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

MAF Information Paper No: 2012/02

Prepared for the Ministry for the Environment
by Simon Wear

ISBN No: 978-0-478-38825-1 (online)
ISSN No: 2230-2832 (online)

April 2012

Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

BIOSECURITY NEW ZEALAND

NEW ZEALAND FOOD SAFETY AUTHORITY

Disclaimer

This report contains projections of greenhouse gas emissions for the agriculture sector. These projections need to be used with an understanding of the significant uncertainties that inevitably arise when forecasting 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 projections as at March 2012, future adjustments will inevitably reflect changes in climatic conditions, economic conditions, international commodity prices and exchange rates.

Requests for further copies should be directed to:

Publications Logistics Officer
Ministry of Agriculture and Forestry
P O Box 2526
WELLINGTON

Telephone: 0800 00 83 33
Facsimile: 04-894 0300

This publication is also available on the MAF website at
http://www.maf.govt.nz/news-resources/publications.aspx

Contents

Page

Executive Summary

This report provides projections 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 projected balance of Kyoto Protocol units during CP1 (the Net Position) can be found on the Ministry for the Environment's website.

Projected emissions

- Emissions from agricultural sources are projected to be 170.5 million tonnes of carbon dioxide equivalent gas (Mt CO_2-e) during CP1. This is 0.4 MtCO_2-e more than was projected in 2011. Table 1 and Figure 1 show the emission projections 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 increased estimated emissions per head of sheep and cattle. Actual data (animal population and nitrogen fertiliser) for 2011 and forecasts for 2012 are lower than forecast in the 2011 net position estimate. This partially offsets the increases in emissions from the methodology improvements.
- Mitigation from DCD is expected to reduce emissions of nitrous oxide 0.1 Mt CO_2-e during CP1.

