reducing stock numbers accordingly. Jiafa Luo, Stewart Ledgard and Stuart Lindsey, *Nitrous Oxide Emissions from Dairy Farm Systems*, AgResearch, reported in proceedings of the Massey FLRC Workshop, 2006, P.269-280.

55 Based on annual emissions per hectare and stocking rate reported in Jiafa Luo et al, and price of maize from AgResearch.

56 At a 22% savings ratio, this yields 0.85 tonnes of CO_2 equivalent.

Quotable Value statistics show the average dairy farm sale price increased approximately to $22,516 per hectare in the half year ending June 2006, (putting the average sale price of a dairy farm up to $3,166,332).[57] The opportunity value on the land hence freed up, assuming a 10% cost of capital, is $473/year. Also to be counted is the additional milksolids yield which at the projected Fonterra payout of $5.53 would provide a further credit of $398 per hectare per year.

Thus if maize is available at the lower end of its price range, the costs of the maize roughly balance with the credits before account is taken of the value of N2O emission reductions. The higher the price of maize, the greater the cost of abatement.

Opportunities for enhanced abatement are also available here. For if the maize were grown using nitrification inhibitors, and this resulted in a 70% abatement of N2O form this source, total system emissions abatement would rise to 29% (based on interpolation of the 2006 results). As with the application of inhibitors to pasture, the indications are that this result could be obtained at a profit through a compensating boost to crop yield.

If the maize were alternatively grown without the addition of nitrogen fertilisers, the system emissions reduction would total 32%, at the penalty of a lower maize yield and thus higher input costs relative to the baseline.

Effectiveness Rating: A PGGRC sponsored study has measured an average mitigation effectiveness of 22%. It can be inferred from the study that a 29% overall mitigation is available if maize is grown using inhibitors.

Cost-effectiveness: PGGRC research reports do not appear to have formally reported on the techniques financial performance. Its annual reporting has noted simply that "Maize silage had a variable effect between years on N2O emissions and total greenhouse gas emissions per $ of economic farm surplus".[58] It appears that if maize is available at a cost near the lower end of its price range, costs balance benefits before counting the value of N2O reductions, but the more costly the maize, the more costly abatement becomes.

Other Techniques

Other techniques that have been less researched include:

- **Improving soil drainage:** As wet conditions promote release of N_2O, improved drainage and less soil compaction reduce emissions. Study to date suggests reductions in the range of 7% to 10%.[59]

57 Bayleys, Lifestyle Property Goes From Strength to Strength, http://bayleys.co.nz/Country/Lifestyle/Lifestyle_News/NZ_Lifestyle_Property_Strong.htm, accessed 15 June 2007.

58 Pastoral Greenhouse Gas Research Consortium, *Third annual Report to the Crown on Progress*, July 2006, p 27.

59 de Klein and Ledgard, *Nitrous oxide emissions from New Zealand agriculture – key sources and mitigation strategies*, Nutrient Cycling in AgroEcosystems, 2005, 83.

- **Liming:** Reduced soil acidity is linked to reduced emissions, though understanding of these processes appears limited.

- **New Grasses:** Breeding of grasses that have a better balance between energy and protein reduces emissions and around 6% according to one study.[60]

We have not seen studies of the cost-effectiveness of these options but it is apparent that at least the first two are also relatively low cost options.

Summary

In summary, it is surprising how little cost-benefit evaluation has been reported, with none of the PGGRC linked studies cited above formally reporting on the economic effects. This is particularly so when the PGGRC defined the target of the research strategy that is the core output from the MOU in the following terms:

> The target is to have **safe**, **cost-effective** greenhouse gas abatement technologies, which will lower total New Zealand ruminant methane and nitrous oxide emissions by at least 20 percent as compared with the 'business as usual' emissions level, by the end of the first commitment period (2012). [Emphasis as per original][61]

The following table sets out the measured effectiveness in emissions reduction for the three main techniques and their expected net cost to farmers (along with savings available under enhanced scenarios for two options).

Technique	Baseline Savings %	Cost	Enhanced Savings %
Nitrification Inhibitors	70	negative	
Standoff pad	10	negative	19
Supplementary maize feed	22	neutral to medium	29

2.3 Other Pastoral Emissions – Sheep and Non-dairy Cattle

While the dairy sector is the most studied and appears to have the most cost-effective abatement options, many of these techniques are also applicable to the sheep and beef farms that account for the bulk of other N_2O emissions.[62] The extent to which these will be similarly cost effective remains to be clearly determined.

Again, nitrification inhibitors are at the forefront. The main issue that has begun to be studied is their application to the sloping ground that makes up most sheep and beef

60 C de Klein et al, *Potential mitigation options for reducing N2O emissions from pastoral soils in New Zealand*, Powerpoint presentation, 2003.

61 Pastoral Greenhouse Gas Research Consortium, *A Pastoral Greenhouse Gas Research Strategy***,** Mark Leslie, and Peter O'Hara, October 2003, p1.

62 Emissions from fertilisers used for horticultural and arable purposes comprise less than 3% of total N2O emissions.

farms. As the trial results are quite recent, little has been formally reported but the researchers say the initial trial results are showing DCD to be just as effective there as on the flat.[63] PGGRC has also reported that:

> The first year of a trial to establish emission levels in hill country situations has been completed and partially analysed. The pattern of emissions is similar to those found in dairy farms albeit at a lower level in keeping with decreased nitrogen loadings of these systems. The incorporation of DCD as a nitrification inhibitor appears to reduce the level of emissions in a similar manner to dairy systems.[64]

And that:

> Interim results from Ballantrae indicated that total N_2O emissions over the 6 weeks period were highest under the urine treatment and that DCD was effective in reducing emissions to background levels.[65]

While none of the researchers in the field appear to have begun to formally weigh the economics for hill country use, the group leading this work think it is likely to prove economic, particularly if there is a value placed on N_2O abatement.[66] Again, because the economics initially hinge on gains in pasture growth and avoided fertiliser spend, the lower quantities of N_2O abated per hectare are a secondary consideration.

Thus indications are that the inhibitors 70% primary effectiveness at abating emissions will be available for all pastoral N_2O emissions, even if the economics are still to be determined. One issue to be considered separately for hill country use (as distinct from flat land use) is the potential for the inhibitor formulation to be carried off down waterways and suppress the nitrification processes that are important to maintain in natural ecosystems. Research into this possibility, and a potential restriction on the locations in which inhibitors can be used, has been celled for by NIWA.

Supplementary maize feeding and standoff pads are also options for beef farmers.[67] While their economics may prove to be less favourable than for dairying, they nonetheless represent additional emissions saving opportunities for evaluation.

63 Personal Communication, H J Di, Lincoln University, 1 June 2007.

64 Pastoral Greenhouse Gas Research Consortium, *Third annual Report to the Crown on Progress*, July 2006, p 35.

65 Pastoral Greenhouse Gas Research Consortium, *Third annual Report to the Crown on Progress*, July 2006, p 31.

66 Personal Communication, H J Di, Lincoln University, 1 June 2007.

67 de Klein and Ledgard, *Nitrous oxide emissions from New Zealand agriculture – key sources and mitigation strategies*, Nutrient Cycling in AgroEcosystems, 2005, p 80.

3. Implications For Climate Change Policy

The agriculture sector has options for reducing emissions that are very significant for the nation in terms of the quantities that can be abated. Taking the information set out in the previous section on the technical potential of different techniques, the following examines the potential to abate N_2O nationally and then the cost-effectiveness in relation to other options.

3.1 Scope for National Emissions Reduction

Dairy N_2O Emissions Reduction

A baseline scenario for the dairy sector is the application of nitrification inhibitors alone. Our calculations indicate that if the inhibitor DCD[68] were used on all dairy pasture in New Zealand, N_2O emissions would be reduced by some 3.7 megatonnes of carbon dioxide equivalent in the year 2010, or 9.3% of then expected total agricultural emissions.

Scaling up the results from farm scale trials to map effects across the country at a future date requires a series of approximations to be used but researchers have been refining these for some time. While the details of our calculation are set out in Appendix 1, the following are key assumptions.

High level projections include the total quantity of N_2O expected to be emitted, and the proportion of this total attributed to each agricultural sub-sector. The total quantity assumed is that projected in the New Zealand Government's most recent reporting under the Kyoto Protocol that carries a 2010 projection.[69] Given the recently announced forecast for future Fonterra payouts, in absence of market interventions (as discussed in Section 6), this projection may well underestimate emsisions and thus the total emissions abated would be understated.[70]

With respect to the proportions attributed to each sub-sector, these again in the first instance rely on official estimates of the position in 2010. While they are necessarily approximations, scenarios comparing different proportionate allocations between dairy, beef and sheep farming, and means of arriving at these (including an allocation used by MAF[71] and under 2005 figures), show rather little difference in the overall results so this is not an important area of uncertainty.

Highly technical issues then arise in determining the degree to which each of four different sources of N_2O is abated. In summary, apart from the effectiveness parameter discussed below, we have adopted the assumptions used by the Lincoln

68 Based on use of the Ravensdown formulation of this, eco-n.

69 MFE, 4NC Table 19, March 2006. This is also understood to be the most recent finalised projection that has been made public at this time. As 2010 is the midpoint of CP1, total emissions savings over the period are assumed to be five times this annual value, an approximation MFE appears to also use.

70 A higher level of agricultural emissions would also carry higher methane emissions, as discussed in Section 6.4.

71 MAF's figures assumed a different total for 2010 N_2O emissions.

University team that has led research into the eco-n formulation of DCD and its application in New Zealand and has set out an approach for making national estimates.[72]

The primary effectiveness of DCD in abating emissions arising from pasture and fertilisers is set at 70%, in line with findings very recently reported that gauged its performance across a range of New Zealand soil types (as earlier cited). The Lincoln team also carried out this research and the figure is in line with that used by MAF of 67%.[73] The inhibitor's effect on retarding emissions arising from leaching is also set at 70%, again reflecting recent findings that its effect on this source of emissions tends to parallel that on the pasture.[74] By comparison, MAF in this case assumes a 74% effectiveness.[75] (Note however that these primary effectiveness ratings are reduced by a series of adjustments (as discussed in Appendix 1) that put its estimated actual effectiveness across all sources of N_2O at 57%.)

These assumptions seem to best describe the technical potential of the inhibitor technology.[76] However, notwithstanding the relative consistency of field research results, it has been postulated that this level of effectiveness may not be so readily obtained when DCD is applied by contractors. So despite the manufacturer's requirement that the product be applied using GPS tracking technology to ensure effective distribution, actual savings may be compromised by the timing of application and/or patterns of coverage.[77]

If effectiveness is assumed to be as low as 50%, this has a proportionate impact but does not greatly alter the general picture. Further, as one moves from the research trials to the general farm position, it is clear that farmers can apply other techniques for mitigation at the same time as inhibitors.

While a number of well reported farm trials have reliably measured the individual effectiveness of inhibitors, standoff pads and maize feeding, the surprising thing is that there has been very limited study of the techniques in combination.[78] Such study would be of interest in any sector for its ability to show integrated savings but is particularly important in agriculture as parts of the systems are quite interactive. Nonetheless, it is possible to get an indication of the level of emissions reduction available by making allowance for the gross interactions that can be expected. The

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72 T. J. Clough et al, *Accounting for the utilization of a N2 O mitigation tool in the IPCC inventory methodology for agricultural soils*, Nutrient Cycling in Agroecosystems, January 2007.

