Ministry for Primary Industries
Manatū Ahu Matua

Projected emissions for the agriculture sector for the Kyoto Commitment Period 2008–2012

2013 Net Position Report

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Growing and Protecting New Zealand

Disclaimer

This report contains estimates of greenhouse gas emissions for the agriculture sector. These estimates need to be used with an understanding of the significant uncertainties that inevitably arise when quantifying complex biological systems: these are inherently variable as they are affected by an unpredictable climate and changing economic conditions. While every effort has been made to provide the best estimates as at March 2013, future adjustments will inevitably reflect changes in climatic conditions, economic conditions, international commodity prices and exchange rates.

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1 Executive Summary

This report provides provisional estimates of carbon dioxide equivalent emissions from agricultural sources for the first commitment period 2008–2012 (CP1) of the Kyoto Protocol. Details of New Zealand's estimated balance of Kyoto Protocol units during CP1 (the Net Position) can be found on the *Ministry for the Environment's* website.

This will be the last net position report for CP1 because next year's greenhouse gas inventory submission covering 1990 to 2012 will contain the final estimates of New Zealand's emissions for CP1.

1.1 ESTIMATED EMISSIONS

- Emissions from agricultural sources are estimated to be 170.2 million tonnes of carbon dioxide equivalent gas (Mt CO_2-e) during CP1. This is 0.3 Mt CO_2-e less than was projected in 2012. Table 1 and Figure 1 show the emission estimates and last year's projection for each year in CP1 and for 1990 for the key activities within the agricultural sector.
- Methodology improvements in the agriculture greenhouse gas inventory have reduced estimated emissions per head of cattle and deer, and have increased estimated emissions per head of sheep. Provisional data for the beef population and nitrogen fertiliser for 2012 are lower than forecast in the 2012 net position estimate.
- Mitigation from DCD[1] is expected to reduce emissions of nitrous oxide by 0.1 Mt CO_2-e during CP1.

1.2 HISTORIC TRENDS

- During 2011 emissions from agriculture were 34.4 Mt CO_2-e an increase of 3.7 Mt CO_2-e from 1990 (12.1 per cent), and an increase from 2010 (33.7 Mt CO_2-e) of 0.7 Mt CO_2-e (2.0 per cent).
- Emissions from cattle, sheep and deer account for 93.1 per cent of agriculture emissions. Direct and indirect nitrous oxide emissions from nitrogen fertiliser contribute a further 6.0 per cent. The remaining 0.9 per cent is due to cropping related activities, and minor livestock species.
- The increase in total agricultural emissions in 2012 from the 2011 level was largely due to a good growing season with better than expected increases in milk solids per cow, supplemented by favourable prices received for milk solids.

1.3 CHANGES FROM 2012 ESTIMATES

- For the 2013 annual submission, recalculations were made for the dairy, beef, and sheep population models agreed by the 2011 *Agriculture Inventory Advisory Panel* meeting but not implemented until the 2013 annual submission. The population model, used to calculate emissions from cattle, sheep and deer, uses assumptions on livestock birthdates, slaughter and culling to determine a monthly population profile. The model breaks the calculation of emissions down into monthly time steps to capture the seasonal variation in emissions throughout each year.

[1] As at Thursday 24 January 2013 there has been a voluntary suspension to the sales of DCD.

- Changes were also made to the parameters for the productivity and energy equations for deer as agreed during the 2012 *Agriculture Inventory Advisory Panel* meeting. The deer population model assumptions, productivity and energy equations for deer have been reviewed and revised following research completed in collaboration between the Deer Industry New Zealand. Overall emissions from deer are now lower each year.