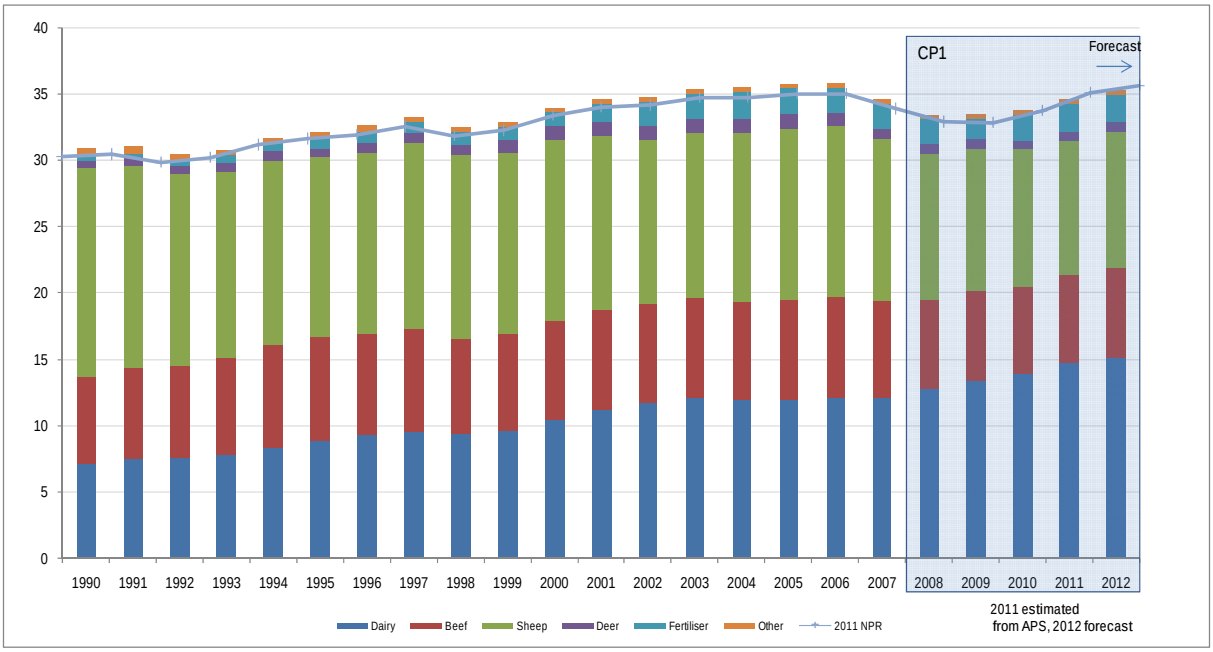
Historic trends

- During 2010 emissions from agriculture were 33.7 Mt CO_2-e an increase of 2.9 Mt CO_2-e from 1990 (9.4 per cent), and an increase from 2009 of 0.3 Mt CO_2-e (0.8 per cent).
- Emissions from cattle, sheep and deer account for 93.4 per cent of agriculture emissions. Direct and indirect nitrous oxide emissions from nitrogen fertiliser contribute a further 5.6 per cent. The remaining 1.0 per cent is due to cropping related activities, and minor livestock species.
- The increase in total agricultural emissions in 2010 from 2009 level is largely due to increases in the population of dairy cattle and nitrogen fertiliser applied. These are both driven by improved returns to dairying. In contrast total emissions from sheep, beef and deer have decreased due to reduced animal numbers.

Changes from 2011 estimates

- In this years agriculture inventory there were seven methodological improvements leading to recalculations of emissions in all years from 1990 to 2009. The key improvement is an enhancement to the methodology used to estimate ewe and beef cow live weight. This has resulted in an increase in sheep and beef cow live-weight and consequently an increase in emissions from sheep and beef cattle. This is because heavier animals require more feed and as a result produce more nitrous oxide and methane emissions.
- The forecasts for New Zealand agriculture production from beef cattle, sheep and deer have been revised down since the 2011 Net Position Report (Figures 2, 3 and 4). The key drivers are the stronger New Zealand dollar and weakening dairy, beef and lamb prices. Demand for New Zealand's primary products remains at historically high levels in spite of the deteriorating global economic circumstances.

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



Note: Emissions for 1990 to 2010 are based on the 2012 National Inventory Submission, 2011 is used provisional data and 2012 is a forecast

Table 1: Summary of annual emission projections for key activities in the agricultural sector for the first commitment period (million tonnes of carbon dioxide equivalent gases)[1]

	Dairy	Beef	Sheep	Deer	Fertiliser	Other	Total
1990	7.1	6.6	15.8	0.5	0.3	0.6	30.9
2008	12.7	6.8	11.0	0.8	1.9	0.3	33.4
2009	13.4	6.8	10.6	0.7	1.6	0.3	33.5
2010	13.9	6.6	10.4	0.7	1.9	0.3	33.7
2011	14.7	6.6	10.1	0.7	2.1	0.3	34.6
2012	15.1	6.7	10.3	0.6	2.1	0.3	35.3
Total for CP1	69.9	33.5	52.5	3.4	9.6	1.6	170.5
Change from 2011 NPR							
Total for CP1	70.0	32.6	51.1	3.6	10.1	2.7	170.1
Change	-0.1	0.9	1.4	-0.2	-0.5	-1.1	0.4

[1] Due to rounding, total cells may not equal the sum of the individual cells. 2011 emissions are estimated using provisional data from Statistics New Zealand. 2012 emissions are projected.

Changes Since the 2011 Net Position Report

There have been several improvements to the methodology used to calculate emissions from agriculture. Also, activity data for 2010 that were previously forecast are now replaced with actual data and updated economic forecasts of agriculture activity for 2011 and 2012 have been used.

METHODOLOGICAL CHANGES

New science has been incorporated into past estimates and current projections of agricultural emissions. The key methodology change is an enhancement to the estimation of ewe and beef cow live-weights to better reflect actual ewe and beef cow live-weight on-farm. The improvements have increased ewe and beef cow live weight as the previous methodology underestimated ewe and beef cow live-weights on-farm. This has resulted in an increase in estimated emissions. This is because heavier animals require more feed and consequently produce more nitrous oxide and methane emissions.

New Zealand specific emission factors have been developed to replace international default emission factors previously used to estimate emissions from poultry and pigs. This has resulted in the halving of emissions from these species. However this will have a small affect on total agricultural emissions as these animal categories only make up a small proportion of the total agricultural emissions. MAF worked with the poultry and pork sector organisations to collect detailed information on animal population and performance and waste management systems.

New Zealand specific information has been used to calculate emissions from goats, the cultivation of organic soils, crop residue breakdown, and tussock and crop residue burning. Total emissions in these areas are small and have not changed substantively, however the methodology is more accurate and transparent for international reporting requirements

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) and used for the Net Position Report. 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 2012 and early 2013.

