PREPARING FOR A LOW CARBON AGRICULTURE

Scott Fraser, Warren Parker and Ann Smith

Climate change has become one of the defining issues of the 21st century. Agriculture, from its roles in food production, energy production, natural resource management and land-use, is at the heart of the transition to a low carbon economy. Developing climate change policies and requirements pushed down the supply chain by retailers are placing increasing pressure on agribusinesses. They need to understand the extent of their greenhouse gas emissions and to implement management practices that will reduce these emissions.

Taking account of greenhouse gases

Agriculture will be brought into the New Zealand Emission Trading System from 2013. This means that farmers will need to take account of greenhouse gas emissions as part of their farm management decisions. Between now and 2013 the agricultural sector has an opportunity to prepare itself for participation in emissions trading. A plan of action is being developed by government by consultation with land based sectors. They will produce a joint work programme to achieve a combined sector and government response to climate change.

Voluntary activities will be encouraged, such as on farm pilot trials to monitor and report greenhouse gas emissions. In addition sector contribution to research and development of greenhouse gas mitigation, technology transfer and adaptation will also be encouraged. A technical advisory group comprising policy and technical experts will report to MAF and information will be made available via a series of workshops.

Key questions are now being addressed in shaping the emissions trading system. What is the extent and rate of change and the capacity of agribusiness to adapt to the new realities of higher fuel prices? How much do we need to reduce greenhouse gas emissions? What about the increased competition for scarce land and water? What of the growing public demands for land owners to exercise responsible stewardship of the natural resources under their management.

The market for carbon and likely other resources is growing in scale and influence, along with higher world prices for food and fibre. Farmers and their advisors face significant challenges in obtaining credible, high quality information for their decision-making. There is a lack of research based evidence on the greenhouse gas emissions of key aspects of New Zealand production systems and agribusiness supply chains. These, along with the policy of uncertainty and inconsistent communication in the farming media, can all add up to farmers feeling confused, and unsure about where they can obtain trustworthy advice.

An environmental footprint is calculated by preparing a cradle-to-grave life-cycle analysis where all of the 'potential environmental impacts of a product are assessed by quantifying and evaluating the resources consumed and emissions to the environment at all stages of its life cycle - from extraction of the resource through the production and use of raw materials, the product itself, and the use of the product to its reuse, recycling or final disposal.'

A carbon footprint is part of this and incorporates the product's greenhouse gas and energy use. The footprint is expressed as carbon dioxide equivalents where methane is 21 carbon dioxide equivalents and nitrous oxide is 310 carbon dioxide equivalents.

The purpose of this article is to provide background on greenhouse gas emissions management at the farm level. It will indicate areas where farmers need to pay particular attention to maximise the opportunity to lower their carbon footprint at least cost.

Agricultural greenhouse gas emissions

New Zealand has a unique national greenhouse gas inventory where methane and nitrous oxide emissions from agriculture make up very nearly half. While significant emissions occur from fuel and electricity use in the agricultural sector, these sources are accounted for under fossil fuels and stationary energy in the ETS.

Methane accounts for 65 per cent of New Zealand's agricultural greenhouse gas emissions, mostly as a result of enteric fermentation – a key process in ruminant livestock. Ruminant methane production represents a net loss of productivity for these systems. Up to 20 per cent of all ingested energy is lost as methane from ruminant livestock, but currently there is limited opportunity to reduce these losses. For the national greenhouse gas inventory, ruminant emissions are calculated using a New Zealand specific modelling approach. This uses animal productivity data to estimate dry matter intake and from the relevant methane emissions.

Nitrous oxide emissions account for 34 per cent of New Zealand's agricultural greenhouse gas emissions and mostly occur as a result of nitrogen fertiliser use and nitrogen inputs from livestock. Emissions due to nitrogen fertiliser use can be reduced by careful management such as timing of application and applying only enough for plant requirements. The use of de-nitrification inhibitors has also been shown to reduce nitrous oxide emissions from soil.

Measuring on-farm emissions

The national inventory gives an idea of the emission sources and scope from agriculture. However in order to document actual emissions and demonstrate reductions it is important to be able to account for emissions at a much smaller scale. Ideally each individual farming operation would produce an inventory of greenhouse gas emissions. Then on-farm management decisions can be based on the reality of the particular agri-business.

Particular attention should be paid to capital investment decisions for farm improvement which will have long-term effects on energy use, water and biodiversity. Where practical, farmers should build as much flexibility into these improvements as possible. For example, it may be better to lease a new tractor for three years when a much more fuel efficient model is expected to be available.