Figure 1: Agricultural emissions 1990 to 2012 (million tonnes of carbon dioxide equivalent)

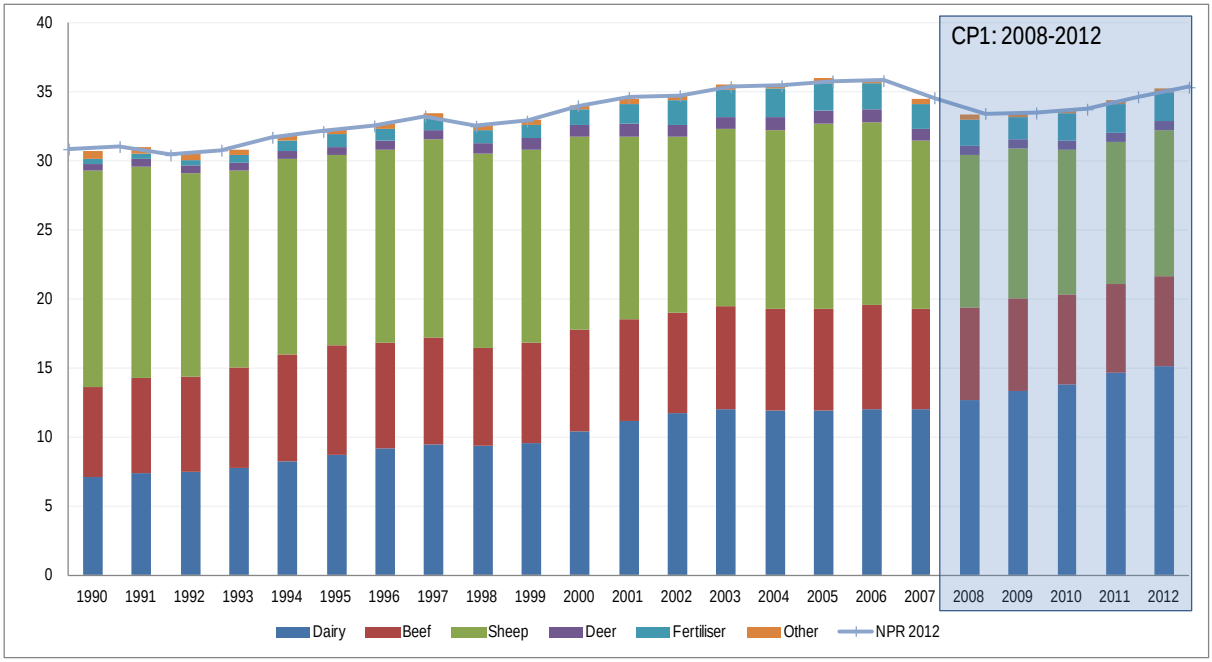


Table 1:Agriculture Emissions (Millions tonnes carbon dioxide equivalent)[2]

	Dairy	Beef	Sheep	Deer	Fertiliser	Other	Total
1990	7.1	6.6	15.7	0.5	0.3	0.6	30.7
2008	12.6	6.8	11.0	0.7	1.9	0.3	33.3
2009	13.3	6.8	10.8	0.7	1.6	0.3	33.5
2010	13.8	6.5	10.5	0.7	1.9	0.3	33.7
2011	14.6	6.4	10.3	0.6	2.1	0.3	34.4
2012	15.1	6.5	10.6	0.6	2.1	0.3	35.2
Total (CP1: 2008-2012)	**69.5**	**33.0**	**53.3**	**3.3**	**9.5**	**1.6**	**170.2**
Change from 2012 estimate							
2012 estimate	69.9	33.5	52.5	3.4	9.6	1.6	170.5
Change	-0.5	-0.5	0.8	-0.1	-0.1	0.0	-0.3

[2] Due to rounding, total cells may not equal the sum of the individual cells. 2012 emissions are estimated using provisional data from 2012 from the Agriculture Production Statistics by Statistics NZ.

2 Methodology

Forecasts of greenhouse gas emissions are derived by applying the agriculture greenhouse gas emissions methodology to economic forecasts of agricultural activity. In order to obtain forecasts of total dry matter intake, animal production and animal population numbers are estimated from the Ministry for Primary Industries' *Pastoral Supply Response Model* (PSRM). These then feed into the agricultural greenhouse gas inventory model to estimate emissions.