ACTIVITY CHANGES

The outlook for New Zealand agriculture production has been revised down since the 2011 Net Position Report. The key drivers are the stronger New Zealand dollar and weakening dairy, beef and lamb prices. Demand for New Zealand's primary products remains at historically high levels in spite of the deteriorating global economic circumstances.

Dairy

Dairy cattle numbers are forecast to increase during 2011 and 2012 but not by as much as in 2011 net position estimate (Figure 2). International dairy prices are falling slightly faster than was expected in 2011. This decrease in prices was due to increasing supply from major dairy exporting countries and sluggish demand because of global economic uncertainty. Based on

recent trading in dairy commodities, prices are expected to deteriorate in 2012. A sudden collapse in prices is not likely due to firm demand from Asian countries and member countries of the Organization of the Petroleum Exporting Countries (OPEC). Forecasts of milk solid production per cow have increased between the 2011 and 2012 Net Position Report (Figure 3) due to a good growing season for the agricultural year ending 30 June 2011.

Beef cattle

Beef cattle numbers are forecast to be lower than forecast in the 2011 (Figure 2) driven by lower forecast farmgate prices when compared to the 2011 report. Export prices in United States (US) dollars for beef are high, but remain below the record high of April 2011. Robust demand from Asian markets has absorbed increased volumes out of the US and Australia. A weakening global economy outside of the US, and slightly increasing exports out of Australia and the US are expected to cause New Zealand export beef prices in US dollars to decrease. Longer term, beef prices are likely to remain higher than past years due to increasing demand for animal protein in Asian and some developing countries. Average slaughter weights for beef cattle are also expected to be lower for 2011 to 2012 compared to last years report (Figure 3).