73 MAF, A summary table entitled "Impacts of DCD - A Scenario, Mean Annual Values", May 25 2007. It is unclear whether this summary is that of a purely in-house study or derived from a Landcare study MAF has contracted that is complete but not in the public domain at the time of writing.

74 The average rate of leaching reported over all trials by the Lincoln team is 69%. T. J. Clough et al, *Accounting for the utilization of a N_2O mitigation tool in the IPCC inventory methodology for agricultural soils*, Nutrient Cycling in Agroecosystems, January 2007, p4.

75 MAF, A summary table entitled "Impacts of DCD - A Scenario, Mean Annual Values", May 25 2007.

76 Technical uncertainties that have been treated cautiously are described in Appendix 1.

77 Ravensdown takes a cautious approach to claimed abatement potential, and uses 50% as a guide as it prefers to understate the claims relating to this new product.

78 Dexcel are reportedly undertaking the field work at present that combines application of an inhibitor with a standoff pad.

scenarios below thus present indicative estimates for how combinations of techniques could be assumed to act on emission levels. (These scenarios and interaction considerations are detailed in Appendix 1)

Scenario description	Annual N2O emissions abated in first period (Mt CO2e)	Proportion of sub-sector emissions abated %	Proportion of agricultural emissions abated %	Proportion of national emissions abated %
Baseline Scenario				
1. Inhibitor 70% effective	3.7	57	9.3	4.6
Low Inhibitor Effectiveness Scenarios				
2. Inhibitor 50% effective	2.8	44	7.1	3.6
3. Inhibitor 50% effective, standoff pad 10%	3.1	48	7.7	3.9
4. Inhibitor 60% effective, standoff pad 10%	3.5	54	8.7	4.3
Expected Inhibitor Effectiveness Scenarios				
5. Inhibitor 70% effective, standoff pad 10%	3.9	60	9.7	4.8
6. Inhibitor 70% effective, maize feeding 22%	4.1	63	10.2	5.1
Enhanced Scenarios				
7. Inhibitor 70% effective, standoff pad 19%	4	62	10.1	5.0
8. Inhibitor 70% effective, maize feeding 29%	4.2	65	10.5	5.2
9. Inhibitor 70%, standoff pad 10%, maize feeding 22%	5.2	67	13.2	6.6
10. Maize feeding 29%, standoff pad 19%	1.8	28	4.5	2.3

A key point in relation to the combinations identified above is that adding other techniques to the use of the inhibitor should not meaningfully alter its economics or proportionate effectiveness. The primary interaction to be allowed for is that the inhibitor will have less nitrogen loaded urine to act on and so the quantity it can abate will be less. However, as its economics depends overwhelmingly on its ability to generate gains in pasture growth through reducing nitrogen lost by leaching (rather than abating N_2O emissions), the financial credit to the system will remain much the same. Equally important, the inhibitors have demonstrated remarkable consistency at reducing *proportionately* the volume of N_2O emissions over conditions that are twenty times different in the amount of N_2O being released.[79] It therefore seems reasonable to make a simple proportionate reduction in the quantity saved after allowing for the effect of any other technique.

In principle, the economics of both the maize feed option and the standoff pad should also remain much the same as those available in isolation. Thus many of the options involving combinations will also tend to be cost-effective options. In particular, those combining DCD and standoff pads at 10% effectiveness, and those incorporating maize feed under conditions where the maize price is suitable. Further, if packages of options are being examined, there is potential to use profits available from using DCD to assist adoption of other techniques, if required.

A corollary is that it is often just the quantity of emission reductions available that is somewhat uncertain, not the cost-effectiveness of employing a particular technique or combination. This distinction is critical for policy making as that uncertainty need not

79 "The total amount of N_2O emitted from the soils varied widely, from 1 kg N_2O-N/ha in the Taupo soil to 20.9 kg N_2O-N/ha in the Templeton soil." H. J. Di, K. C. Cameron & R. R. Sherlock, *Comparison of the effectiveness of a nitrification inhibitor, dicyandiamide, in reducing nitrous oxide emissions in four different soils under different climatic and management conditions*, Soil Use and Management, March 2007, p 8.

affect the decision about whether it is economic to invest in measures that are cost-competitive under any reasonable assumptions about volumes abated.

It should also be noted that an assessment of the technical potential does not attempt to second-guess farmer responses and project a particular level of uptake. It is apparent that an alternative to optimising a farm system for emission reductions is to make use of the improved nutrient efficiency to further intensify production. However, that choice depends on what price signals are sent to farmers – an issue picked up further below.

Beef and Sheep N_2O Emissions Reduction

A similar quantity of N_2O can apparently be abated from the beef and sheep industries as is available to the dairy sector. Again assuming as a baseline scenario the application of DCD alone to all beef and sheep pasture, the following are the estimated emission reductions.[80]

Scenario description	Annual N2O emissions abated in first period (Mt CO2e)	Proportion of sub-sector emissions abated %	Proportion of agricultural emissions abated %	Proportion of national emissions abated %
Baseline Scenario				
1. Beef: Inhibitor 70% effective	1.2	53	3.1	1.5
2. Sheep: Inhibitor 70% effective	2.7	52	6.7	3.4

There is also the potential to make use of multiple techniques in beef farming operations and these provide savings in line with those for dairy, though somewhat less due to less fertiliser being displaced.

Summary of Emission Reduction Potentials

Putting together the above results from the baseline scenarios, the following table provides estimates of the technical potential for reduction of N_2O from all sub-sectors.

	Annual N2O emissions abated in first period (Mt CO_2e)	Proportion of sub-sector emissions abated %	Proportion of agricultural emissions abated %	Proportion of national emissions abated %
Dairy: Inhibitor 70% effective	3.7	57	9.3	4.6
Beef: Inhibitor 70% effective	1.2	53	3.1	1.5
Sheep &deer: Inhibitor 70%	2.7	52	6.7	3.4
Total	**7.6**		**19.1**	**9.5**

80 These make use of the same assumptions as above.

3.2 Placing the Results in Context

To understand the significance of these potentials, they first need to be compared to New Zealand's Kyoto Protocol obligation and current performance under it. On the basis of the most recent estimates prepared by the Environment Ministry in June 2006, the nation is projected to be 41.2 megatonnes in excess of its commitment, after making allowance for forestry credits the Government currently holds.[81] If those June 2006 figures are updated for the most recent change to New Zealand's estimate of the Kyoto baseline (1990 emission levels), the excess emissions are 31.8 Mt or a 10.3% overshoot (before counting a related liability that raises the complete Kyoto liability to 39.3 Mt).[82]

Evaluating potential reductions in agricultural emissions against this position, the following observations flow:

- Emission reductions available from the dairy sector alone can effectively halve the nation's excess emissions. Under baseline assumptions for the application of inhibitors alone, the 3.7 Mt of annual saving equates to 18.5 Mt over the first commitment period. At current carbon prices, this has a value to the nation of about $550 million (or $278 million at the $15/tonne price that is close to the Government's assumed price).

- This baseline measure for the dairy industry is profitable to undertake and on its own would also make reductions almost sufficient to cover agriculture's share of New Zealand's Kyoto liability. If the baseline dairy savings are augmented by the use of standoff pads throughout the dairy sector, this would effectively meet agriculture's share of the nation's excess emissions and this is also indicated to be profitable in its own right.

- A range of scenarios examining the effectiveness of inhibitors and use of multiple techniques indicates considerably higher levels of abatement are available above the baseline.

- An additional 1.5% reduction in national emissions is indicated as being highly likely to be available from beef farming, based on the trial use of inhibitors in hill country. A further 3.5% from the use of inhibitors on sheep farms seems similarly likely to be available.

- If each of the baseline options identified for N_2O mitigation were adopted throughout the country over the first commitment period, the savings would

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81 Ministry for the Environment, *Projected balance of emissions units during the first commitment period of the Kyoto Protocol*, June 2006, p 34. Note this is an underestimate of the cost to the nation as a whole as it does not count all deforestation liabilities. These are capped by the Government, which assumes they will be picked up by private parties. The figure does however assume an additional related liability of 7.5 Mt for credits given to projects to reduce emissions, and in total represents a 13.3% excess under the Protocol.

82 The liability has shifted to a slightly lower amount due to assumptions for the 1990 level of emissions having been reworked, as documented in New Zealand's National Inventory Report for the 2005 year.

largely cover New Zealand's currently projected Kyoto liability. They amount to a 9.5% reduction in New Zealand's total emissions from all sources.

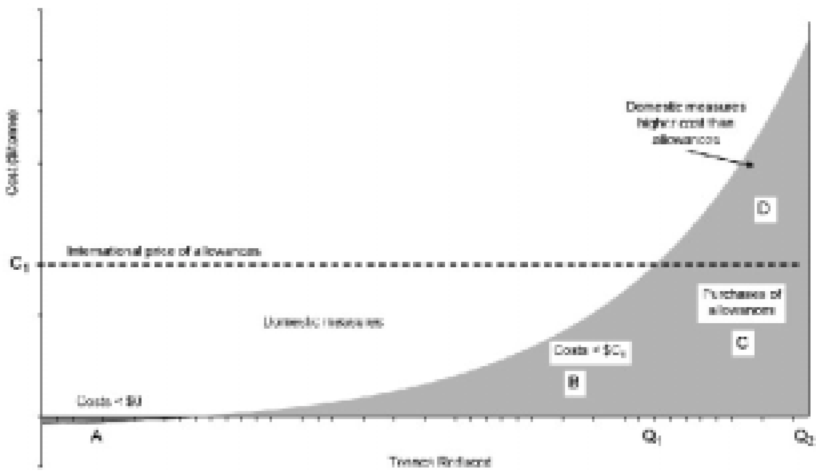
- These same options would reduce total agricultural emissions by around 19% purely through mitigation of N_2O – that is, before options for methane abatement are even considered.

To further put these potential savings in perspective:

- Dairy industry baseline savings alone would account for about half the current emissions from all the nation's power stations.

3.3 Cost-effectiveness of the Potential Reductions

Given that New Zealand is currently projected to be in deficit on its Kyoto abatement target, the nation faces what is sometimes termed a "make or buy" decision. It either makes sufficient emission reductions locally, or buys equivalent reductions in other countries – by way of carbon credits. Thus it is economically efficient for New Zealand to utilise abatement opportunities available that are no more than the international price for those credits, and then purchase offshore to cover any remaining deficit. The following diagram sets out this recipe for least cost emissions abatement.



83

While the ruling price for acquiring credits over the first commitment period can not be known in advance, markets trading credits operative in that period arguably provide the best present estimate. These are currently trading on the European carbon market (which accounts for around 80% of the traded volume in these instruments) at about NZ$38 per tonne of CO_2 equivalent.[84] However, taking account of recent price levels and the current very high exchange rate, a figure of NZ$30/tonne seems more

83 COVEC, *Achieving emission reductions at least cost: international lessons*, Tim Denne, 6 October 2006, p 14.

84 As at 25 June 2007, the 2008 and 2009 period units are priced at 21.88 and 22.13 Euros respectively. At the ruling exchange rate of that day of 0.567, the 2008 price translates to a NZ dollar value of $38.6 per tonne of CO_2e.

appropriate. This then sets the currently indicated ceiling for those options that are economic to undertake in New Zealand.

