present there is no provision in the New Zealand emissions trading scheme to recognise good performance or low emissions, at the farm level as the emission factors apply uniformly across the country at processor level. However, it will be possible to develop unique emission factors for farms or groups of farms that can demonstrate superior performance, or the adoption of proven measures to reduce emissions.

In conjunction with AgResearch, Sheep Improvement Ltd. and AbacusBio Ltd., we funded the setup of the central progeny test programme in 2002 (Young & Amer, 2003). The CPT operates as a ram progeny comparison programme to examine how industry rams vary in growth rate and carcass merit. The programme uses the sophisticated VIAscan® carcass assessment tool that is installed at Alliance Group plants. The central progeny test programme is now funded by Beef and Lamb New Zealand as an industry programme. As part of the central progeny test, rams are being assessed for variation in GHG production with the ultimate aim of being able to select rams that are top producers and have the lowest GHG production.

CONCLUSIONS

The key challenge for us and our shareholders is how do we farm sustainably and remain profitable? We do not have all the answers and much needs to be debated at national and international levels. What we are doing though, is steadily building our research and development programme, our production systems and our marketing programme to incorporate sustainability at all levels of our business. Sustainability, that 14 letter word, with so many meanings and so many opportunities

The role of legislation in improving farm sustainability and how the New Zealand Government intends to incentivise the agricultural industry

E.H. VAN REENEN* and A.H. PICKERING

Ministry of Agriculture and Forestry, P.O. Box 2526, Wellington, New Zealand
*Corresponding author: erica.vanreenen@maf.govt.nz

ABSTRACT

The New Zealand Government has put in place a number of mechanisms aimed at improving farm sustainability and incentivising action. In relation to climate change, the key mechanism is the New Zealand Emissions Trading Scheme (ETS), which has been designed to put the New Zealand economy on a path to lower greenhouse gas (GHG) emissions and to respond to the country's international obligations. Although all developed countries that have ratified the Kyoto Protocol are responsible for their agricultural emissions, New Zealand is the only country in the world to include agriculture in an emissions trading scheme. With the inclusion of agriculture there are three key ways to incentivise a reduction in GHG emissions on-farm. These are through the point of obligation, the emission factor methodologies, and the allocation of "New Zealand Units" to the sector. Introducing agricultural GHG emissions into a New Zealand emissions trading scheme brings with it challenges and opportunities in a country that is heavily reliant on primary production for the health of the economy.

Keywords: agriculture; allocation; emission factor; greenhouse gases; New Zealand emissions trading scheme; point of obligation; processor; sustainability.

INTRODUCTION

New Zealand's economy is closely linked with its natural and physical resource base. Agricultural and forestry commodities made up 64 percent of merchandise export trade in 2009 and 12% of gross domestic product (Ministry of Agriculture and Forestry, 2010). Therefore, New Zealanders, particularly the primary sector, have a strong incentive to ensure that the natural environment is used sustainably.

There are a range of government tools and instruments relating to sustainable development that have been implemented to address issues such as water, climate change, land management, energy, transport policy, and waste management. Examples of these include the Resource Management Act 1991, the Sustainable land management and hill country erosion programme, the New Zealand energy strategy, and the New Zealand emissions trading scheme (NZETS). To address climate

change and greenhouse gas (GHG) emissions from agriculture, the New Zealand Government is taking a multi-faceted approach. The key regulatory mechanism is the NZETS, which includes agriculture. Alongside this there is substantial Government and industry investment into mitigation technologies for the agriculture sector. Finally, there is a programme on adaptation to climate change and a technology transfer programme. This paper will focus on agriculture in the NZETS. There are three key ways the NZETS can incentivise behavioural change: through the point of obligation, through the emission factor methodology, and through the allocation methodology.

NEW ZEALAND'S EMISSIONS PROFILE

New Zealand has a unique GHG emissions profile for the developed world with 47% (32.8Mt CO_2-e/annum) of the country's emissions coming from the agriculture sector. Emissions from energy contribute 44% (31.4 Mt CO_2-e/annum), industrial processes 6% (4.3Mt CO_2-e/annum), and waste 3% (2.0 Mt CO_2-e/annum). In contrast, the forestry sector contributes as a sink for 29.7 Mt CO_2-e (Ministry for the Environment, 2011). The high percentage of emissions from the agriculture sector is largely due to New Zealand having a high number of ruminant animals, a small number of industrial factories, and using a large amount of renewable energy (73% in 2010; Energy Efficiency and Conservation Authority 2010), compared to other developed nations.

