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Climate Change: The Global Problem Requiring a Global Response

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ABSTRACT
The New Zealand Government has stated its intention to ratify the Kyoto Protocol to address climate change. This has set in train a period of intensive policy development to assess the implications, derive policy measures and establish the appropriate legislative framework to carry out these intentions. Agricultural emissions in New Zealand, and particularly rumen emissions, place New Zealand in a unique position compared to other developed countries. Ruminant agriculture provides both a potential solution and a threat to New Zealand meeting its targets under the Kyoto Protocol. The Convenor of the Ministerial Group on Climate Change has indicated that research is an important element in seeking to reduce New Zealand’s greenhouse gas (GHG) emissions from agriculture. Animal science has an important role to play. Animal science in New Zealand is at the cusp of a new and exciting era. Any advances that scientists can make in unravelling, and finding practical solutions to reducing nitrogen throughput and methane emissions, whilst maintaining or increasing animal productivity, will have significant economic value to New Zealand. The background to the Kyoto Protocol, the Government’s response, and the opportunities provided to animal scientists, are discussed.

Keywords: climate change; mitigation; national inventory; adaptation; Kyoto Protocol.

INTRODUCTION
The Intergovernmental Panel on Climate Change in its 2001 Third Assessment Report concluded: the world is warming and the climate is changing (IPCC, 2001).

Climate change is considered one of the most serious threats to the sustainability of the world’s environment, human health and well being, and the global economy. Mainstream scientists agree that the Earth’s climate is being affected by the build-up of greenhouse gases (GHGs), such as carbon dioxide, methane and nitrous oxide caused by human activities. A majority of scientists believe that precautionary and prompt action is necessary.

The effects of climate change are already measurable and include:

- the world’s 10 warmest years have all been since 1983, seven of them since 1990;
- the global mean temperature went up about 0.6°C between 1861 and 2000;
- sea levels rose 10 to 20 cm between 1900 and 2000;
- glaciers are retreating;
- Arctic sea ice is thinning and reducing;
- 1998 was the world’s – and New Zealand’s – hottest year since records began (Ministry for the Environment, 2002).

Figure 1 clearly illustrates the increasing global temperature pattern and the temperature rise projected under various future IPCC scenarios.

International treaties and climate change
The international political response to climate change took shape with the development of the United Nations Framework Convention on Climate Change (UNFCCC). Adopted in 1992, the UNFCCC sets out a framework for action aimed at stabilising atmospheric concentrations of greenhouse gases at a level that would prevent human-induced actions from leading to “dangerous interference” with the climate system. The UNFCCC entered into force on 21 March 1994. It now has 186 Parties, including New Zealand.

In 1995, the Ad Hoc Group on the Berlin Mandate was established by the first Conference of the Parties (COP-1) to reach agreement on a further step in efforts to combat climate change. Following intense negotiations, culminating at COP-3 in Kyoto (Japan) in December 1997, countries agreed to a Protocol that committed developed countries and countries making the transition to a market economy to achieve quantified targets for decreasing their emissions of greenhouse gases.

COP-4 met in Buenos Aires, Argentina, in November 1998, to set out a schedule for reaching agreement on the operational details of the Kyoto Protocol and for strengthening implementation of the UNFCCC itself. This work schedule was outlined in a decision known as the Buenos Aires Plan of Action (BAPA). Numerous formal and informal meetings and consultations were held from 1998 up to the time of the COP-6 in The Hague in November 2000 to help lay the detailed foundations for the Kyoto Protocol. COP-6 was unable to finalise the necessary negotiations and COP-6 met at a resumed
session (COP-6.5) in Bonn, Germany in July 2001 COP-6.5 was a success in that it agreed most of the political issues necessary to ensure that COP-7 could complete the outstanding technical issues.

The COP-7 opened on 29 October 2001 in Marrakech to finalise the legal texts for the Kyoto Protocol. This meeting would complete the process of translating the Bonn Agreements into legal language, and brought work on the Buenos Aires Plan of Action (BAPA) to a successful conclusion. Ten years of intense international negotiations has elapsed to achieve a legally binding climate change agreement to take concrete action in addressing GHG emissions.