The question then is how do agricultural abatement options compare against this international benchmark?

The baseline dairy option can be obtained at a profit. The question for this sector is simply what further enhancements in addition to the base case are economic? Research attention needs to focus on the costs of combinations of options as a first priority. The more cost-effective options can be shown to be economic to also combine, the more these can go ahead irrespective of the precise levels of savings assumed. While a 57% effective abatement potential is a great start, if there are measures that can be added to the baseline package at less than the ruling international price, these will be economic for the nation to pursue.

The economics of applying nitrification inhibitors to beef and sheep farms revolves around the value of extra pasture growth this allows. As DCD is currently cheaper to apply for the same pasture gain than urea fertiliser, and cheaper still than maize feed, it follows that inhibitors could displace the 10% of national urea fertiliser sales estimated to be applied to beef and sheep pastures.[85] This would result in an additional 0.2 Mt of savings per annum. Beyond that, the economics will depend on the additional value farmers can obtain from the extra feed generated, as is also the case for supplementary maize feed. In principle, where the additional value is greater than the international price of abatement, such applications and combinations of techniques would be economic.

All the above however does not begin to take account of the significant co-benefits available from a reduction in nitrate runoff that inhibitors also deliver.

To date MAF has not undertaken any formal studies of the cost of abating agricultural emissions. Its efforts in this regard have been focused on scenario studies of the quantity of emissions that could be abated using nitrification inhibitors on dairy pasture.[86]

It is difficult to provide a precise picture of how N_2O abatement options rank alongside other options across the New Zealand economy as there is a paucity of information in the public domain on relative costs. In December 2006, consultants evaluating future abatement options for New Zealand noted the general lack of quality data on this question. Since this time, a series of reports have been prepared for Government. While a number of these have been made public, access to a few that would provide the most useful information has been denied under the Official Information Act. This includes in particular a consultant report commissioned by the Environment Ministry that brings together estimates of the cost of abatement across

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85 MAF, A summary table entitled "Impacts of DCD - A Scenario, Mean Annual Values", May 25 2007.

86 Personal Communication, Julie Collins, MAF, 7 June 2007. An Official Information Act request remains to be responded to at the time of writing.

all sectors under a single set of assumptions.[87] It appears to be the first time such a set of estimates has been brought together in any substantive study.

There are however some clear benchmarks against which agriculture abatement options can be measured.

Analysis begins by noting that for the big three emission sectors, emissions splits roughly: Agriculture 49%, Stationary Energy 23%, and Transport 20%. The Ministry of Transport currently does not have an ability to model how changes in transport would affect emissions, nor the cost of such actions, partly as a result of a lack of data collection.[88] Policies that assist climate change mitigation are under consideration but frequently are part of wider programmes where emissions reduction is simply a co-benefit. The current exception is work examining differential pricing for vehicle registration. The general picture nonetheless is that reductions in transport emissions over the next five years will tend to rely on gradual replacement of the fleet with more fuel efficient vehicles in absence of any reduction in demand. Alternative fuels and serious public transport generally require timeframes that extend beyond the first commitment period to achieve significant effects.

This leaves the stationary energy sector as the main alternative source of emission reductions – the one the Government singled out in December as the focus for its "transitional measures". A study prepared for government on efficiency savings opportunities in stationary energy (other than for power stations) identified just 0.8 Mt of emission reductions as being both available and economic to implement by 2010.[89] These are a quarter of those available from just the baseline dairy savings.

Aside from savings that can be made by avoiding construction of new fossil fuel burning electricity plant in the future (which will often happen anyway), reductions in emissions from power stations would centre on cutting back the coal-fired Huntly plant. It alone generates close to 2 Mt of emissions each year. While Contact Energy believes the plant's owner, Genesis Energy, could be incentivised to withdraw it from service if a price on carbon were $20/t or more, the Ministry of economic development's model suggests the figure is about twice this – one exceeding the current international price of carbon.[90] Genesis states that while such prices would likely see it cut back its rate of production at the station, neither price would see Huntly withdrawn from service.

These comparisons are set out in the following table, also showing volumes saved for each measure or sector, to give a "bang for buck" rating.

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87 ICF International, *Analysis of the Potential and Costs for Greenhouse Gas Emission Reductions*, 2007.

88 Personal Communication, Kathy Perreau, Ministry of Transport, 20 June 2007.

89 COVEC, *Sustainable Energy Value Project: Evaluation of options for intervention in the stationary energy sector*, February 2007, p v.

90 Contact Energy, Submission to Government, March 2007 and MED, slide presentation, March 2007.

Measure	Cost of abatement $/tonne CO_2e	Quantity abated Mt CO_2e/yr
Dairy - inhibitor	negative	3.7
Beef – inhibitor	?	1.2
Sheep – inhibitor	?	2.7
Energy efficiency - negative	negative	0.6
Energy efficiency - low to medium	15	0.2
Existing electricity generation	20 – 40?	0.5-1.0?

There is also the option to meet New Zealand's Kyoto commitments through increased forest plantings. However, aside from the question of New Zealand having made explicit commitments to cut emissions, rather than just mop up the excess with trees, the time for new forests to mature to the point where they begin to make an important contribution to extracting carbon from the atmosphere is generally beyond the first commitment period. Other forestry related options could still contribute during this period but the understanding of these and their potential is still developing.

So despite the limited data available on the public record, the following can be stated:

- Reductions in dairy industry N_2O emissions represent not only the largest single slab of potential reductions readily available across the economy at present, these savings can be accessed at a profit.[91]

- Further, dairy industry savings can be activated comparatively quickly,[92] meaning that high levels can be counted for those five years making up the first commitment period. Energy efficiency measures in contrast are in large part dependent on the displacement or replacement of old hardware with new. They are therefore introduced only progressively over the period so the savings accumulate more slowly.

- The options for bringing in standoff pads, maize feed and other measures are a veritable treasure trove of only dimly explored opportunities (in policy terms) for abatement in dairy emissions. Their use in combination with inhibitors shows major promise in comparison with other sources of abatement nationally.

- The options for abating N_2O emissions from beef and sheep are also extremely significant in scale on a national basis. The extent of their role will depend on economic analysis yet to be undertaken, with expected prices for carbon and the pastoral products being key determinants.

91 The only other contender for such a large and cheap reduction will be potentials for methane abatement not recognised to date.

92 Activating the saving would rely on the production of DCD being ramped up sufficiently, which Ravensdown advises can be achieved with sufficient notice in advance of the season for application. Personal Communication, Ron Pellow, 9 May 2005.

To the extent that there proves to be a greater quantity of cost-effective emissions savings opportunities than New Zealand needs to meet its Kyoto obligations, all such options should still be pursued. Any emissions-reducing option costing below the ruling international price for carbon will in principle be attractive to overseas purchasers of credits, as well as helping to reduce New Zealand's carbon footprint and thus assist its clean green branding.

There is of course considerable uncertainty as to what the price of carbon will be in the future, and thus what will be cost-effective. This however is one of the chief arguments for ensuring that the Kyoto Protocol obligations are transferred through to major emitters such that they can individually take decisions as to whether they "make or buy".

3.4 Measurement and Securing Kyoto Credits

An issue that has differentiated agricultural emissions from the start is that their measurement is not nearly as straightforward as that for fossil fuel combustion. Inevitably, proxies for actual measurements on the farm have had to be used for New Zealand to estimate its N_2O emissions and report these, as required under the Protocol. Equally, proxies have to be developed to allow emission reductions to be estimated, relative to what is otherwise assumed to be released.

A key tool in the measurement process is a computable programme developed by AgReserach named OVERSEER. Although devised as an aid to nutrient budgeting, it has been adapted to assist in estimating farm N_2O emissions. In particular, it has recently been modified to allow for the effects of a standoff pad and is due to shortly be able to accept data relating to application of inhibitors. As most dairy farmers use this tool and there are moves to seek its universal adoption, a full suite of relevant data is set to become available to the Government with which it could compile filings under the Protocol.

The Government even has an offer from the sector to coordinate this process:

> The fertiliser industry is prepared to become the point of obligation for the primary sector and in addition, would be prepared to undertake estimates of emissions at the farm level, using tools such as the OVERSEER model. If Government is interested in pursuing this further the fertiliser industry would welcome discussions as soon as possible after March 30th 2007.[93]

The one snag New Zealand faces is that the way it currently reports under the Protocol will not register anything like the savings that are being physically measured on the ground. While New Zealand has developed and had accepted, a range of country specific "emission factors" as they are known, they do not at present begin to adequately register the effects of N_2O abatement technologies.

93 New Zealand Fertiliser Manufacturers' Research Association, (Fert Research), Sustainable Land Management and Climate Change –Options for a Plan of Action. Submission to Government, March 2007, p 4.

This poses a degree of uncertainty for gaining recognition of the benefits abatement investments will bring. However, although the nation's measurement of 1990 emission levels are now locked in,[94] and with it to an extent the methodology, New Zealand has until 2013 to file a final statement as to the emissions (and savings made) for the first commitment period. Thus there is considerable time to optimise a new methodology for measuring the effect of all major forms of emission reduction techniques and then make a case to have a modified reporting framework adopted.[95]

A methodology for incorporating at least the gains from inhibitors has been developed by the Lincoln research team and thus provides a ready template for adoption.[96] MAF noted the potential need for this in 2005:

> There is considerable interest in the potential of new technologies to mitigate on-farm greenhouse gas emissions. For such on farm mitigation technologies to be recognized they need to be incorporated into the national inventory that is reported to the UNFCCC. To be recognized by the UNFCCC, any mitigation options need to meet Good Practice Guidance tests and pass international review.[97]

It is not certain that a modified methodology will be accepted, but since such a change could be backed by hard evidence of real savings and the change would clearly incentivise uptake, it would seem at least inconsistent with the objectives of the Protocol not to permit such a change. Landcare Research, which has undertaken research for MAF on N_2O abatement potentials, is confident that such a modification can be obtained so long as the scientific justification for the change is rigorous.[98]

Exactly why MAF has not acted on the need for modifications that recognise the potential of inhibitors and other abatement techniques to play an important role in New Zealand's Kyoto accounting and ensure that the methodology finalised this year fully allowed for such abatement measures raises questions addressed in Section 6.

3.5 Government Statements and Industry Positioning on Potentials

Recent government and industry documents have consistently been suggestive of very limited potential for N_2O emissions to be reduced.

In the case of Government estimates, this has often resulted from the use of extremely constrained scenarios for the uptake of inhibitors, rather than examining the technical potential and then separately looking at means of accessing that potential. When officials conducted a major review of climate change policy in November 2005, they

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94 They have been repeatedly revised over the years but as of the 2005 filing sent through this year, they can not be altered.

95 Fonterra state that "it will require an additional year's research before use of nitrification inhibitors can be counted in New Zealand's greenhouse gas inventory" but it is unclear if this will affect the ability to later re-estimate for that year. Fonterra, Submission to Government, March 2007, para 7.1 b.

96 T. J. Clough et al, *Accounting for the utilization of a N2 O mitigation tool in the IPCC inventory methodology for agricultural soils*, Nutrient Cycling in Agroecosystems, January 2007.