Close attention should also be paid to fertiliser practice. Life-cycle analysis studies of New Zealand dairy farms has shown that fertiliser practice has a dominant influence on a farm's energy use. Overseer is a powerful tool for exploring ways to optimise nutrient management. It also, from an environmental viewpoint, minimises leakage into waterways and the atmosphere. With fertiliser prices already dramatically increasing and set to increase further over the next 12 months, efficient nutrient management has become important for a farm's productivity, profit and carbon footprint. The Overseer model is being upgraded to include information on greenhouse gas emissions. At Landcare Research we are working closely with AgResearch to ensure the improvements to Overseer synchronise with the carbon zero programme and our carbon calculators.

Farmers should also carefully consider their future land use. Those with reasonable areas of steep, easily eroded land or land not well-integrated into the normal farming operations may have scope to covenant land for indigenous forest regeneration. They could then receive payments for carbon sequestration.

The carbon zero programme, administered by Landcare Research, offers tools that can be used by individual agri-businesses to measure, manage and mitigate greenhouse gas emissions. An inventory of greenhouse gas is compiled and is consistent with the Greenhouse Gas Protocol. This is a corporate accounting and recording standard, which outlines what should be measured and which establishes how these measurements should be made.

Direct or indirect emissions

The measurement takes, as the starting point, an organisation such as a farm, and draws organisational and operational boundaries around it. This will define how emissions will be accounted for and identifies emissions as direct or indirect.

Direct emissions arise from business activities or emissions sources that are owned or operated by the organisation such as fossil fuel burnt in boilers or vehicles. Methane produced by ruminants and nitrous oxide emissions from soil due to fertiliser or animal excreta are direct emissions. Indirect emissions are emissions that occur as a consequence of activities carried out by the organisation, but not owned or controlled by it. These include purchased electricity and all other emissions where the business procures a product or service for which another organisation owns and controls the greenhouse gas emissions.

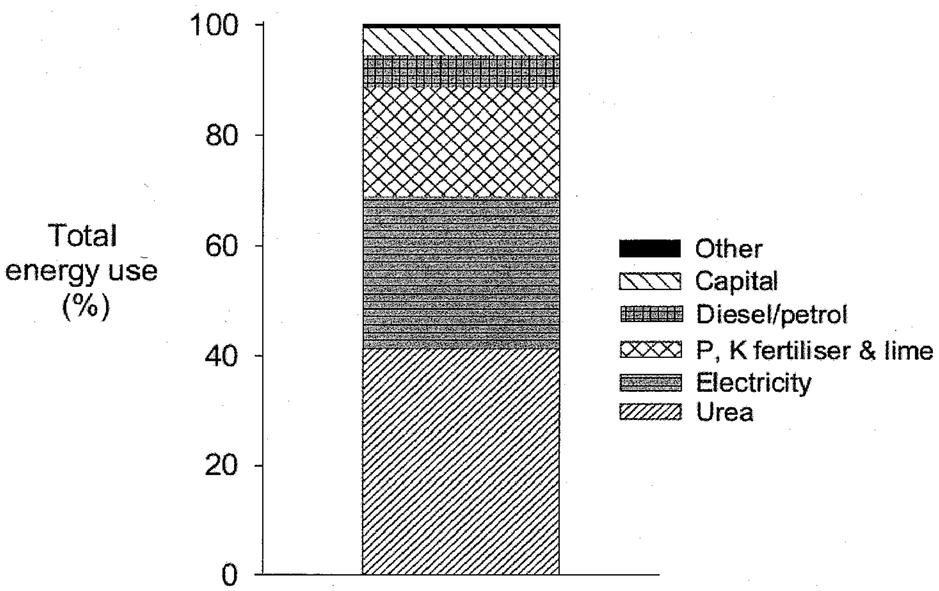
Examples of other indirect emission sources are air travel, contractors, freight and embodied emissions in fertiliser from, for example, mining, manufacturing and freight. While only greenhouse gases other than carbon dioxide are included in the national inventory under agriculture, a farm scale inventory would include all emissions sources such as fuel use and electricity that result from farming operations.

Embodied emissions in agricultural products

Internationally there is a growing awareness of the effect of consumer products on the environment. Recently the focus has turned towards embodied greenhouse gas emissions in products. These include emissions associated with growing and extracting raw materials, manufacturing and processing of these raw materials, and the distribution of materials along supply chains. Finally there is the use by the consumer and disposal at the end of the product's life.

Emissions associated with retail, consumption and disposal of waste should be included. However the methodology for these measurements is poorly developed. There is resistance to including these parts in a product's life cycle as producers may have little ability to influence emissions associated with these activities.