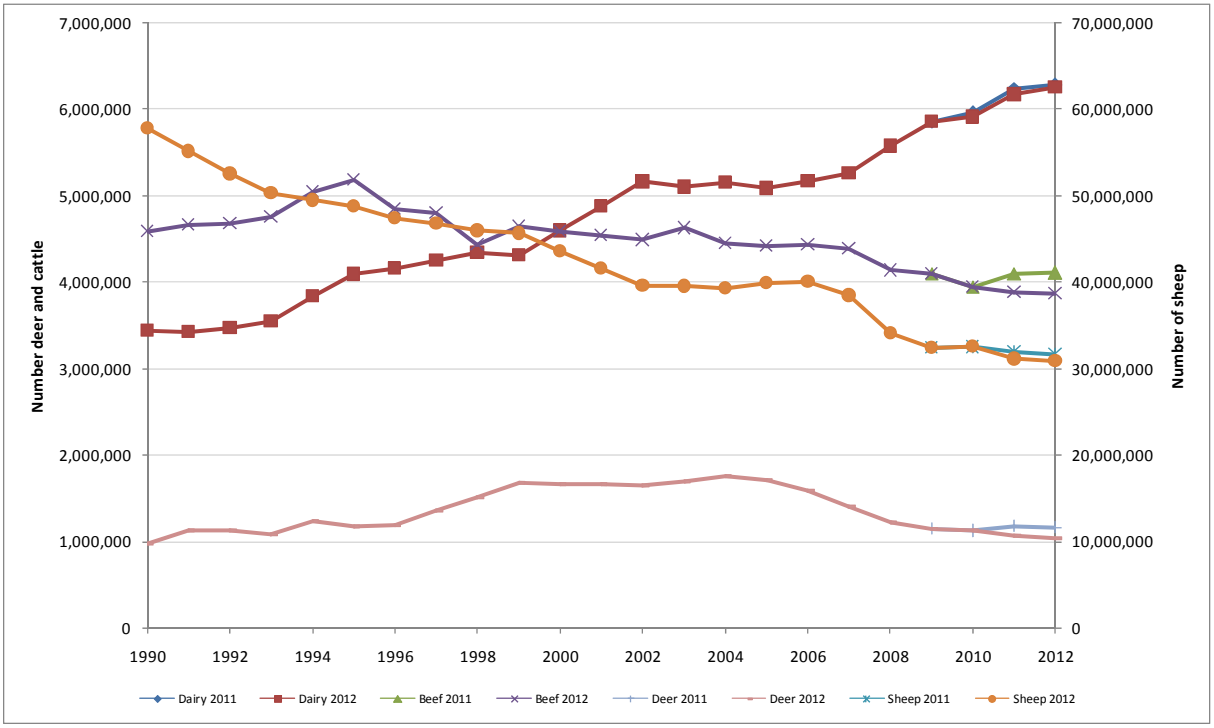
Sheep

Sheep numbers are forecast to be lower in 2011 and 2012 compared to the forecasts used for the 2011 Net Position Report. The key driver is the expected farmgate prices for lamb during 2011 and 2012. Weakening demand in the European Union (EU) is putting downward pressure on lamb prices. However, the New Zealand lamb schedule price for December quarter 2011 was high as favourable pasture conditions kept lambs on farms, requiring meat companies to pay premiums to entice supply for overseas markets. Increased lamb slaughter numbers at heavier carcass weights will mean lower international prices and schedule prices over the March to September quarters. Over the forecast period, schedule prices are expected to increase in line with slowly rising export prices in United Kingdom pounds and an assumed exchange depreciation of the New Zealand dollar. Lambing rates are lower than forecast in the 2011 Net Position Report and are expected to fall from the high of the good 2010/2011 growing season (Figure 3).

Deer

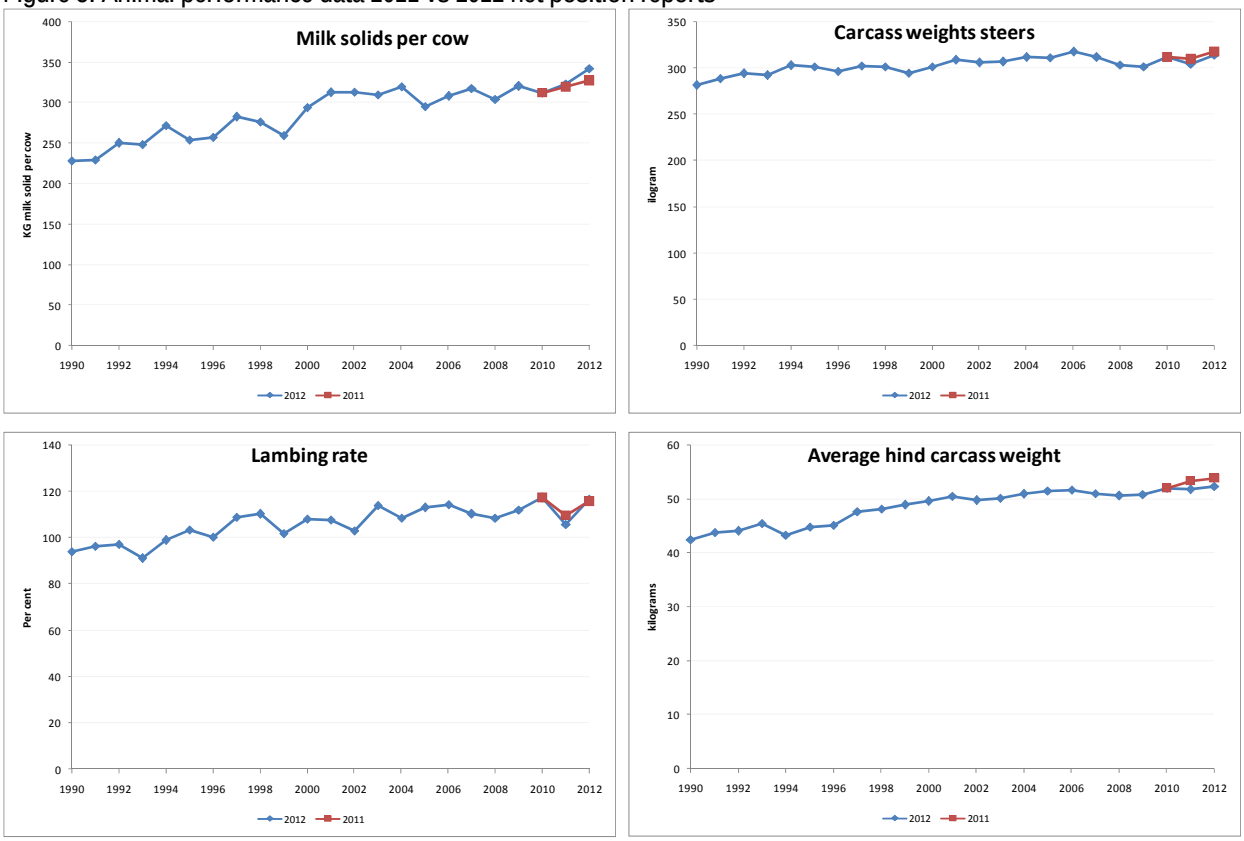
Deer numbers and average carcass weights of slaughtered hinds are forecast to be lower than forecast in the 2011 Net Position Report (Figures 2 and 3). The venison export price in Euros per kg of product weight peaked in October 2010. New Zealand supplies about 70 percent of global traded venison with the main market in Germany. Demand for venison in Europe and farmgate prices are expected to be lower than expected for the 2011 Net Position report due to recent economic problems in Europe and depreciation of the Euro compared to the New Zealand dollar.