97 MAF, *Agriculture: Briefing for incoming ministers*, October 2005, p 13.

98 Personal Communication, Landcare Research, 1 June 2007.

described the potential for N_2O reductions as "a few percent" of N_2O emissions - as against the 26% of total emissions that could be saved if all dairy land was treated with inhibitors under baseline assumptions.

> There are realistic prospects based on currently identified solutions to reduce nitrous oxide emissions by a few percent relative to business-as-usual by 2012, and more significantly by 2020.[99]

Note that here the potential was being assessed on the basis of voluntary adoption and a start date of 2010. While these assumptions my have been prompted by agriculture's exemption from non-CO_2 emissions charges until after 2012, this example underscores the importance of estimating technical potential separately from assumptions about adoption rates. The same report further stated:

> If nitrification inhibitors were applied on 50% of all dairy farms and were to sustainably reduce nitrous oxide emissions on those farms by 50% between 2010 and 2020, total non-CO_2 greenhouse gas emissions from agriculture would reduce by up to 3% relative to business-as-usual.[100]

By December 2006, the scenario construction was shifted to at least bring it more into the first commitment period. However, adoption rates were pitched at a very low rate such that it would be very hard for a non-specialist to appreciate the potential of inhibitors. For the purposes of the example however, an incentive payment to farmers was assumed - one estimated to reflect the value of savings in terms of the international price of carbon.[101]

> Adoption rates are hard to predict. However, a 50 percent increase in the use of inhibitors each year from 2006 to 2012 would result in 26 percent of dairy farms using inhibitors by the end of 2012. This could result in the reduction of nitrous oxide emissions of up to one million tonnes of carbon dioxide equivalent over this period.[102]

The one million tonnes of emission savings thus projected compares with the baseline technical potential of 18.5 million tonnes over a shorter period.

Recent work undertaken by MAF suggests that a reappraisal of the potential of inhibitors is underway. In particular, a forthcoming study by Landcare for MAF is expected to suggest higher levels of savings are available.

There has been no apparent leadership from the agriculture sector however in response to the consultation documents. Fonterra saw no significant reduction in dairy industry emissions until after 2012.

> There is limited scope to bring mitigation technologies to commercialisation in sufficient time to significantly reduce emissions by the end of [the first commitment period].[103]

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99 New Zealand Government, *Review of Climate Change Policies*, November 2005, p 136.
100 New Zealand Government, *Review of Climate Change Policies*, November 2005, p 137.
101 MAF stated this "could be up to 25% of the current product cost".
102 MAF, *Sustainable Land Use and Climate Change*, December 2006, p 48.
103 Fonterra, Submission to Government, March 2007, paragraph 5.2 (b)2.

Federated Farmers went further in its response, stating that the effectiveness of inhibitors would be "minimal at best".

> There are few steps farmers can take to reduce the methane and nitrous oxide emissions of their farm operations without severely limiting their financial viability. New technologies are a long way off yet. Although recent technologies like nitrification inhibitors have emerged it is clear their impact on reducing emissions is minimal at best and their uptake reliant on financial support.[104]

The major agricultural representatives have an incentive to underplay reduction potentials. For they tend to predicate any move to price emissions on the availability of cost-effective options, as Fonterra clearly spelt out in its submission to government:

> Fonterra considers practical and cost effective mitigation tools to be a necessary prerequisite to effective use of price mechanisms. Given the absence of solutions (for example, nitrification inhibitors which have widespread utility in New Zealand) a charge on nitrous oxide at this stage may generate some of the risks described in 7.3 above, … [105]

The risks Fonterra had in mind were particularly those related to "exposing our producers to the true cost of their emissions" ahead of competitors in overseas markets.[106] And the company's prescription?

> In Fonterra's view, transitional policies need to be designed on the principle that they reduce emissions at the lowest economic cost. This may imply that New Zealand makes use of the international flexibility mechanism and purchases credits from other countries rather than making more costly reductions at home.[107]

In other words, Fonterra is signalling it is likely to argue that agriculture does not have options competitive with others in the economy or the world price for carbon credits.

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104 Federated Farmers, *Sustainable Land Management and Climate Change Feedback*, March 2007, p 8.

105 Fonterra, Submission to Government, March 2007, para 7.4 (b), p 8.

106 "… we have a significant tradable sector that cannot simply pass costs on; Competitiveness at risk and "carbon leakage" issues arise to the extent that we get too far ahead of trading partners in exposing our producers to the true cost of their emissions." Fonterra, Submission to Government, March 2007, para 7.3 (b), p 8.

107 Fonterra, Submission to Government, March 2007, para 7.3 (c), p 8.

4. 'Til the Cows Come Home

4.1 One Rule For All?

On May 8 2007, Climate Change Minister David Parker announced some useful progress in the quest for an equitable and sustainable basis for pricing greenhouse gas emissions. In addition to confirming that the Government preferred to set prices via some form of tradeable permit arrangement (rather than a carbon tax), he announced a radically advanced timetable for implementation of this. Instead of beginning at some point after 2012 (as had been signalled in December), it would commence in 2008 (if formally approved).[108] The minister's statement then set out the following commendable principles:

- All sectors of the economy will be covered;
- All greenhouse gases will be priced;
- The cost of greenhouse gas emissions should be met by those who produce them.

That however was the long term picture. For the statement also noted that there "could be different start dates and different transition paths for different sectors". While the minister would not be drawn by journalists on the details of which sectors would be early candidates, he was reported by the New Zealand Herald as indicating that "Industries, including dairy and meat companies, would be included over time based on their ability to reduce pollution at least cost".[109]

The idea that agricultural producers in particular would be offered an advantage over other sectors (by way of a later start date for payments) had also been indicated the week before in Parliament when the minister stated that:

> Approximately 49 percent of New Zealand's greenhouse gas emissions come from the agricultural sector, and it is important that all sectors do their bit. That is not to say that the agricultural sector should have to reduce emissions at the same rate of reduction that would be achievable, for example, in the transport or electricity generation sectors.[110]

What was newly signalled however was that agriculture may also be granted a huge holiday on its share of the excess emissions taxpayers must pay for. This would be achieved by adjusting the base date for calculating the quantity of agricultural emissions that would be priced. The base would be switched from the 1990 levels New Zealand will be assessed on under the Protocol to the level emitted at a more recent date. For Parker also said on May 8 that:

> If the dairy sector for instance were to take responsibility for growth in livestock methane emissions between 2005 and 2012, it would equate to less than 4 cents per kilogram of milk solids.[111]

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108 *An introduction to emissions trading*, David Parker, 8 May 2007.
109 NZ Herald, 9 May 2007.
110 Oral answer by David Parker to Parliamentary question, 3 May 2007.
111 *Fishing Quota Touted As Emissions Trading Model*, Marie McNicholas, Newsroom, 08 May 2007

While ostensibly offered as a hypothetical example to show that a permit trading regime "would not break" farmers financially,[112] it has to relate to a real prospective outcome to have meaning.

It must be noted at this point that since Minister Parker presented the example in late May, Fonterra announced it was forecasting a 27 per cent jump in the price of milk solids next season – a gain per farmer of around $140,000.[113] Although it is possible Government had taken account of the firming international dairy prices when designing the example, it could well alter what is ultimately a political calculus. However, if a change in thinking were to result, it would more likely affect the extent of the subsidy on offer than the subsidy mechanism described here. So while the numbers may shift, the principles at stake are key.

Thus, two separate means of reducing the agriculture sector's obligations have been floated:

1. A delay in the date from which permits to emit would need to be held. (A date after the 1 January date taxpayers are accountable from);
2. A change in the 1990 base date from which agriculture's share of emissions is calculated.[114]

Fonterra apparently seeks both. The company's Milk Supply Director states:

> We don't agree dairy farmers – or any sector of the economy – should be punished retrospectively for past emissions back to 1990, as this would be blatantly unfair.
> …
> Fonterra accepts some form of emissions pricing beyond 2012 is almost inevitable.[115]

The implicit basis Parker put forward for privilege being offered to agricultural producers is that "Some sectors can do more because they have more cost-effective choices".[116] While this proposition is now a familiar one,[117] it does not become any fairer with repetition.

Any system of user charges that granted huge discounts to a sector of society simply because others had more cost-effective ways of avoiding using that service would very quickly break down. Imagine for example if parking fees were set on the basis that those not on bus routes were exempted from paying. Similarly, any suggestion that those making domestic flights should pick up all airport charges because international travellers did not have a cost-effective surface transport option would be difficult to sustain.

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112 Context of speech and personal communication with David Parker's office, 18 May 2007.

113 New Zealand Herald, *Farmers set for extra $140,000 dairy payout*, May 24, 2007

114 See further Parker's reported statement that: "We think all sectors can and should do their fair share ... but we also make it explicit that some sectors can do more than others because they have more cost-effective choices, so that has a bearing on when different sectors come in and how tough the cap should be," *Emissions scheme given a timeline*, Vernon Small, Dominion Post, 9 May 2007.

115 Barry Harris, *Green post-1990 penalty policy blatantly unfair*, Farmers Weekly, 4 June 2007, p21.

116 NZ Herald, 9 May 2007.

117 It was the formally declared basis for the exemption set out in the MOU in 2004, sections 1.2 and 1.3 and has been a frequent rejoinder on ministerial statements since 2002.

Finding out which agents throughout the nation (or internationally) can save a unit of emissions most economically is one of the chief virtues of an emissions trading approach the Government favours. To take what should be an outcome - price discovery in the market - and propose it as an *a priori* input is a complete inversion of the economic logic of market mechanisms.

Agricultural emissions contribute proportionately[118] to the risks posed by climate change and charges for emissions must directly reflect their contribution to atmospheric warming, not any sector's ability to abate those emissions.

In any case, as we have seen, agriculture has some very cost-effective options available to it.

4.2 Approach to Emissions Pricing

The subsidy resulting from agriculture being granted a delayed start date for permit payments can be readily calculated. New Zealand's commitments under the Kyoto Protocol begin on 1 January 2008 and run to the end of 2012. So each month's delay represents a proportionate subsidy, relative to what the taxpayer is liable for, unless later made up.

There are however two possible ways to calculate a change of the base year.

1. Assumed Historic Entitlement

One approach is to assume that charging will relate only to growth in the agriculture sector's emissions since 1990 - not its share of the nation's total emissions. This involves a presumption that the sector has some form of entitlement to the base year level. This would be inappropriate for a number of reasons.

a) The Kyoto Protocol is not framed in this way. It sets a target for New Zealand as a whole and issues the New Zealand Government sufficient credits to meet that target. Any overrun must then be met through the purchase of credits on world markets. Thus all greenhouse gases are treated equivalently, with no 'jam jars' for any sector or type of gas.

b) The Government has not made any allocation of prior entitlements to any sector.

c) To do so would reduce the incentive on those sectors with lower rates of growth since 1990 to make savings, regardless of their potential for saving. This would in turn reduce the incentives nationally for least cost abatement across the economy – something in the interest of all New Zealanders.

d) It would usher in a fractious debate about which sectors were advised when, and who made investments on the basis of what signals that would divert attention from the key goal of stimulating emissions reductions.

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118 Each greenhouse gas contributes to global warming per molecule in quite different ways depending on its individual warming potential and decay period but once adjusted for these factors in particular, the gases can be priced on equivalent bases.