2.1.1 Estimating Greenhouse Gases

Estimates of emissions from New Zealand's four largest sources of livestock emissions (dairy, beef cattle, sheep and deer) are determined using a Tier 2 inventory Model. Greenhouse gas emissions are proportional to the dry matter intake of an animal. Dry matter intake in turn is determined by the energy requirements of that animal to meet the needs of maintenance living, and the extra energy required to meet the demands for growth, conception/gestation, milk production and wool growth. Therefore, if dry matter intake is estimated, this can be multiplied by a species specific factor to estimate methane emissions.

The amount of nitrogen in the feed consumed by an animal can be estimated using dry matter intake if the nitrogen content of the feed is known. Determining the difference between nitrogen intake and the estimate of how much nitrogen is retained in the animal and animal products, results in an estimate of nitrogen excreted by an animal. From this excreted nitrogen, nitrous oxide emissions can be determined by using emission factors.

For other animal species and emissions from crop related activities, emissions are estimated using a combination of New Zealand specific emissions factors and default emissions factors applied to livestock population estimates and crop production.

New Zealand's greenhouse gas methodology is based on the Revised 1996 Intergovernmental Panel on Climate Change (IPCC 1996) Guidelines and the IPCC good practice guidance (IPCC 2000). A further summary of the methodology can be found in the current submission of the *National Inventory Report*, with full details outlined in the *Detailed methodologies for Agricultural Greenhouse Gas emission calculation* document on the Ministry for Primary Industries' website.

2.1.2 Inventory Methodological Changes

For the 2013 annual submission (chapter 6 of the *National Inventory Report* on the MfE website), recalculations were made for the dairy, beef, and sheep population models agreed by the 2011 *Agricultural Inventory Advisory Panel* but not implemented until the 2013 annual submission. Changes were also made to the parameters for the productivity and energy equations for deer agreed during the 2012 *Agricultural Inventory Advisory Panel.*

The population model for livestock in the Tier 2 model uses assumptions on livestock birthdates, slaughter and culling to determine a monthly population profile. The population model assumptions for sheep and cattle have been revised following the work by Muir and Thomson (2010). These improvements were approved at the end of 2011 but were not fully implemented in the Tier 2 inventory model in time for the 2012 submission. The report by Muir and Thompson (2010) and the briefing to the Panel recommending changes are available on the Ministry for Primary Industries' webpage for the *Agricultural Inventory Advisory Panel*.

The deer population model assumptions, productivity and energy equations for deer have been reviewed and revised following research completed and reported by Suttie (2012) and

Bown et al (2012). These improvements were approved and recommended during the 2012 *Agricultural Inventory Advisory Panel* meeting.

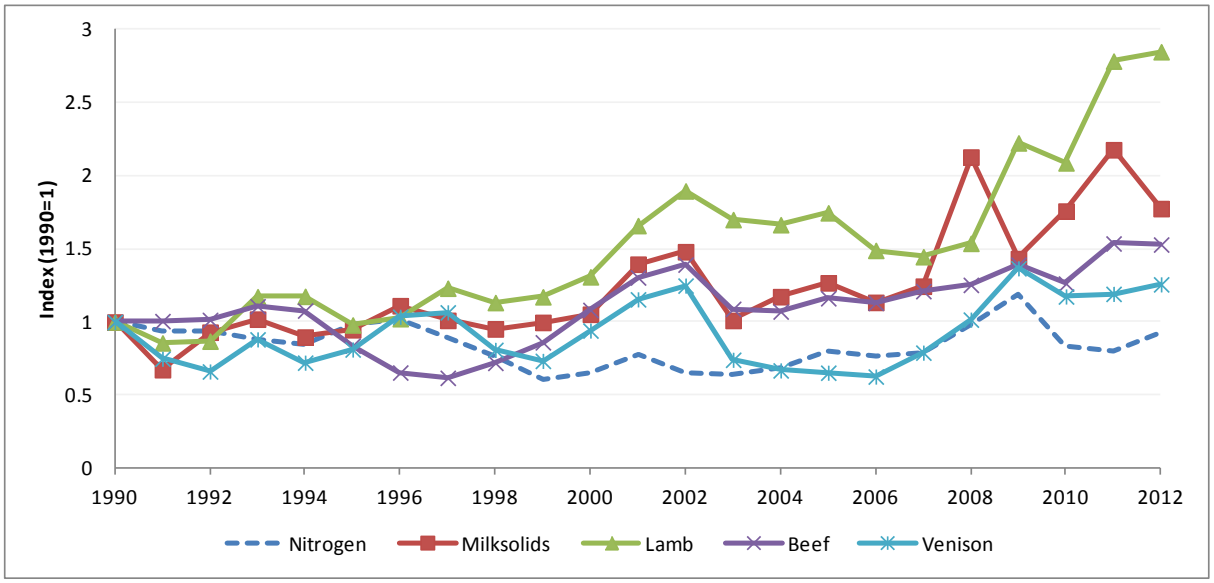
This research was peer reviewed and assessed by an expert *Agricultural Inventory Advisory Panel* before being adopted in New Zealand's national inventory submission under the United Nations Framework Convention on Climate Change (UNFCCC). Any future improvements will follow the same process. The improvements will also be reviewed by an expert review team coordinated by the UNFCCC between September 2013 and early 2014.