BACKGROUND TO THE NEW ZEALAND EMISSIONS TRADING SCHEME

In 2008 the Climate Change Response Act (2002), set up the NZETS. The NZETS is an economy wide market mechanism designed to pass the cost of GHG emissions onto those who emit, and in doing so, create an incentive to reduce emissions. Emissions may increase in one area but decrease in another, this encourages emission reductions to occur where they can be achieved at least cost. The unit of trade for the NZETS is a New Zealand Unit (NZU).

The NZETS has been chosen as a tool to reduce emissions because:

- there is broad consensus that it is an effective and economically efficient approach,
- it is the most flexible option,
- it provides an incentive for industry and private individuals to improve their resource use, and
- it is consistent with the principles of the Kyoto Protocol.

The NZETS works on an emitter pays principle so participants report their emissions, or the emissions that will arise from their activities, and surrender units equal to those emissions. There are severe penalties for deliberate failure to meet both reporting and surrender obligations. The scheme runs a self-assessment model for monitoring, reporting and verification. Although a self-assessment system is used, the NZETS is designed so that external verification of reporting can be audited.

Unlike New Zealand's Kyoto Protocol obligations, which for the first commitment period from 2008 to 2012 are all emissions over and above 1990 levels, the NZETS is for absolute emissions. This is because this limits perverse effects such as, a sector's emissions reducing below 1990 for reasons other than climate change and potentially gaining from this, and international obligations are likely to increase over time. However, to manage this and other issues such as preventing carbon leakage, the New Zealand Government is awarding an allocation of NZUs to those sectors considered trade affected, such as agriculture, but phased out over time at 1.3% per annum. This is to ensure that the emissions do not "leak" from the economy and that producers are not unfairly penalised in overseas markets because the agriculture sector is meeting the cost of carbon which is not being met elsewhere.

AGRICULTURE IN NEW ZEALAND EMISSIONS TRADING SCHEME

The Intergovernmental Panel on Climate Change has grouped individual countries within annexes according to their acceptance of emission targets for the period 2008-12 (Intergovernmental Panel on Climate Change, 2001). Although all Annex 1 countries are required to account for their agricultural emissions above 1990, New Zealand is currently the only country to include all sectors and all gases including methane (CH_4) and nitrous oxide (N_2O) from the agricultural sector in a domestic emissions trading scheme. Primary production in New Zealand contributes to over half of the country's merchandisable exports and also nearly half of its GHG emissions in CO_2 equivalents (CO_2-e). So on the one hand we have economic benefit, and on the other a cost to the economy of GHG emissions from agricultural production. This creates a unique challenge for New Zealand.

The agriculture sector has the option of reporting their emissions from 1 January 2011, reporting is mandatory from 1 January 2012, and the sector will face surrender obligations from 1 January 2015 with an allocation of units. There are a number of challenges in bringing agriculture into the NZETS which will be discussed in more detail for the remainder of this paper.

TABLE 1: Comparison of processor level and farm level obligation in the New Zealand emission trading scheme for monitoring, reporting and verification.

Aspect	Farm level	Processor level
Number of participants	35,000+	~200
Monitoring/Audit	Expensive, high rates needed and has to be done in real-time.	Simple, low cost, can be carried out through paper records.
Reporting	Simple and complex options. Many returns to process.	Simple (supplied emission factor multiplied by output). Low number of returns to process.
Verification	Difficult due to combination of paper records and real-time data that is difficult to collect.	Simple, almost all data required can be verified through independent sources.
Compliance	Difficult – high level of scepticism within sector and difficult to identify every participant.	Simple – nearly all processors are known to Government through other mechanisms.

POINT OF OBLIGATION

One of the principal questions when designing an emissions trading scheme is who will have responsibility for reporting and surrendering the units traded. There are two key options; at the emitter level or an upstream point of obligation. For agriculture, the emitter level is with individual farmers, but the upstream point of obligation is with processors. The New Zealand Government favoured the upstream point of obligation because the monitoring, reporting and verification is relatively simple. There is, however, much debate over the point of obligation for the agriculture sector.

In the 2009 amendment of the NZETS, the Government confirmed the point of obligation for the agriculture sector would be at the processor level rather than at the farm level. However, there is flexibility in the Climate Change Response Act, 2002, to move to a farm level point of obligation in the future. This would require the Minister for Climate Change Issues to be satisfied that verification issues have been sufficiently solved, that a reduction in emissions will occur, and that there is minimal compliance and administration costs to participants and to the Crown.

There is a trade-off between a farm level point of obligation and a processor level point of obligation. In theory, a farm level point of obligation generates a superior price signal by attaching the cost of emissions to farm inputs. In a broad sense, inputs include management practices (Ministry of Agriculture and Forestry, 2009a; Kerr & Sweet, 2008). This means that an emitter can use low-emission inputs instead of high-emission inputs and reduce their liability, or change land use to generate fewer emissions, if this is profitable. An example is applying nitrification inhibitors with urea, or substituting forestry for livestock.