2. Pro-rata Share of New Zealand's Total Emissions

The alternative is to charge for emissions in proportion to the total actually emitted. This is the appropriate methodology as:

a) It makes no presumption of prior property rights over the proportion of a global commons New Zealand may ultimately be allocated to work within. That commons being the ability to release greenhouse gases into the atmosphere on a sustainable basis.
b) It is consistent with a charging basis whereby all emitters face a common price for each equivalent unit emitted, for all quantities emitted. (It can however be made compatible, if required, with different sectors having different transition paths to paying their full share.)

The next question is whether the total volume of emissions is priced, or simply the excess emissions taxpayers must otherwise pay for under the Protocol.

The short answer is that the economically efficient response is to price all emissions so as to fully internalise the environmental costs emissions pose. In a market economy, unless the full cost is signalled, agents have an incentive to expand production beyond that which is economic for society as a whole.

This end game position (which Parker's statement supports) is separate from the question of whether there is merit in certain sectors or industries receiving transitional assistance. Governments may provide some period over which the new pricing is phased in to allow for an adjustment.[119]

How any transition to an international price for carbon is constructed is a critical question. It is however a far broader one than this paper addresses, as it requires knowledge of the costs of abatement across the economy and the positions of individual major emitters, along with judgments about acceptable rates of change.

A clear bottom line constraint on devising a transition that can nonetheless be set at this point is that taxpayers should not shoulder any part of the Kyoto bill. In the case of agriculture, Sections 2 and 3 identified ways for agriculture to abate its share of excess emissions at no cost. There is no reasonable construction under which emitters collectively should not bear the full cost for all emissions in excess of the nation's 1990 levels.[120] This would amount to a direct subsidy to emitters, using hard taxpayer cash.[121]

Yet that is precisely what the Climate Change Minister is signalling when speaking of a shift in the base year for measuring emissions.[122]

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119 Even though emitters have had over a decade to prepare since New Zealand signed the Protocol, the absence of a credible government programme meant that until quite recently there was room for considerable doubt that action would be taken any time soon.

120 Note that certain firms could still successfully gain transition subsidies from the taxpayer so long as the total net revenue from emission permits more than offset the Kyoto obligations.

121 The extent to which not charging for the balance of emissions also represents an undue cost to other parties depends on a host of factors that are part of the bigger question of how the transition is structured.

122 Such a subsidy would occur even if other sectors cut emissions sufficiently that there was no longer a Kyoto deficit as agriculture could then sell credits for savings made when others had in effect been compelled to surrender at least some of theirs to the Government.

4.3 Scale of Taxpayer Subsidies

A shift in the base year can amount to a huge fees holiday, regardless of whether there is any delayed introduction. If charges for all livestock emissions[123] were based only on the growth in those emissions from 2005 to 2012, as in Parker's example, this would represent an 85% exemption. An appreciation of the scale of subsidy this involves is revealed by putting this in context:

- Livestock account for half of the nation's total emissions.[124]
- The growth in these emissions represents just 22% of total livestock emissions;
- An 85% exemption on the growth component means only 3% of total projected livestock emissions would actually be charged for.

As noted above, methane accounts for two thirds of livestock emissions on a carbon equivalent basis. Interestingly, Parker is reported to have specified on May 8th that it would be the growth in "methane emissions from livestock" that informed his example.[125]

The minister appears to often use "methane" as a communications shorthand for livestock emissions in general. When the Sustainability Council checked with the minister's office, this was the interpretation we were informed should indeed be applied to his description. Thus the example was meant to indicate a similar treatment for N_2O and methane (rather than methane being largely exempted and N_2O not).[126]

At the same time, the Council sought details of the other assumptions used in calculating the example and was informed that these could not be provided as the documentation from which they were drawn was currently subject to ministerial consideration.[127] A particular issue is whether the minister's example used historic agricultural emissions as the basis for calculating the extent of the exemption up to 2005. While this would be consistent with a number of veins of Government

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123 Agricultural emissions do not include related CO_2 emissions for the purposes of Protocol reporting so they are essentially those arising from livestock.

124 Methane emissions alone rival those for the nation's total CO_2 emissions.

125 He similarly specified methane alone when participating in a public debate at Victoria University, May 16th 2007: "If by 2012 the agricultural sector was responsible for increases in methane emissions from 2005 to 2012, the cost is something like 2c per kg of milk solids. It's $435 per kg of milk solids at the moment …".

126 If an exemption were given only to methane emissions, this would likely be paired with the assumption that the agriculture sector would then pay for all the growth in the other third of emissions from nitrous oxides. This would result in a 55% exemption for the growth in total livestock emissions, based on agriculture's share of the nation's total projected emissions (0.85 x 0.64).

127 Personal communication with representatives of the Office of the Minister for Climate Change, 18 May 2007 and 25 May 2007. The Sustainability Council was further informed that should it nonetheless seek a copy of the assumptions, an Official Information Act request could be made but that such a request was unlikely to yield the information sought due to it being under consideration by government.

thinking, it would require granting some prior entitlement to historic levels – the concept earlier rejected as a very poor basis for policy.

Nonetheless, if the pricing of emissions were instead calculated on that basis, with only growth in emissions from livestock above 2005 levels being counted, then this option represents a 68% reduction relative to 1990 levels for livestock emissions, and would result in 6% of livestock emissions being priced.

The following table summarises the effect for these two options.

Subsidy Option	Proportion of excess emissions unpriced	Proportion of total agricultural emissions unpriced
Share of NZ Total - charged for proportion of NZ's total emissions growth since 2005	85%	97%
Agriculture Only - assuming base of agricultural 1990 levels and growth since 2005 in agricluture	68%	94%

The second option that relies on a notion of historic entitlements is more stringent on agricultural emitters only if the proportion exempted is large. This arises because agriculture's rate of growth in emissions post 2005 is projected to be higher than that for the country as a whole. However, if agriculture were to be charged for all its emissions (rather than a small portion), then on an historic allocation basis it would be paying for just a 22% rate of growth versus the 29% excess over 1990 levels that New Zealand as a whole faces. Thus historic allocations favour the agricultural sector overall. (There are however sharp differences between diary, beef and sheep as dairy accounts for almost all the growth since 1990).

The cost in dollar terms of these subsidy options depends on a series of assumptions including:

- What share of the forestry credits the Crown ultimately keeps;[128]
- Whether the forest credits are treated as an integral part of the Kyoto agreement and are thus immediately applied to any taxpayer liability (as is currently the case) or are considered a related but separate income stream that emitters do not have first call on any more than if the foresters had owned all the credits;
- The exchange rate – currently at an historically high level;
- The international price for carbon credits that New Zealand will have to purchase to make up for the projected deficit.

With respect to the last of these, the Government's accounts assume a price of around $15 per tonne of carbon for purchase of these credits, while its current price on the European exchange for sales in the relevant period is taken as $30 per tonne (though it is considerably higher at present, as discussed in Section 3). What the price will be at the time credits need to be purchased cannot be known today but the Government's estimate is based on the view of a single London-based economist whereas the market

[128] The National Party for example is promising a "proportion" be given to forest owners and the Government could yet return to its original position which also involves sharing a proportion of the credits.

reflects the combined judgement of players on the world's largest carbon exchange.[129] A number of other parties have forecast much higher future prices. The following table shows the extent of the subsidy under a range of carbon prices.

Costs to Taxpayer of Pricing Only Growth in Emissions from 2005 ($ millions)

Subsidy Scenario	Exemption %	Price of Carbon NZ$/tonne $15	$30	$60
Agriclture's share of NZ's total emssions from 2005				
No forestry credits used to offset	85%	631	1,262	2,525
All forestry credits used to offset	85%	264	529	1,057
Agriculture's emissions from 2005	68%	371	742	1,484

What the table makes clear is that subsidies of the form outlined above that equate to a 68% to 85% monetary exemption are worth hundreds of millions of dollars over the Protocol's First Commitment Period under any credible pricing scenario. At a carbon price of $30/tonne, they are worth at least half a billion dollars, with values ranging from $529 million to $742 million assuming all the forestry credits are used to offset the Kyoto liability, or $1.26 billion if none are used.

The table however understates the effect of the subsidy. This is because the taxpayers' share is front-loaded. Taxpayers take on virtually all the past excess emissions when charges are levied only on growth from 2005. Agricultural producers are essentially given a clean slate for 15 years of excess emissions at no penalty. Farmers then have the choice not to undertake the further expansion projected in Government forecasts and so incur essentially no penalty and bear no share of the payments required under the Protocol if current production levels are frozen.

Neither do these values include any effect from a delayed start date. Given that Government does not expect to pass the legislation required to establish the tradeable permit scheme before early 2008, some delay will be inevitable. However, the notion that different sectors will be progressively introduced to the permit system suggests many months if not a year or two's delay for agriculture.

Under the approach that provides an 85% exemption, the extent of the exemption would be increased by 3% for each year of delayed implementation.

If the rate of exemption is 68%, then a two-year delay would turn this into an 80% subsidy, relative to the bill the taxpayer would have to pay.[130] In diagram form, this translates to the following.

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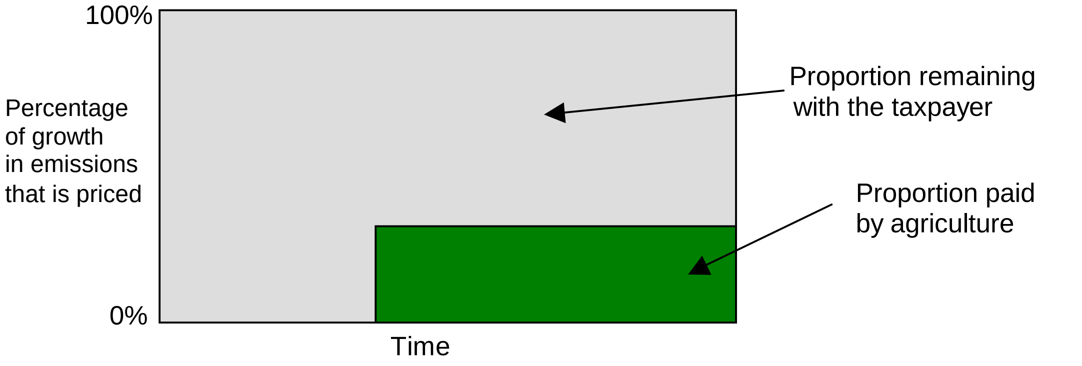
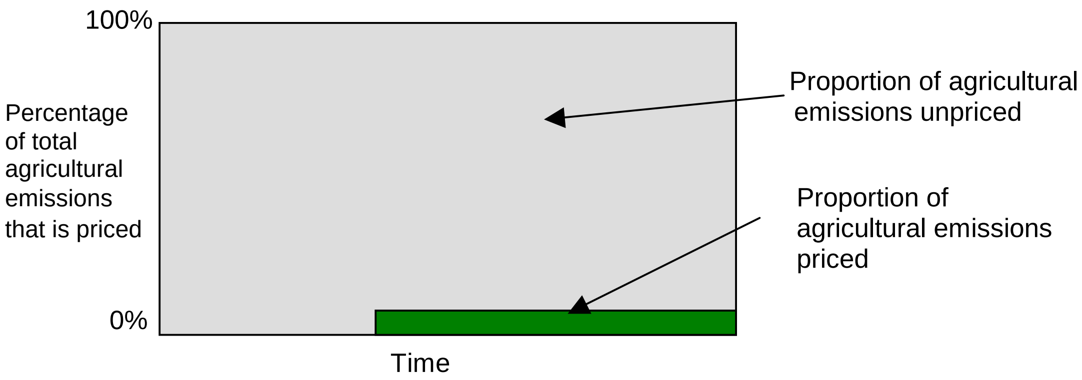
[129] Note also that Parker has stated that: "I am agreeing that there will be a firming of the price of carbon. I don't agree that it will go to the European price overnight." Radio NZ Morning Report, 20 April 2007.