Figure 2: Animal population data and forecast (animal numbers)



Source: Statistics NZ, MAF forecasts

Figure 3: Animal performance data 2011 vs 2012 net position reports



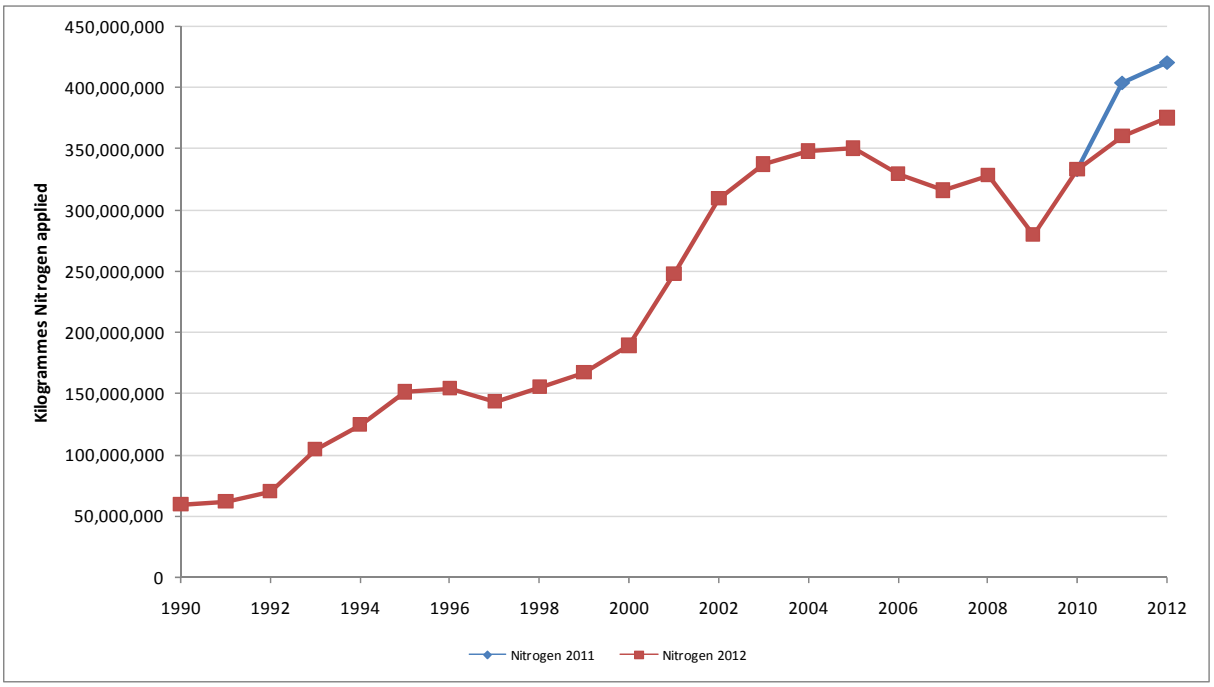
Source: LIC data, MAF slaughter data, Agriculture Production Statistics, and MAF forecasts

Nitrogen Fertiliser

The largest sources of nitrous oxide emissions during 2010 were direct and indirect emissions from animal excreta on agriculture soils contributing 77 per cent of nitrous oxide emissions on agriculture soils (the main source of nitrous oxide emission in agriculture). In 2010 direct

and indirect nitrous oxide emissions from fertiliser contributed 22 per cent of nitrous oxide emissions from agricultural soils. The dairy cattle industry is the biggest user of nitrogenous fertiliser in New Zealand. The increase in dairy cattle numbers is less than forecast in 2011 and the outlook for dairy prices is also lower. With the lower returns to dairy expected the application of nitrogenous fertiliser is lower in the 2012 Net Position Report compared to the 2011 report (Figure 4).