The Kyoto protocol
The Kyoto Protocol forms the framework on which the New Zealand Government’s policies are being developed. In summary the Kyoto Protocol provides for the following:
• The greenhouse gases covered by the agreement are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride, taken in aggregate on a CO₂ equivalent basis.
• Legally binding emission constraints are set for countries listed in Annex B for the period 2008–2012. Annex B contains a list of developed countries and countries undergoing the process of transition to a market economy with quantified emission limitation or reduction commitments under the Kyoto Protocol.
• Different percentage reductions relative to 1990 emissions are set for different countries, such that total emissions of Annex B countries are reduced by more than 5 percent. The calculated amount of emissions allowed a country is its starting ‘assigned amount’.
• New Zealand’s commitment is not to exceed 1990 emission levels, on average, during 2008–2012 or otherwise take responsibility for emissions above 1990 levels.
• Parties have to take policies and measures in accordance with national circumstances and cooperate to enhance their effectiveness.
• ‘Demonstrable progress’ towards meeting the commitments under the Protocol is to be achieved by 2005.
• Forest sinks can be included as changes in forest carbon storage arising from certain actions (afforestation, reforestation and deforestation) taken since 1 January 1990. Parties will have credited/debited a quantity of ‘assigned amount’ equal to increases/decreases in carbon stock over 2008-2012 from these actions. Additional carbon storage activities may also be used in the first commitment period (forest management, cropland management, grazing land management and revegetation).
• The Parties included in Annex B may participate in greenhouse gas emissions trading for the purposes of fulfilling their commitments under the Protocol.
• A clean development mechanism (CDM) is defined in the Protocol. The CDM is designed to assist both Annex I and non-Annex I Parties by allowing certified emission reductions accruing from CDM projects to contribute to compliance by Annex I Parties.
• Entry into force of the Protocol occurs when at least 55 countries, including developed countries representing at least 55 percent of developed country CO₂ emissions in 1990, have ratified it.

New Zealand’s emissions profile
New Zealand is required to submit an annual greenhouse gas inventory to the UNFCCC. The inventory reported in 2001 gave the following GHG emission and sink levels in carbon dioxide equivalents for the years 1990 and 1999 (Table 1).

Note the significant increase in carbon dioxide emissions over the nine-year period due largely to increases in transport and energy emission increases. Recent reviews of the methodology used for establishing emissions from agriculture suggest that there is an increase (rather than decrease) in methane emissions (above 1990 levels) and that current nitrous oxide emissions (above 1990 levels) are also greater than currently identified. These changes have yet to be peer reviewed and incorporated into the national inventory. The reasons for these differences are discussed later. Table 2 presents the distribution of GHG between sectors in 1990 and 1999. The dominance of the agriculture sector is clearly evident. The agricultural sector emissions are made up largely of methane and nitrous oxide and have significant uncertainties associated with them. This means New Zealand has one of the highest uncertainties in its national inventory compared to other developed countries. These high uncertainties mean New Zealand needs to ensure that research and “good practice” methods are used in deriving our agricultural inventory.

The New Zealand government’s response
At a national level, the Government is faced with making decisions on what policies and measures to implement to meet its commitments under the Kyoto Protocol. These fall into three broad categories: the policies needed before implementation of the Protocol in 2008; those policies required over the commitment period 2008-2012, and polices needed beyond the first commitment period. Negotiations for this latter period are commencing this year.

There are a number of key principles that have guided the development of the Government’s preferred policy package. The principles will ensure that policies introduced – now and in the future – will:
• result in permanent and sustainable reductions in greenhouse gas emissions;

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The Government has also identified key criteria to help guide the choice between different policy options. These criteria are:

- **Economic efficiency.** Over the long term, what policies will minimise the cost and maximise the benefits to the economy as a whole, of meeting New Zealand’s Kyoto Protocol obligations?
- **Equity.** How fair will policy measures be to different stakeholder groups?
- **Feasibility.** Can the option be carried out?
- **Environmental integrity.** How effective will a policy be in reducing global greenhouse gas emissions, compared to what the emissions would have been in the absence of the policy?
- **Competitiveness.** In an open trading economy like New Zealand, will the policy reduce the competitiveness of business?

The Government is considering a range of market-based policy instruments that, alone, or in combination, can serve the objective of setting up comparable incentives for the commitment period (or earlier). These include:

- Government retaining full responsibility for emissions;
- charges on all emissions or activities leading to emissions (e.g. a carbon charge);
- domestic emissions trading;
- levies on activities that are not directly related to emissions;
- project based initiatives including project-based trading;
- hybrids of the above, or the above plus other programmes e.g. Negotiated Greenhouse Agreements. Negotiated Greenhouse Agreements during the commitment period with specific sectors or industries are also an option. Other non-market policy measures are also being considered including research, education and communication programmes. The preferred policy package once released by the Government will be subjected to a further round of public consultation.

### Specific policy issues related to agriculture

Agriculture is a major contributor to the New Zealand economy, and also contributes more than 50% of New Zealand’s greenhouse gas profile through the emissions of methane and nitrous oxide. There are two additional factors that influence the selection of policy for this sector.

Firstly, no clear options are currently available for farmers to reduce these emissions, other than through reducing stock numbers. Secondly, there are significant technical difficulties in measuring and monitoring non-carbon dioxide greenhouse gases (methane and nitrous oxide) from agriculture on farm.

Investment in research is an important policy option to move the agricultural sector to the point where it would not need to reduce stock units to reduce emissions. Moreover, research that reduces methane emissions is likely to increase on-farm productivity through increased efficiency in feed conversion. Also, research that results in reductions in nitrous oxide may have productivity or environmental benefits, such as improved water quality. In this sense, research may pay for itself if appropriate technical solutions are found.