[130] A two-year delay on a 68% exemption adds 32 x 0.4 = 80%.

Taxpayer Subsidy
68% exemption, two years delayed start



Quantity of Total Agricultural Emissions Priced
68% exemption, two years delayed start



5. Al Gore's Big Friend

The potential for reducing agricultural emissions is much greater than has generally been acknowledged. The repeated shorthand that agricultural emissions are methane and methane cannot be abated without culling livestock has proven a powerful but false message: a convenient untruth.[131] This has served to deflect scrutiny from the agriculture sector and protect it financially - by acting as an apparent justification for not passing through to agricultural producers the fiscal and environmental costs of their activities.

Given that New Zealand research is showing major emission reductions can be achieved at no cost, one could be forgiven for wondering why leading agricultural representatives are not spotting a big opportunity to save the country's Kyoto bacon and raise the sector's green credentials in one stroke. However, agricultural leaders will be looking ahead to two issues.

The first is that the sector's business strategy centres on growth in volume, not growth in overall financial returns. The dairy sector alone has set a goal of 3% per annum compound growth in its industry strategy. In consequence, the research the sector has commissioned on greenhouse gases is generally framed in terms of allowing greater output for each unit of emissions, rather than a net reduction in emissions as an end goal. Under its growth assumptions, agriculture's incentive is to reserve any savings that can be made by mitigation for later use as room for expansion, rather than yield these as genuine cuts on current emission levels.[132] Hence its push for a change of the base date for measuring emissions - from 1990 to perhaps 2005.

The sector's wider concern will be that pricing even some emissions is the thin end of the wedge. That because the cuts required to avoid "dangerous" climate change[133] are much greater than a return to 1990 levels, if agriculture accepts "responsibility" for its share of the current excess emissions, over time farmers will be picking up responsibility for an increasing proportion of their emissions – and eventually all of them. Further, such a precedent only serves to underline the ability to price scarce environmental services that agriculture is drawing on, sometimes at quite unsustainable rates - such as water abstraction in Canterbury and the assimilation of nitrates in many catchments.

Agriculture here is up against Al Gore's "big friend", reality.[134] This has both a domestic component and an international one.

The domestic political reality is that New Zealand has ratified the Kyoto Protocol and given the recent shifts in domestic opinion in support of action to address climate

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131 The Oxford Concise Dictionary gives one definition of 'untruth' as "the quality of being false", and it is used in this sense.

132 Even though the dairy industry could make savings sufficient to cover all growth to 2012, it will be looking beyond that period.

133 A rise greater than 2 degree Celsius is currently projected to pose risks that the European Union believes constitutes "dangerous" climate change.

134 Al Gore's description to reporters of what was helping him project his message on climate change during his flying visit to New Zealand on November 23, 2006.

change, withdrawal from the Protocol is not an option for any political party. (Even agricultural leaders would now likely judge it better for the sector to remain with the treaty in light of the trade ramifications of a withdrawal).

Given that the nation as a whole is far over its Kyoto target, and a projected bill of $1.2 billion is set to come to taxpayers under business as usual, agricultural lobbyists lack a coherent rationale for their current stance. A sector that accounts for half the nation's emissions, and has options that would allow it to meet its share of excess emissions at a profit, cannot credibly ask taxpayers to pick up the bill instead, especially when profitable options mean there is no question about remaining internationally competitive.

Federated Farmers' declaration in 2003 that "Government needs to stop passing the buck to rural New Zealand for the Kyoto commitments it made on behalf of all New Zealanders" is no more tenable today than the prospect of the federation running another FART tax campaign. The current proposition from the sector is that ordinary taxpayers meet the costs of excess emissions generated primarily as a result of land newly converted or more intensively farmed, in pursuit of commercial gain. With the dairy industry set to receive bumper export prices,[135] and the agriculture sector registering only 12% public support for any form of assistance[136] (even before there is public understanding of its cost-effective abatement options), the position is unsustainable no matter how much 'fonterror' is applied to the Government.

The international reality is a commercial one. Concerns about climate change are increasingly driving consumer buying patterns and, in turn, wholesaler purchasing requirements. In the UK for example, Marks & Spencer supermarkets has declared it will become carbon neutral and is demanding its suppliers also conform within a few years.[137] Brands will be made and lost on their ability to walk this road. And brands are what New Zealand needs at this time much more than additional volume.

As AgResearch CEO Andy West notes, the agricultural sector has not only to create more value by better meeting consumers needs, it also has to capture more of that value for itself. Business commentator Rod Oram further observes that:[138]

> Farmers get perhaps as little as 10-15% of the total value created by raising and slaughtering lambs, then shipping and selling the meat to consumers overseas. Meanwhile, the UK supermarkets capture as much as 65% of the value. There may be ways to shift a bit more of the value back to farmers and processors here by producing even higher quality, more customised products. But if it wants to earn big money, the primary sector will have to build its own brands and value chains direct to consumers.

Whatever the specific focus of those brands, a baseline component will need to be that a good from New Zealand is an environmentally sustainable product. This is no longer simply a marketing opportunity: it is a defensive necessity. It will increasingly

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135 MAF estimates that "The average dairy farm has total assets of $3.6 million, a sheep and beef farm $3.4 million". MAF, *Agriculture: Briefing for incoming ministers*, October 2005, p 4.

136 ShapeNZ, *New Zealanders' views on climate change, and related policy options*, 13 April 2007.

137 Rod Oram, *Don't be fooled by food miles*, Sunday Star Times, 10 June 2007.

138 Rod Oram, *Farmers hold key to the market*, Sunday Star Times, 13 May 2007.

be a requirement of wholesale purchasers, just as EurepGAP specifications effectively set a floor for access to the supermarkets participating in that scheme.

When Fonterra announced the high forecast for 2008 prices, the chairman of the dairy industry's environment leadership group usefully advised farmers to make sure some of the new wealth was devoted to putting in place first class management systems, fence off waterways, and keep commitments to farming "more and more sustainably".[139] However, the dairy industry's environmental strategy currently advocates in respect of greenhouse gas abatement that the industry simply maintain a "continued contribution to the Pastoral Greenhouse Gases Consortium".[140] That is, more research, not an action focus.

In short, the agricultural sector's central goal of increased volume has incentivised it to first resist responsibility for its emissions, and then seek to leave as much of the Kyoto liability with the taxpayer as possible in order to protect room for growth. This is a strategic culvert.

An agriculture sector without environmental sustainability at the core of its business planning, and thus one fully embracing responsibility for emissions, is something the nation cannot afford. For the concern is not just that the sector will lose markets and competitiveness: the sector is so dominant it puts the economy at risk. As Rod Oram notes:

> Being leaders in the principles and practice of sustainability is the only way we can combat the pernicious campaigns of our competitors. If we're laggards, we'll play into their hands to the serious detriment of our economy. Roughly 80% of our foreign exchange earnings and 40% of our GDP rely in some way on our environment.[141]

Rather than Government continuing to 'cowtow' to agriculture and offering up lame justifications, it is time to activate the MOU's clearly marked exit clause and inform the sector it will be paying for its excess emissions, as will everyone else.

The flip side of enforcing "polluter pays" involves a fair share of the forestry credits (and liabilities) being passed to forest owners. This unwinds the other major distortion in land use. While absence of these credits was not the most important influence on planting rates going into freefall, this change is important to restoring confidence in forestry investment.

Such a passing through of the costs and benefits is the approach required to protect against large transfers of wealth from taxpayers to emitters, and from foresters to taxpayers. It would also provide crucial price signals - to investors in new dairy farms in particular.

This would bring home that the future reality is a carbon-constrained world where a price on emissions will be a normal cost of production. The question then is whether pastoral farmers can grasp the quite extraordinary opportunity that a suite of simple

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139 John Penno, May 28 07, Rural Report

140 Dairy Environment Review Group, *Dairying For The Environment – A Summary of the Sustainable Environmental Management Strategy,* Dairy InSight, 2006, p4.

141 Rod Oram, *Don't be fooled by food miles*, Sunday Star Times, 10 June 2007.

and cost-effective techniques offer to not just abate current excess emissions, but be the nation's leading source of abatement in a world increasingly looking for a post-Kyoto agreement that will lock in deeper cuts.

To the extent growth exceeds the sector's ability to abate emissions, the question will then be whether it can pass on those costs to end consumers (in whose name the emissions are produced), or whether land values are shaved or there are changes of land use.

The best response to the sustainability challenge is to position at the premium end of overseas markets, where less volume can be sold at higher prices, and take leadership in delivering the environmentally sustainable products they increasingly value. It is about turning threat to opportunity and getting ahead of the competition, not being "shielded" from change that is needed for the country as a whole.[142]

[142] This thinking was earlier set out in the New Zealand Listener, Simon Terry, 24 March 2007.

6. Climate Medicine

6.1 Cost-competitiveness the Yardstick, Transparency the Requirement

The economically efficient way for New Zealand to meet its Kyoto commitments at least cost it is to select (or to set up incentives for private sector players to adopt) a package of measures that produces the required savings for the least all-up cost. Usefully, there appears to be general consensus that this approach should guide decision-making.

Climate change minister David Parker stated on 8 May 2007 that:

> "We think all sectors can and should do their fair share ... but we also make it explicit that some sectors can do more than others because they have more cost-effective choices, so that has a bearing on when different sectors come in and how tough the cap should be," Mr Parker said. He was seeking broad political support. [143]

National's leader John Key is similarly of the view that cost-effectiveness is the test.

> The overriding question for National will always be: who can reduce emissions at least cost to society and to the economy? We will work to reduce the cost of climate change to businesses, to taxpayers and to the environment.[144]

Fonterra too supports this proposition:

> In Fonterra's view, transitional policies need to be designed on the principle that they reduce emissions at the lowest economic cost.[145]

Unfortunately, there is inadequate information in the public domain to determine the cost-competitiveness of some major agricultural abatement options. In particular, Government has decided to withhold one report that does compare options across the economy on a consistent basis. The consulting report prepared by ICF simply processes information that is already public and apparently contains no policy advice to Government. However the Ministry for the Environment states:

> This report will be considered for release … once decisions on the core elements of emissions trading and transitional measures have been taken, but prior to final decisions being taken on the package.[146]

In other words, Government seeks an information advantage while it makes decisions about what is arguably the leading public policy question before it.

The public availability of information necessary for decision-making is a first required reform.

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143 *Emissions scheme given a timeline*, Vernon Small, Dominion Post , 9 May 2007

144 *50 by 50: New Zealand's Climate Change Target*, John Key, speech to National Party Northern Regional Conference, 13 May 2007

145 Fonterra, Submission to Government, March 2007, para 7.3 (c), p 8.

146 MFE CEO Hugh Logan, letter to Sustainability Council, 30 May 2007.

6.2 Agriculture First, not Last, for Emissions Pricing

What information is publicly available points to emission reductions available from the dairy industry as a central part of the nation's package of least cost options. Further, these savings are large in relative terms. They count for far more than can be achieved from the electricity sector. Only banning all fossil fuel generation would exceed the quantity of emissions that can be readily cut from the dairy industry.