A processor point of obligation attaches the cost of emissions to farm outputs. This means there are fewer options for reducing farmers' liability. Under the NZETS processors are given GHG emission factors to apply to the product they process. These are based on average emissions across New Zealand and determine a participant's liability. The methodology behind the emission factors in the NZETS is outlined below. The NZETS allows participants to apply for a unique emission factor if they consider their emissions to be below the average emission factor supplied.

The NZETS also allows for removal activities which will have their own emission factors. Removal activities are GHGs that are either removed from the atmosphere, not released into the atmosphere, or a reduction in emissions reported in the inventory or successor international agreements. Currently there are no removal activities that apply to the agriculture sector, but nitrification inhibitors may meet the criteria. In this instance, participants would receive one unit for every tonne of CO_2-e avoided. This means participants would receive the full benefit of using the product.

A further trade-off between farm level and processor level point of obligation is with monitoring, reporting and verification. As mentioned, the NZETS is a self-reporting system and emissions reported need to be verified and stand-up to audit when necessary. Table 1 outlines a comparison of monitoring, reporting, verification and compliance at the farm level versus processor level obligations for the New Zealand agriculture sector.

EMISSION FACTOR METHODOLOGY

New Zealand's GHG inventory calculates agricultural emissions based on national animal population data. However, for the purpose of the NZETS, emission factors needed to be developed by product output ,as for example, tonne CO_2-e per head at slaughter or tonne CO_2-e per tonne of milk solids processed).

Using the National Inventory as a basis, a methodology was developed that recognises emissions at different stages of an animal's life. This also reflects the different energy requirements at those same different stages of life (E.H. van Reenen, Unpublished data). There were a number of policy considerations in the methodology development and these were balanced with scientific best practice. Table 2 outlines the emission factors for dairy cattle milk solids, lamb, steer, and fertiliser.

Participants in the NZETS are milk and meat processors, fertiliser importers and manufacturers, live animal exporters, and egg producers. This meant that the emission factors were designed for different outputs depending on the participant.

A key challenge for the methodology came from the fact that meat processors do not, and cannot easily distinguish between a beef cow and a dairy cow at the time of slaughter. Thus, for the purpose of the NZETS the emission factor for cull cows needed to be the same.

To develop the emission factors the Ministry of Agriculture and Forestry looked at the production animal and its energy requirements throughout its life. These requirements are in turn, directly related to its GHG emissions. Animals can be split into two key groups for the purpose of emission factors: breeding females and everything else. All animals have a mother who has maintenance, gestation and lactation emissions to produce it. This effectively means every animal has an emissions liability from the point of conception (Ministry of Agriculture and Forestry, Personal communication). Meat animals also have growth and maintenance emissions to reach slaughter weight. Therefore, for meat animals, there are two emission factors:

- a per head emission factor which represents the emissions of maintenance, gestation, and lactation from an animal's mother for the year she was pregnant with the animal; and
- a per tonne of carcass weight emission factor which represents the emissions of maintenance and growth up to an animal's slaughter weight.

The two emission factors are applied to the total output of a meat processor and added together to calculate their total liability (Ministry of Agriculture and Forestry, Personal communication).

For dairy animals, there is one emission factor which is applied to the tonne of milk solids processed. This emission factor represents the emissions associated with producing milk independent of all other emissions associated with growth, maintenance, and pregnancy which are captured at slaughter (Ministry of Agriculture and Forestry, Personal communication).

Between the meat and milk emission factors there is a small efficiency of production incentive, although the strength of this is still being debated and is unlikely to be known until after the agriculture sector faces liabilities in 2015. Where there is more than one product being produced per animal, such as with meat and milk, there is a lower GHG emissions liability per tonne of total product. This is because more product is spread over less animals, with the per head charge divided over more product. At this stage there is no recognition of the time it takes for an animal to reach slaughter weight, which would strengthen the incentive to increase the amount of product produced per animal (Ministry of Agriculture and Forestry, Personal communication).

TABLE 2: Examples of emission factors for the agricultural sector in the New Zealand emission trading scheme.