Figure 4: Nitrogen fertiliser data and forecast



Source: Fert Research, MAF forecasts

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 MAF's Pastoral Supply Response Model (PSRM). These then feed into the Agricultural greenhouse gas inventory model to estimate emissions.

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 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 in the amount 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.

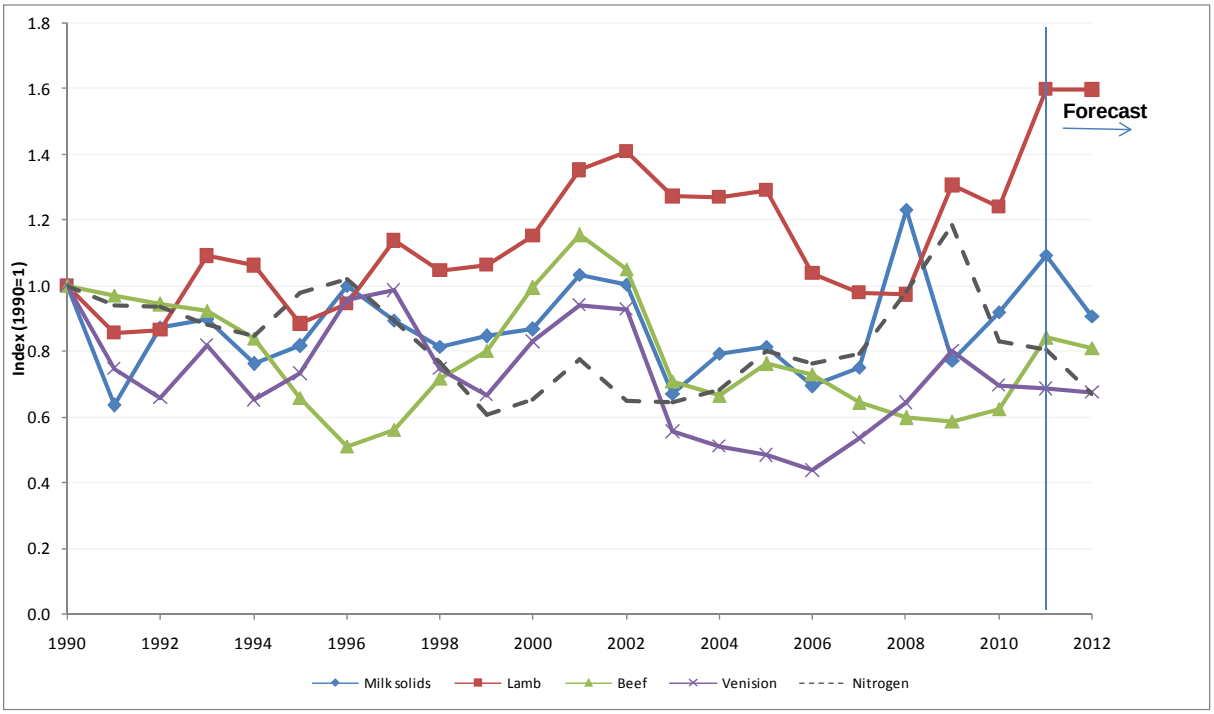
New Zealand's greenhouse gas methodology is based on the Revised 1996 Intergovernmental Panel on Climate Change (IPCC 1996) Guidelines and the IPCC good practice guidance (IPCC 2000). A further summary of the methodology can be found in the current submission of the *National Inventory Report*, with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

Projected agricultural activity

MAF 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 MAF's PSRM and projections of nitrogen fertiliser use are obtained from MAF's 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. MAF 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 2011 December fiscal and economic update. Figure 5 illustrates MAF's current expectations for key farm-gate prices to 2012 in real terms.

Figure 5: Real farmgate prices (Index 1990=1)