Also important is that these savings can be brought on quickly. While many options for cutting CO_2 involve plant replacement, and so can only be accomplished as equipment is turned over, the major techniques available to agriculture can be cranked up and applied with less than a year's notice. That means savings can be made right from 2008 when New Zealand is first measured for excess emissions. After seventeen years of targets without measures to achieve them, and a lack of time to get serious emissions reductions from many other options, the availability of a cornucopia of cheap and rapidly adoptable agricultural options is a remarkable break.

As a result, agriculture should be in the first group of sectors to have emissions priced. There is a range of ways a price can be set, including establishing a market for tradeable permits, as Government has signalled is its preference.

A major Government review of climate change policy completed in November 2005 observed that:

> The absence of a price signal at the farm level means that farmers have no incentive to implement mitigation measures that come at a net cost to their operation even if the cost is small, unless there are other benefits from undertaking such actions.[147]

Even options available at a profit, such as those identified in this report, are often not taken up without an explicit driver. Further, if the economy is to abate emissions at least cost, a price signal needs to extend beyond just the N_2O savings that are clearly available. All emissions specified under the Protocol must be subject to the pricing mechanism. As earlier noted, the pace at which a transition moves emitters across the economy from a starting position[148] to fully meeting the cost of their emissions is a separate question of the transition strategy to be adopted.

From 2008, the agriculture sector can clearly bear at least its share of the nation's excess emissions. There is no argument for delay on the grounds that such measures cannot earn credits until New Zealand's accounting under the Protocol is changed. The data can be gathered now and processed any time up to 2013. In the unlikely event that Government is unable to achieve a change in the accounting practice, it is well placed to underwrite agriculture on this so that farmers still get equivalent value for their emission reductions through action taken in the meantime. Neither is there escape through uncertainty over the effectiveness of inhibitors in abating N_2O, as their economics do not depend on this. A 2006 review of inhibitors for PGGRC that recommended more multi-year research on effectiveness before making policy is a

147 New Zealand Government, *Review of Climate Change Policies*, November 2005, p 339.

148 This may be some proportion of emissions that are priced or some proportion of the world price across all emissions.

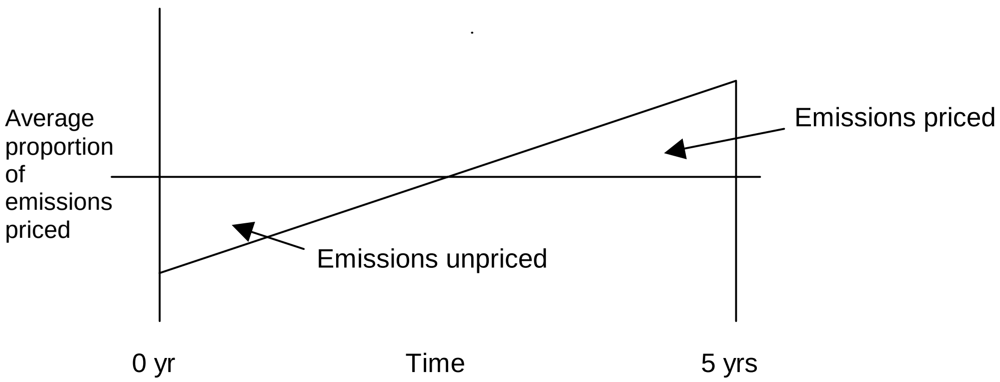
call for taxpayers to meet the cost of emissions while researchers polish up numbers that already more than satisfy the decision-making requirement.[149]

In all, there is no case for any level of subsidy by way of exemptions. The sector is well capable of taking responsibility for all emissions in excess of its pro rata share of the nation's excess over 1990 levels. The dairy industry can effectively achieve the required savings on its own.

If Government ensures all sections of the agriculture industry face a price for their greenhouse gas emissions, this will be economically efficient while still allowing sheep and beef farmers to make claims on the dairy sector if the sector itself wants to engage in some internal allocation of responsibility that reflects recent emissions patterns.

Where Government can assist is by ramping the introduction of the obligation. As the Protocol measures excess emissions not year by year, but over the full five year period, if the sector is given a lower level of responsibility at the outset and a proportionately larger one near the end, this advantages agriculture at no loss to the taxpayer. It not only better matches the industry's ability to organise for savings, it sets a higher target rate for the finishing year. For there is a good prospect that following the end of the first commitment period, the nation's abatement target will be tougher again. This approach is illustrated in diagram form below.

Ramping the Proportion of Emissions Priced



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149 "Investigation of the efficacy of both DCD and DMPP throughout a wide range of soil, latitude, climatic and other environmental conditions as experienced in the New Zealand pastoral sector is recommended. … Following peer reviewed publication, policy makers can then also use these data in formulating defendable abatement strategies for New Zealand agriculture." Helen Suter, Richard Eckard, Robert Edis, *A Review of Nitrification Inhibitors and Other Nitrogen Cycle Modifiers in New Zealand Pastoral Agriculture, University of Melbourne*, September 2006, p18.

6.3 Burial of the MOU, and a Reincentivised PGGRC

If agricultural producers face either a financial cost or a financial opportunity for each tonne of greenhouse gas they emit or abate, then the appropriate incentives will also be in place to drive the next part of the livestock emissions story: methane.

The real potential to abate methane remains to be determined as the research publicly reported to date does not provide a clear reading of its potential. It is clear however that the current incentive structure for research into abatement of it and nitrous oxides is abysmal.

Firstly, the MOU that sets up the research partnership between the agricultural sector and Government does not require any minimum level of investment by the industry. Of the total annual budget of $4 million committed to the PGGRC last year, Government met more than half.[150] Industry's total input of some $2 million is less than a quarter of the $8.4 million that Government was advised by an independent review would be required from industry for the work – an amount Government then said it would levy from the sector if it did not voluntarily fund the required research.

> The $8.4 million a year that the research levy will raise is a very modest amount to ask from a $15 billion dollar industry - about 9c a year for each mature sheep and 54-72c a year for each mature beef or dairy animal.[151]

Secondly, the MOU sets only a general requirement for the parties to seek out "cost-effective" abatement options and places no specific onus on the parties to report any and all the costing information it obtains. Yet Government must have access to that cost information in order to determine the economics of options for intervention. PGGRC's reports are extremely light on cost information, even where relevant data would have been collected as part of the research programmes.

Thirdly, the MOU's undertaking from Government that no livestock emissions would be priced before 2012 removed the incentive to adequately prioritise and fund research into techniques that could make early and significant emission reductions – such as integrating multiple methods for N_2O reduction and simple techniques for methane reduction.

The MOU provides for a review in June 2007 and also provides an unqualified right for the Crown to terminate the agreement at 30 days notice.[152] This option ought to be exercised without delay. The MOU is a thoroughly inappropriate structure, and the sooner it is wound up, in favour of research driven by world carbon prices, the better. This does not mean Government should not contribute public funds to research in this field. It simply acknowledges the reality that industry needs to face a price signal before it will optimise its share.

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150 PGGRC 2006 annual report. The dairy industry pays less than a quarter - $800,000, p38.

151 Pete Hodgson, Convenor of the Ministerial Group on Climate Change, *Agricultural greenhouse gas research levy is modest and fair*, 2 July 2003.

152 Clauses 12.4 and 12.5.

It is also apparent that MAF requires a new structure for its climate change team and new tools to manage Crown exposures arising from livestock emissions. In particular, it requires staff skilled in risk management.

6.4 Business as if Sustainability Were Central

The sharp jump in Fonterra's projected payout has overnight altered price relativities for agricultural land and commentators are forecasting a rise in the rate of conversions to dairy. This, and a trend to intensification of existing dairy farms, spells increased environmental pressure not just from emissions, but also from increased demand for water abstraction and from nitrate runoff.

That pressure is set to reinvigorate the debate that then Parliamentary Commissioner for the Environment, Morgan Williams, kicked off in 2004 with the report *Growing for Good*.[153] The report warned of the cumulative impacts of increasing intensification of farming and the need to fully integrate farming practices with ecological sustainability. MAF has also recognised in principle the need to move the sector to conform to sustainability requirements and sets this out in the following terms:

> Sustainable development policy must … move towards full social pricing of natural resources (rather than seeing them as "free goods") and must address the major negative impacts that result from industry activity. Examples include impacts on water quality and the effect methane emissions have on global warming. As far as practicable and appropriate industry is expected to reduce or bear the costs of negative impacts.[154]

Just what change in the level of dairy production the new Fonterra payout price will actually lead to will depend a good deal on the extent to which Government agencies are prepared to begin implementing what has been a purely notional agenda to date. More than ever, business-as-usual modelling cannot reasonably provide the answer. The dairy industry already makes use of large volumes of unpriced inputs, which means the Fonterra payout significantly overstates the true net gains that would be available to farmers if all costs were accounted for. If the industry is to further significantly expand in pursuit of commercial gain, then business cannot be as usual any more. It has to be business as if sustainability were a core business requirement. That means full pricing of all environmental services for at least the additional growth. Only then are environmental costs a part of the new investor's equation instead of implicit subsidies.

MAF is provisionally forecasting substantial rises in livestock numbers on the back of increased dairy product prices, but has yet to make public its final projections for the resultant emissions. Whatever picture those projections paint, they will need to be accompanied by a clear specification of what prices are assumed for environmental services. To the extent that the figures show significant rises in emissions above the most recent public projections (as used in our modelling), they will further highlight

153 Parliamentary Commissioner for the Environment, *Growing for Good*, October 2004.
154 MAF, *Agriculture: Briefing for incoming ministers*, October 2005, p 12.

the need for research to be focused on low tech and readily adoptable abatement techniques, for methane in particular.

What is abundantly clear under any scenario is that agriculture must pay for all its growth, regardless of whether it has cost-effective options for cutting emissions. As noted previously, the alleged absence of cost-effective options is no sound basis for exempting emitters at any time. However, the case is even clearer when an industry expands with the clear understanding that extra emissions otherwise carry a cost for the taxpayer.

How the industry allocates those additional costs is an issue that can in the first instance be placed with Fonterra as the point of obligation for payment.

Appendix 1 Modelling of N_2O Abatement Potentials

The results reported in Section 3 arise from a model designed to understand the technical potential for abatement of N_2O through use of nitrification inhibitors, standoff pads, and supplementary maize feeding techniques. The particular focus is the potential to reduce emissions during the first commitment period.

The estimation process relies first on projections of future emission levels. The Environment Ministry's most recently published projection for 2010 is for emissions of 46.5 Gg.[155] As this is the midpoint of the five year commitment period and official projections tend to be linear extrapolations, it can be used as a median value for estimating annual reductions over that period. The four sources of emission that make up this total are then assumed to arise in the same proportions as those for the most recently recorded actual emissions, those for 2005.