2.1.3 Projected agricultural activity

The Ministry for Primary Industries projects New Zealand's agricultural activity, such as animal numbers and nitrogen fertiliser use, by using economic analysis and modelling. Projections for animal numbers and performance data are obtained from the Ministry for Primary Industries *PSRM* and projections of nitrogen fertiliser use are obtained from *Ministry for Primary Industries' Nitrogen Demand Model.* Animal performance is modelled as a function of a linear trend of past performance, days of soil moisture deficit and, where statistically significant, farm-gate price.

Animal number projections are driven in the PSRM by prices and farm income levels for different sectors. Therefore, an increase in income in one sector, relative to another, should see animal numbers in that sector increase while decreasing in sectors of competing land use. The Ministry for Primary Industries estimates key farm-gate prices based on international price movements and the Treasury's assumptions on the future exchange rate and inflation, as published in their 2012 December fiscal and economic update. Figure 4 illustrates for key farm-gate prices between 1990 and 2012 in real terms.

Figure 4: Real farmgate prices (Index 1990=1)



3 Uncertainty

In previous years, the Ministry for Primary Industries provided a high and low scenario around the best estimate forecast based upon high and low forecast of activity data. This year only a single estimate is provided as provisional data is already available for 2012.

The uncertainty usually reported for agriculture production forecasts is different to the uncertainty around the agriculture sector emissions estimate presented in New Zealand's national inventory report. The national inventory report's assessment of uncertainty is

designed to report the difference between the estimated level of emissions and the actual level of emissions given production data.

3.1.1 Inventory Uncertainty

There is still considerable uncertainty in the agriculture greenhouse gas inventory methodology not quantified for the net position estimate. The uncertainty in the methodology will continue to be estimated and reported with annual inventory submissions after CP1 has finished.

There is a comprehensive science programme managed through Ministry for Primary Industries to improve the accuracy of greenhouse gas emissions estimates from agriculture. All countries are continually improving their methodologies to report and account for greenhouse gas emissions and removals. Continual improvement is part of good international practice. The improvements are particular to the land based sectors because of the uncertainty inherent in estimating emissions from biological systems. Improvements to the science will flow through to the national greenhouse gas inventory.

The overall uncertainty of the enteric methane emissions inventory, expressed as a 95 per cent confidence interval, is ± 16 per cent while the uncertainty of the nitrous oxide emissions from the agriculture soils inventory is +74 per cent and – 42 per cent. When combined, these uncertainties expressed as a 95 per cent confidence interval on the agriculture inventory are +25 per cent and – 17 per cent relative to the mean at 2012. Research to be published is expected to show that the uncertainty in direct nitrous oxide emissions from sheep and cattle excreta will halve due to more field studies having been completed over the past decade. Emissions of nitrous oxide from sheep and cattle excreta explain approximately 78 per cent of total nitrous oxide emissions from agricultural soils. Therefore, the uncertainty reported with agricultural soils in New Zealand is expected to be lower in future years.