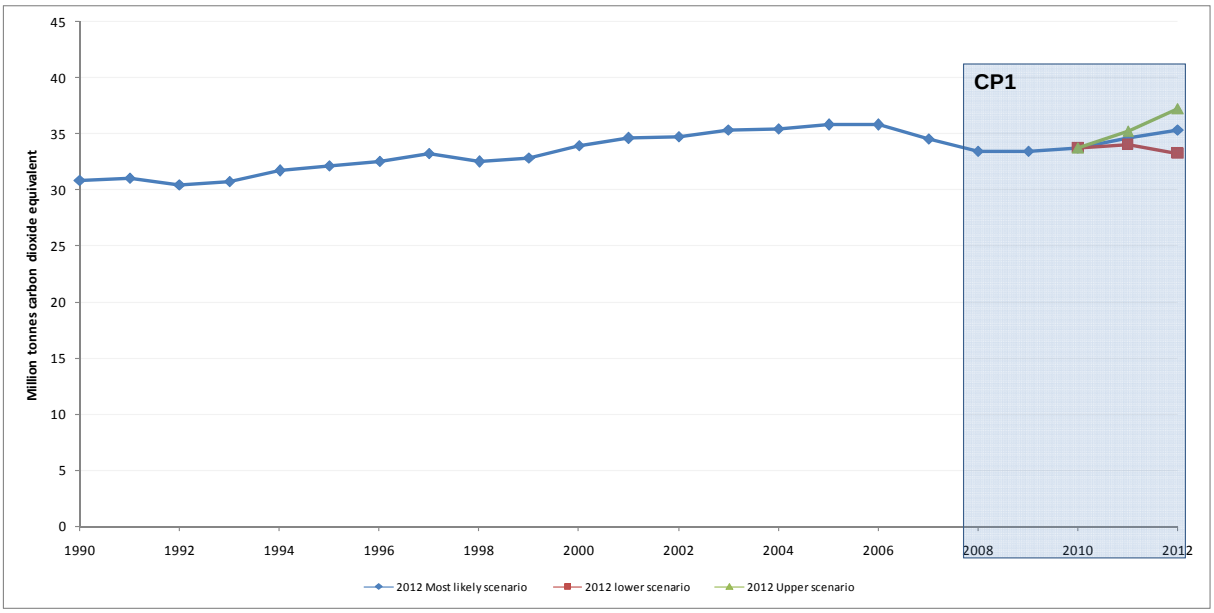
Uncertainty

Given current scientific data lower and upper estimates for agricultural greenhouse gas emissions range from 168.1 to 173.1 Mt CO_2-e. This range represents the variability in projections of agricultural activity such as cow numbers, slaughter weights nitrogen fertiliser application for the years 2011 and 2012. This range is narrower than that reported in the *2011 Net Position Report* as, with the passing of 12 months, more data for CP1 is available.

The total range of uncertainty across the agricultural sector has decreased from 10.0 Mt CO_2-e tonnes reported in the *2011 Net Position Report*, to 5.0 Mt CO_2-e. The uncertainty was estimated by developing two further scenarios: a lower and higher scenario. The higher scenario is one standard error above the most likely scenario values for each of the animal numbers, animal performance and nitrogen fertiliser use forecasts. The lower scenario is one standard error below the most likely scenario values for each of the animal numbers, animal performance and nitrogen fertiliser use forecasts. Cross-correlations between these variables are not modelled. These two scenarios estimate the values of the upper and lower bounds of future projected emissions.

These calculations attempt to provide some insight into the uncertainty surrounding this forecast of the estimate that will be reported at the end of CP1. This is different to the uncertainty around the agriculture sector emissions estimate presented in New Zealand's national inventory report which try to capture the difference between the estimated level of emissions and the actual level of emissions. Figure 6 demonstrates the estimated uncertainty of emissions over the CP1.

Figure 6: Projected emissions from 1990 to 2012 (million tonnes carbon dioxide equivalent)



All the above projections need to be assessed within the inherent uncertainties of biological systems. Climate shocks such as droughts, and the economic conditions which are largely driven by overseas markets, can rapidly change the circumstances under which the agricultural industry operates over the next few years.

Uncertainty in projections of animal populations and animal performances and of science underlying measurement methods all contribute to uncertainty in projections of total emissions.

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 MAF 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, and 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. 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 2010. Research to be published is expected to show that the uncertainty in direct nitrous oxide emissions from sheep and cattle excreta to 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.

Future improvements and reporting

Work is being carried out by research scientists, MAF 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 *2012 National Inventory* submission.

References and links

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.

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 2010 emissions is submitted in April 2012.

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.

Situation and Outlook for New Zealand Agriculture and Forestry

Situation and Outlook for New Zealand Agriculture and Forestry (SONZAF) looks at some of the broader issues facing the agricultural and forestry sectors and discusses the work on these issues that MAF is undertaking. For each of the key primary sectors (from kiwifruit to dairy), we forecast the likely economic and market conditions in the five-year period from 2010 to 2014.

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.

External references

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.