Product	Emission factor per head (tonnes of CO_2-e)	Emission factor per tonne of product (tonnes of CO_2-e)
Milk solids (bovine)	N/A	6.14
Lamb	0.30	4.5
Steer	1.98	10.5
Fertiliser	N/A	5.72
Pork	0.027	3.5

Emissions of nitrous oxide (N_2O) from the use of synthetic fertilisers are also included in the agriculture sector of the NZETS and therefore face the same timeframe as emissions from animals. The emission factor developed for fertiliser is taken directly from the National GHG Inventory and is applied to the tonnes of synthetic nitrogen imported or manufactured, less tonnes of synthetic nitrogen exported as emissions for exported nitrogen fertiliser occur off-shore (Ministry of Agriculture and Forestry, Personal communication).

Emission factors for egg producers and live animal exporters are per animal and make an assumption on the age of the animal at slaughter or departure from New Zealand (Ministry of Agriculture and Forestry, Personal communication).

ALLOCATION

Agricultural participants will be eligible to receive a free allocation of NZUs from the government to help mitigate the cost of participation in the NZETS. The sector does not need to pass a trade exposure or emissions intensity test like the industrial sector does to receive the allocation. This is because the Government recognises that the entire agriculture sector is "trade exposed". The price of the products produced in the sector is not able to be adjusted as the producers face a global market price rather than a domestic market price, due to over 80% of product being exported overseas.

Allocation will be on an "intensity" basis, meaning participants receive an allocation that is linked to their output. The assistance level will start at 90% of the sector's emissions baseline and will phase out at 1.3 percent per annum from the previous year's allocation, starting in 2016. The emissions baseline is yet to be established but will be the industry average of emissions per unit of output in a chosen year or combination of years.

The calculation for allocation is as follows:

Allocation = Output x Allocative baseline x Assistance level

The allocation will be uncapped, meaning that there is no set limit on the number of NZUs that may be allocated and each participant will receive the 90% allocation.

Allocating NZUs to participants is a mechanism that could substantially alter the impact of the NZETS. There are numerous different methodologies for allocating NZUs and different methodologies place different incentives onto the emitter (Ministry of Agriculture and Forestry, 2009a). For example, using a fixed methodology that establishes a fixed level of NZUs to allocate means the marginal cost of increasing emissions, or production, is the same as the cost of CO_2-e. This is effectively establishing a GHG emissions cap. Conversely, an intensity based system fluctuates with production and therefore GHG emissions', meaning the marginal cost of increasing emissions remains the same. Take a company that produces 100 tonnes of CO_2-e in 2015. Under a fixed system assuming they get 90% of 2010 emissions, which are 100 tonnes and the price of carbon is $20 per tonne. Under an intensity system they receive 90% of emissions. Under both systems the company would receive 90 units in 2015 so the liability is 10 units, or 10 x $20 = $200 worth of liability. What are the implications if the company increased their emissions to 150 tonnes of CO_2-e in 2016? Under the fixed system they would receive 90 units and they would have a liability of 60 units, or 60 x $20 = $1,200. In contrast, under an intensity based system they would receive 135 units and the liability would remain at 10%, so would be 15 units or 15 x $20 = $300 worth of liability. A stronger incentive to reduce emissions exists under a fixed system, compared to an intensity based system.

The Government has agreed to an intensity based system to help transition the agriculture sector to a low carbon economy at a rate that is sustainable. An intensity based system does not necessarily discourage increasing production; instead it encourages more efficient production.

CONCLUSION

Agriculture's inclusion in the NZETS has not been without its challenges. However, the settings within the NZETS on how liabilities are calculated can still incentivise behaviour on-farm to better manage GHG emissions. The inclusion of agriculture in the scheme is part of the Government's approach to environmental sustainability on-farm for climate change. The NZETS will affect all aspects of agriculture and therefore will have a significant impact on the behaviour of the sector. Incentives are likely to develop over time with refinement of the NZETS for agriculture and other sectors and with changes in farming practices.

Can livestock production be increased without increasing greenhouse gas emissions?

G.C. WAGHORN*

DairyNZ, Private Bag 3221, Hamilton 3240, New Zealand
*Corresponding author: garry.waghorn@dairynz.co.nz

ABSTRACT

More efficient farming practices will increase livestock production without increasing greenhouse gas (GHG) emissions. GHG emissions of methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) have always been part of agriculture, but national and international concern about global warming has focused research towards their mitigation. CH_4 production represents a loss of about 9% of metabolisable energy in feed, whilst N_2O production represents a loss from excessive nitrogen (N) application. Mitigation should therefore provide benefits for farming by conserving dietary energy and reducing fertiliser costs. Unfortunately there are limited options for reducing CH_4 loss. Nevertheless, by ensuring animals are productive and fertile and adopting management systems that ensure a high utilisation of feed grown, it is possible to lower CH_4 emissions per unit of product. There are more opportunities for reducing N_2O emissions, because these originate in large part from N fertiliser application, and more prudent use will lower costs, minimise nitrate