In sensitive markets such as in the UK, consumers are demanding more detailed labelling, especially food and beverage,



Sources of energy used by the average 2005 New Zealand dairy farm from production to milk-in-the-vat

so that they can make informed and ethical decisions when shopping. The UK supermarket chains have responded by signalling that food and beverages will need to have carbon labelling allowing comparison in terms of their embodied greenhouse gas emissions.

No standard

Currently there is no international standard for determining the embodied emissions in products and services. However, in the UK, British Standards are working with the Carbon Trust and the Department for Food to develop a publicly available specification PAS2050. This outlines the requirements for measuring embodied greenhouse gas emissions in products and services. The specification has been through two cycles of public consultation and a final version will be available in July 2008. The International Standards Organisation has recently signalled that it intends to develop a new greenhouse gas standard for products and services taking into account the work already done on PAS2050. It will include a potential supply chain standard under consideration by the World Resources Institute.

In some export markets, New Zealand products have been portrayed as having high climate change effects due to the distance to market – the food miles campaign. However, it is important that New Zealand exporters respond to these campaigns in a pro-active manner. The PAS2050 system offers benefits to New Zealand exporters as it allows comparisons of embodied emissions to be made in a standard manner. It also allows businesses to identify significant emissions sources and take steps to reduce emissions intensity, often leading to cost savings.

Cradle-to-grave

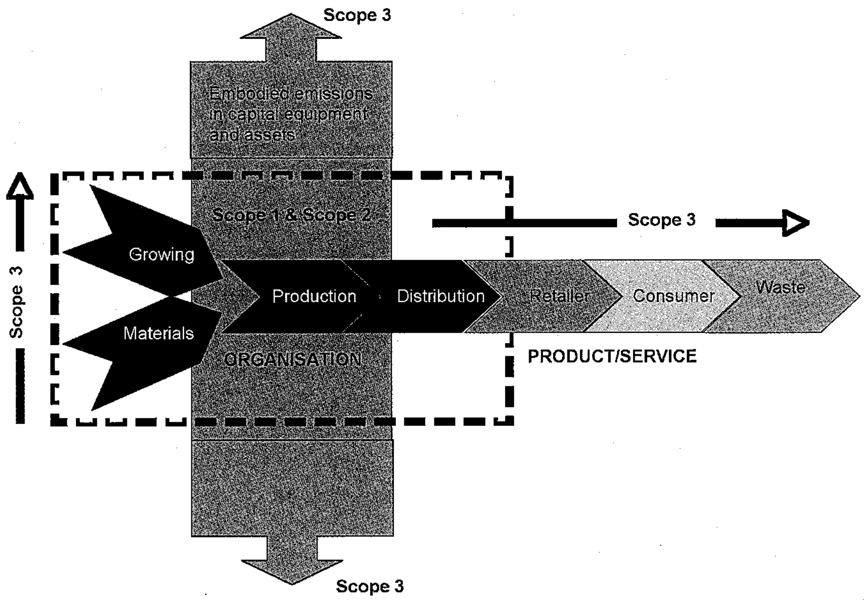
With regard to measuring embodied emissions in products and services, the carbon zero programme is aligning its measurement requirements for products and services with the PAS2050. In order to achieve certification and market a product as carbon zero certified, an organisation must demonstrate where possible, reduction in emissions intensity, and offset the remaining embodied emissions by the purchase of high quality carbon credits. The organisation applying for product certification must also be certified. In practice, the boundary for measurement of the organisation is extended to include the product or service life cycle emissions that fall outside the ownership and control of the organisation.

A supply chain process map is produced which identifies greenhouse gas emission sources for the product life cycle. Ideally this is a cradle-to-grave approach which includes emissions associated with raw materials, processing, distribution, retail, consumption and disposal at the end of life. The end of life is defined as the point when a product and associated packaging is disposed of or becomes the raw material in another product. Realistically it may not be possible to calculate emissions beyond the destination on a shipping note, and this is often where the downstream boundary is drawn for carbon zero certified products.

Certification of carbon neutral status

Under the carbon zero programme, if an organisation or product needs carbon neutral certification, there is a series of steps to be undertaken. The organisation must commit to measuring and reducing greenhouse gas emissions year on year. The first step is for the organisation to measure its greenhouse gas emissions and produce an inventory report. Then an emissions reduction plan is written including targets for reducing emissions intensity.

These targets should be aligned with climate change policy at sector, regional or national level. Any remaining unavoidable emissions are offset by the purchase of high quality carbon credits. These must be separately verified as real, permanent, additional and cancelled from a recognised registry. These actions and the accompanying calculations are then verified by an external independent auditor. Once certified, the organisation can claim



Comparison of the greenhouse gas emissions sources for the organisation and product

carbon neutrality for the 12 months following the measurement period. The process is repeated on an annual basis.