4 Future improvements and reporting

Work is being carried out by research scientists, the Ministry for Primary Industries' officials and industry to improve the calculations and assumptions used in estimating emissions reported in the National Inventory. As this work comes to fruition, proposed changes are assessed by an expert *Agricultural Inventory Advisory Panel* to ensure all work is robust and meets international review requirements. Once any changes are approved by this panel they can then be incorporated into the inventory and subsequently into the *Net Position Report*. Details on what improvements are currently being investigated are outlined in the *2013 National Inventory* submission.

5 References and links

5.1.1 Expert Agricultural Inventory Advisory Panel

The Agricultural Inventory Advisory Panel is an independent expert panel which assesses the robustness of proposed changes to the inventory. Major changes to the agricultural section of the inventory are required to go through the panel process before incorporation into a submission of the National Inventory. Meeting minutes, briefings on proposed changes put to the panel and recommendations can be accessed from this link.

5.1.2 National Inventory Submission

New Zealand has a requirement to report annual greenhouse gas emissions to the UNFCCC. This report details calculated emissions that are estimated to have occurred and methodology

for the calculations for each of the main sectors of Energy, Industrial Processes, Solvent and other product use, Agriculture, Land Use Land-use Change and Forestry (LULUCF), and Waste. Due to the availability of data the report tends to be submitted 2 years behind, that is, the inventory for 2012 emissions is submitted in April 2014.

5.1.3 Nitrogen model

Austin, D; Cao, K; Rys, G, (2006). *Modelling Nitrogen Fertiliser Demand in New Zealand*.

Paper presented at the New Zealand Agricultural and Resource Economics Society conference, Nelson on how the nitrogen model used for projecting nitrogen use works.

5.1.4 Situation and Outlook for Primary Industries

Situation and Outlook for Primary Industries (SOPI) is an annual publication that looks at some of the broader issues facing the agriculture, fishing and forestry sectors. For each of the key primary sectors (from kiwifruit to dairy), we forecast the likely economic and market conditions over a five-year period.

5.1.5 Pastoral Supply Response Model (PSRM)

Dake, CKG (2009). *The Econometrics of New Zealand Pastoral Agriculture: With Special Reference to Greenhouse Gas Emissions*.

A report prepared for the Ministry of Agriculture and Forestry by AgResearch on the equations and assumptions used in the Pastoral Supply Response Model. This model is used in the projection of animal population and productivity values in forecasting rounds carried out by the Ministry of Agriculture and Forestry.

5.1.6 External references

Bown, MD, Thomson, BC, Cruickshank GJ, and Muir P.D. 2012. "*Evaluation of the energy equations used by the National Enteric Methane Inventory*", Report prepared for the Ministry for Primary Industries by On-Farm Research. Wellington: Ministry for Primary Industries. Available on the *Agricultural Inventory Advisory Panel* website.

IPCC (1996). Houghton JT; Meira Filho LG; Lim B; Treanton K; Mamaty I; Bonduki Y; Griggs DJ; Callender BA (Eds). IPCC/OECD/IEA. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* UK Meteorological Office: Bracknell.

IPCC (2000). Penman, J; Kruger, D; Galbally, I; Hiraishi, T; Nines, B; Emmanul, S; Buendia, L; Hoppaus, R; Martinsen, T; Meijer, J; Miwa, K; and Tanabe, K (Eds). *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.* IPCC National Greenhouse Gas Inventories Programme. Published for the IPCC by the Institute for Global Environmental Strategies, Japan.

MAF (2012) *Projected emissions for the agriculture sector for the Kyoto Commitment Period 2008-2012: 2013 Net Position Report* Ministry of Agriculture and Forestry, Wellington.

Muir PD, Thomson BC. 2010. *Better Estimation of National Ewe and Beef Cow Liveweights*, Technical paper prepared for Ministry of Agriculture and Forestry by On-Farm Research.

Wellington: Ministry of Agriculture and Forestry. Available on the *Agricultural Inventory Advisory Panel* website.

Suttie (2012) *Report to the Deer Industry New Zealand: Estimation of Deer Population and Productivity Data 1990 to 2012*. Ministry for Primary Industries. Available on the *Agricultural Inventory Advisory Panel* website.