### What role can animal research play?

Animal science has a key role to play in each of the following three areas.

- National Inventory development including improvement of measurement technologies and techniques, and scaling up measurements.
- Mitigation practices and technologies to reduce the major agricultural GHGs.
- Adaptation research including practices and technologies to allow animals to adapt to climate change and extremes.

### Inventory

Establishing the current quantity of emissions from agriculture at national level is not a trivial exercise. While standard (default) values can be adopted from the IPCC inventory guidelines, these values do not reflect the unique circumstances of New Zealand agriculture. New Zealand
is seeking to adopt a more comprehensive national approach to assessing our GHG emissions from agriculture. The Government approved additional funds last year to improve the national agricultural inventory. This has enabled a detailed re-valuation of the basis for calculating national emissions. The research results have identified some interesting factors that will change the basis of past, present and future calculations. These factors include incorporating assessment of changing animal performance, New Zealand specific methane emission and nitrogen input factors. One key question that the animal science community can address is the extent to which changes in animal performance, over time, are the result of more efficient feed conversion or better and/or more forage intake, and the relationship of these to methane and nitrogen output. Table 3 presents MAF figures on changes in some livestock performance attributes over the last ten years. This is clearly due to past research, and its adoption by farmers, and are a tribute to the success of past agricultural research in New Zealand.

Mitigation
To meet Kyoto Protocol targets in the long term, there is clearly a need for research into mitigation of agricultural emissions. MAF has commissioned several reports (Cameron et al., 2000; Clark et al., 2001) seeking to identify the options available and their impact in reducing GHG emissions. Mitigation options can be broadly identified for each of the three major gases: methane, nitrous oxide and carbon dioxide. Knowledge about, and solutions to, some of the means for mitigation are partially identified for each of the three major gases: methane, nitrous oxide and carbon dioxide. Knowledge about, and solutions to, some of the means for mitigation are partially identified. The animal science community has a role in understanding and adapting to the resulting climatic changes and their affects. The animal science community has a role in identifying the effects and evaluating the vulnerability of the agricultural sector, identifying solutions and ensuring the uptake of these solutions by the sector. Specific examples include impact of more subtropical pasture species on animal performance, heat stress and change in potential animal disease and pasture toxin profiles.


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<tbody>
<tr>
<td>Wool/sheep (kg Greasy)</td>
<td>30 June</td>
<td>5.1</td>
<td>5.3</td>
<td>5.4</td>
<td>4.9</td>
<td>5.7</td>
<td>5.8</td>
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<td>5.7</td>
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<tr>
<td>Lambing %</td>
<td>30 June</td>
<td>96.6</td>
<td>100.4</td>
<td>105.7</td>
<td>95.4</td>
<td>102.5</td>
<td>107.3</td>
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<td>113.6</td>
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<td>Graded Lamb (kg/carcass)</td>
<td>30 Sept.</td>
<td>13.8</td>
<td>14.1</td>
<td>14.3</td>
<td>15.1</td>
<td>15.2</td>
<td>14.6</td>
<td>15.2</td>
<td>15.9</td>
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<td>16.7</td>
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<tr>
<td>Graded Beef (kg carcass)</td>
<td>30 Sept.</td>
<td>237</td>
<td>240</td>
<td>233</td>
<td>248</td>
<td>250</td>
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<td>254</td>
<td>241</td>
<td>240</td>
<td>245</td>
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<tr>
<td>Milksolids/cow (kg)</td>
<td>31 May</td>
<td>232</td>
<td>233</td>
<td>254</td>
<td>252</td>
<td>275</td>
<td>255</td>
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### CONCLUSIONS
Animal science can pay a pivotal role in addressing New Zealand’s GHG emissions. A key question is the quantum of research funding that is required to make real progress in this area in New Zealand. Bearing in mind that this is a global problem, there is already increased international interest in mitigation research in animals. The Australian vaccine that claims to substantially reduce methane emissions springs to mind (Clark, et al., 2001). A large proportion of current agricultural/land based research programmes have potential climate change outcomes. We should exploit this. There is a need to have “add-on” research to current programmes to take account of climate change needs. Mitigation solutions will be difficult and take time to develop and adopt. Win/win solutions are needed that both maintain or increase animal productivity and reduce total emissions. A systems-based approach is required that considers the full consequences of a particular technology or practice. Industry and government also need to work more closely in integrating public and private funding streams, identifying priorities, and making sure solutions are adopted.

Is there a human resource problem in animal science in relation to climate change needs? In my experience human capability or highly capable scientists’ flow to areas of research excitement, good research leadership, world class facilities and sufficient, secured research funding. The signs are there that most of these criteria will be met in the near future. The future prospects for animal science in New Zealand look good.

### REFERENCES