Difficulties with measuring farm emissions

Ideally all emission sources are measured using direct activity data collected in appropriate units, for example litres of fuel burnt, or kilowatt hours of electricity purchased. However, not all data can be collected in this way and estimated emissions are calculated by converting data to the appropriate units. This leads to uncertainty in the measurement of emissions. In general estimates should over-estimate emissions rather than understate them.

Different levels

Emission factors are used to convert activity data, such as litres of fuel, to carbon dioxide equivalents. A hierarchical system is used to qualify different emission factors and decide on the most appropriate factor to use, the highest quality factor being Level 1. Level 1 factors are based on actual verified measurements, for example the calorific value and carbon content of fuel.

Moving down the hierarchy of levels of factors, the accuracy of measurements decreases. Level 2 factors are derived from national average emissions for a particular activity, and Level 3 factors are based on international average emissions. Level 4 emission factors are derived, for example, from emissions from fuel use calculated over the distance travelled. Level 5 emission factors are derived from international data and used to estimate embodied emissions in products when direct measurements are not available.

Farm emissions, such as nitrous oxide and methane, are impractical or not possible to measure with current technology at a farm scale. Estimates of ruminant methane production are based on models developed from actual measurements where methane production is estimated using micro-meteorological mass balance and tracer techniques.

These techniques are not practical to use for on-farm measurements and derived emission factors must be used. Where emissions for live-stock are estimated from the national inventory or modelled in Overseer, the resultant measurement will not reflect management techniques that have reduced methane emissions. Emission reductions can not be demonstrated by using derived emission factors in this way.

Variability

A similar situation arises when calculating nitrous oxide emissions from soil. By nature soil has considerable variability. Many factors influence nitrous oxide emissions from soil, including the source of nitrogen, soil moisture, soil structure, soil type, quantity of fertiliser applied and the number of applications. Some of these parameters can be modelled and predictions can be made using software such as Overseer, but this calculation may not reflect actual efficiencies gained by good fertiliser management techniques.

In the future farmers may be able to off-set a proportion of their greenhouse gas emissions by soil sequestration of carbon dioxide. While there is research that indicates that soil management practices can increase sequestered soil carbon, it is not yet practical to measure and document these emissions at the farm scale. Research is in progress in Australia and the US on the potential for farmers to benefit from soil ecosystem services. Higher levels of emissions may be released by soils where good soil management practices are not maintained.

Conclusion – to widen the focus

The primary sector faces significant challenges to reduce New Zealand's greenhouse gas emissions. But there are also significant opportunities to benefit from making management changes that account for these emissions. For farmers to make significant emissions reductions they must understand the sources and sinks of these emissions. This requires a reliable measurement before they can implement reduction actions. New Zealand has an opportunity to be a market leader in developing technologies to reduce on-farm emissions and to competitively market its produce as sustainable.

Agri-businesses expecting to be involved in the New Zealand ETS or affected by prices pushed downstream from points of obligation, can best prepare by measuring and understanding their organisational footprint. To avoid misleading conclusions and incorrect management action, only tools and advice from credible providers should be used for this purpose.

For New Zealand primary production exports, access to markets that favour carbon neutral products or carbon footprint disclosure is becoming increasingly important. Transparent and accurate assessment of the embodied emissions in products, based on international standards and using internationally recognised methodology and industry best practice, will become a pre-requisite to compete in these markets.

Carbon footprint calculator

We recommend farmers establish access to regular, user-friendly information updates on climate change and its implications for them. For example, perhaps collectively by discussion group, a consultant newsletter or accessing newsletters such as that of the Landcare Research carbon zero programme.

They should also access, directly or through their advisor or trusted science organisation, a carbon footprint calculator for their farm and household. This should have government sanctioned emission factors in order to generate an understanding of the main contributors to the emissions associated with their business activities. In addition there should be an understanding of the scope and cost for these to be reduced and, equally important, opportunities to benefit from carbon credits.

Climate change is important, but is not the only factor driving change towards more eco-friendly and sustainable agricultural production. Food safety, animal welfare and environmental regulations have been shaping farm practice and supply chain credence for at least two decades. The concerns associated with climate change and new government policy to reduce greenhouse gas emissions have given these initiatives added impetus and widened the focus for sustainable dairy production.

Scott Fraser is Sustainability Advisor, the Carbon Zero Programmme, Hamilton, Warren Parker is Chief Executive, Landcare Research, Lincoln. Ann Smith is Programme Leader, the Carbon Zero Programme, Lincoln