The proportion of dairy cattle, beef cattle and sheep that make up this total is based initially on MAF estimates for animal numbers and nitrogen deposited per animal per year, and are set out below.[156]

GREENHOUSE GAS SOURCE	Population size - estimated for 2012	Nitrogen excretion	Total Nitrogen excretion	Fraction contribution	Percentage contribution of cattle, sheep& deer
	(1000s)	(kg N/head/yr)	(kg N/yr)		%
Dairy Cattle	5,605.00	122.70	687,733,500.00	0.41	40.53
Non-Dairy Cattle	3,886.00	76.50	297,279,000.00	0.18	17.52
Sheep	39,908.00	15.90	634,537,200.00	0.37	37.40
Deer	1,658.00	31.00	51,398,000.00	0.03	3.03
Other			25,732,594.58	0.02	
Total			1,696,680,294.58	1.00	98.48

These yield a split that directly informs the proportions to be applied to the largest source of N_2O emissions defined in the IPCC guidelines, "pasture, range and paddock manure". That set of proportions is also taken as the basis for allocating emissions from leaching (as MAF also applies). Strictly speaking, emissions from leaching arise from fertiliser use and excreta, and a weighed average should be employed (which would raise the abatement potential of measures). However, we have been unable to find information that would clarify the appropriate weighting.

A third category covering emissions arising from fertilisers is allocated according to a split of fertiliser sales recorded, as also used by MAF.[157]

Applying these various factors then allows a matrix of emission sources to be mapped against sector origins, and this allows sub-sector emission reductions to be estimated.

The next stage involves the assignment of effectiveness factors for the various abatement techniques. Those for standoff pads and maize supplementary feeding are set out in Section 2. However, the assumptions behind the inhibitor calculations are more complex.

155 Ministry for the Environment, 4NC Table 19.

156 Ministry for the Environment, 4NC Tables 20 and 22.

157 MAF, A summary table entitled "Impacts of DCD - A Scenario, Mean Annual Values", May 25 2007. Dairy accounts for 70% of such sales, while sheep and beef each account for 5%.

As noted in Section 3, we have generally adopted the assumptions used by the Lincoln University team, as reported in Clough, 2007. The two divergences of significance are the factor for emissions from range and pasture (set at 70%) and that for emissions from leaching (also set at 70%). The rational for adopting these is also discussed in Section 3. However we note that in the same paper Clough et al report the average reduction in emissions over all the trials the team has completed for pasture emissions is 72%, and the average rate for abatement of leaching is 69%.[158]

The next significant factor is to allow for eco-n to be applied twice yearly (in spring and autumn) and remain effective only so long as temperatures do not rise beyond critical levels, after which it tends to decompose. Clough et al argue that as N_2O emissions are strongly correlated to wet conditions, and these predominate in winter, that the two applications will be effective over 84% of emissions. This is also essentially the view of others who suggest figures of 80 and 85%.[159] Leaching is however assumed to be abated consistently throughout the year. A conservative approach is taken to emissions from volatilisation and inhibitors are assumed not to abate emissions from this source.

As inhibitors cause additional pasture growth, their application displaces fertiliser use. Ravensdown notes that urea fertiliser use is extremely variable to begin with and that while a high user may cut back, a low user may cut applications altogether.[160] We have also been told that perhaps half the previous fertiliser would no longer be used and have settled on this assumption in absence of reliable data.

All other assumptions are as detailed in Clough. Together these provide the basis for the baseline scenario relied on, with the baseline results detailed in the following output table.

Baseline Scenario

	Annual N_2O emissions abated in CP1 (kt CO_2e)	Proportion of sub-sector emissions %	Proportion of agricultural emissions %	Proportion of national emissions %	Proportion of excess over 1990 %
Dairy Cattle - Inhibitor	3689	57	9.3	4.6	46.9
Non-Dairy Cattle - Inhibitor	1214	53	3.1	1.5	15.4
Sheep and Deer - Inhibitor	2671	52	6.7	3.4	34.0
Total	7574		19.1	9.5	96.4

158 T. J. Clough et al, *Accounting for the utilization of a N2 O mitigation tool in the IPCC inventory methodology for agricultural soils*, Nutrient Cycling in Agroecosystems, January 2007, p4. Clough assumes a 35% reduction of leaching and a 50% reduction for pasture.

159 "Ledgard et al. (1996) indicates that about 80% of annual denitrification losses from grazed dairy pasture in New Zealand occurred from April to August. Similarly, Muller and Sherlock (2004) reported that 85% of total N_2O emissions from urine-amended grassland soil in New Zealand occurred when soil WFPS exceeded 50%." From de Klein et al, *Restricted autumn grazing to reduce nitrous oxide emissions from dairy pastures in Southland, New Zealand,* Agriculture, Ecosystems and Environment, October 2005.

160 Personal Communication, Ron Pellow, 18 June 2007.

Lower Performance Inhibitor Scenario – 50% effectiveness

A source of doubt that has been discussed in respect of the use of inhibitors is that extrapolating from farm scale trials to normal on farm use may not result in yields as high as have been achieved due to less stringent patterns of application of the product - in terms timing of use and coverage. It should be noted that this doubt is not mentioned in the main studies that have assessed field performance to date. Further, if the purpose of study is to evaluate the technical potential, rather than what farmers may actually achieve without adequate experience and training, then there is limited rationale for adopting a lower rate of effectiveness. However, the following tests out abatement potentials under this assumption.

	Annual N_2O emissions abated in CP1 (kt CO_2e)	Proportion of sub-sector emissions %	Proportion of agricultural emissions %	Proportion of national emissions %	Proportion of excess over 1990 %
Dairy Cattle - Inhibitor	2835	44.1	7.1	3.6	36.1
Non-Dairy Cattle - Inhibitor	896	39	2.3	1.1	11.4
Sheep and Deer - Inhibitor	1936	38	4.9	2.4	24.6
Total	5667		14.3	7.1	72.1

Dairy Sector Scenarios Making use of Multiple Techniques

To determine the overall savings potential of a diary farm geared to maximise cost-effective abatement, it is necessary to move from the study of individual options to the potential for mitigation using multiple techniques. This also necessitates a move from relative precision to somewhat rougher estimates due to lack of study of interactive effects.

One factor that eases this situation is that two of the options considered are profitable options to start with, and maize feeding is also cost-effective providing maize prices do not exceed a threshold. In particular, the inhibitor's economics do not depend on the amount of N_2O saved - only on added pasture growth. Thus if maize feeding reduces nitrogen deposits on the land and the inhibitor in turn abates less N_2O, this does not retard its case for application.[161] Similarly, if maize feed reduces the effectiveness of the standoff pad, given that its starting economics leave some margin for reduced performance, it seems unlikely that the change would significantly alter the cost-effectiveness.

Inhibitor 70%, plus Maize 22% Scenario:
Combining the use of a nitrification inhibitor with maize feed brings together two techniques that operate on different parts of the throughput cycle and thus have more limited interactive effects than other combinations. If the baseline savings measured through the PGGRC linked trials are used, the interaction to be allowed for is that the

161 In just reduces the potential gains under a system that provides for tradeable rights to saved emissions.

inhibitor will have less excreta to act on and so the quantity abated will be proportionately less. As inhibitors have demonstrated remarkable consistency at reducing proportionately the volume of N_2O emissions, we make a simple proportionate reduction in the quantity saved after allowing for the effect of the feed.

Note also that when considered as a package, there is the ability to take savings from use of the inhibitor to support the use of the maize feed option if it does not fully cover itself.

	Annual N_2O emissions abated in CP1 (kt CO_2e)	**Proportion of sub-sector emissions** %	**Proportion of agricultural emissions** %	**Proportion of national emissions** %	**Proportion of excess over 1990** %
Dairy Cattle – Inhibitor and Maize feed	4055	63	10.2	5.1	51.6

A similar scenario changes the effectiveness rating through use of an enhanced maize feed technique. An increased effectiveness of the supplementary feeding from 22% to 29% can be interpolated from the AgResearch data by reducing the N_2O emissions that result from maize growing through the use of inhibitors - at 70% effectiveness and no net additional cost.

Inhibitor 70%, plus Maize feed and Standoff Pad Scenario:

If in addition to the maize feed enhancement, a standoff pad was also introduced, savings can be gained through this alternative. The effect of the standoff pad occurs after the impact of maize feed has reduced nitrogen throughput, but before the inhibitor acts on the residual nitrogen delivered to pasture. The assumption of a nil cost to achieve abatement through the standoff pad is very unlikely to be affected by it processing less nitrogen as a result of the maize feed, especially as the pad is better than cost neutral to begin with. With respect to interactions between the pad and inhibitor action, as a first approximation, the pad will proportionately reduce the quantity of N abated by the inhibitor, but will not significantly affect its economic performance. However, the timing of the application of the inhibitor will become more important and this and other synergistic effects could influence overall abatement levels. Thus the following is simply indicative of what might be expected.

Scenarios explored effectiveness ratings of maize at 22% and the pad at 10%, and then the option of maize at 29% and the pad at 10%. The following reports the latter scenario.

	Annual N_2O emissions abated in CP1 (kt CO_2e)	**Proportion of sub-sector emissions** %	**Proportion of agricultural emissions** %	**Proportion of national emissions** %	**Proportion of excess over 1990** %
Dairy Cattle – Inhibitor, pad and maize feed	4342	67	10.9	5.4	55.2

If the pad effectiveness is also enhanced to an overall 19% (up from 10%) through storing effluent and delayed spreading on to pasture, this would by the same formula raise the abatement level slightly but involves further uncertainties about interactive effects and so it is not formally considered here.

Maize 29% and Standoff pad 19% Scenario

Interestingly, if inhibitors are completely removed from the equation, the enhanced options for the other two techniques still allows a combined 28% abatement effect, as follows:

	Annual N_2O emissions abated in CP1 (kt CO_2e)	Proportion of sub-sector emissions %	Proportion of agricultural emissions %	Proportion of national emissions %	Proportion of excess over 1990 %
Dairy Cattle – Maize feed and standoff pad only	1801	28	4.5	2.3	22.9

Finally, none of these scenarios incorporates measures to improve drainage (which is indicated to offer additional emission reductions in the range of 7% to 10%), soil liming, or the impact of new grasses being bred.

The full set of results, in summary, is as follows:

Scenario description	Annual N2O emissions abated in first period (Mt CO2e)	Proportion of sub-sector emissions abated %	Proportion of agricultural emissions abated %	Proportion of national emissions abated %
Baseline Scenario				
1. Inhibitor 70% effective	3.7	57	9.3	4.6
Low Inhibitor Effectiveness Scenarios				
2. Inhibitor 50% effective	2.8	44	7.1	3.6
3. Inhibitor 50% effective, standoff pad 10%	3.1	48	7.7	3.9
4. Inhibitor 60% effective, standoff pad 10%	3.5	54	8.7	4.3
Expected Inhibitor Effectiveness Scenarios				
5. Inhibitor 70% effective, standoff pad 10%	3.9	60	9.7	4.8
6. Inhibitor 70% effective, maize feeding 22%	4.1	63	10.2	5.1
Enhanced Scenarios				
7. Inhibitor 70% effective, standoff pad 19%	4	62	10.1	5.0
8. Inhibitor 70% effective, maize feeding 29%	4.2	65	10.5	5.2
9. Inhibitor 70%, standoff pad 10%, maize feeding 22%	5.2	67	13.2	6.6
10. Maize feeding 29%, standoff pad 19%	1.8	28	4.5	2.3