"In the long term the way in which food is grown, and the types of food grown, will have to change if biological emissions are to be reduced."
Dr Jan Wright, Former Parliamentary Commissioner for the Environment, NZ Herald, October 2016

Since 2013, Motu has worked on the multi-disciplinary programme "Shaping New Zealand's Low-Emission Future". This involves significant research, stakeholder dialogue, and international exchange to explore New Zealand's potential pathways, policy options and practical actions for transitioning to a successful low-emission economy.

This booklet highlights some of the work that has emerged from the programme. More information is available from http://motu.nz and from our blog, New Zealand's Low-Emission Future, at http://low-emission-future.blogspot.co.nz/

November 2017

Hollis, Michele, et al. 2016. *"Cows, Sheep and Science: Consensus and Divergence on the Science of Agricultural Non-CO2 Emissions."* Motu Working Paper 16-17. Wellington: Motu Economic and Public Policy Research.

The overriding need to reduce carbon dioxide (CO_2) emissions is scientifically uncontentious. For the climate to stabilise, net CO_2 emissions must ultimately be cut to zero. There is debate about whether, when and how much action to take on other gases. There is support for 'easy wins' on all gases, but it is unclear how easy it is to reduce total nitrous oxide (N_2O) and methane (CH_4) emissions while maintaining production.

The report summarises options, and discusses methods to calculate CH_4 and $N2_O$ emissions at the paddock, farm, regional and national scale. Finally, it considers metrics used for comparison between gases, focusing on Global Warming Potential (GWP) and Global Temperature change Potential (GTP). The authors reached consensus that the 'right' value depends on the policy goal and could change substantially over time; and if the main policy goal is to cost-effectively limit global average warming to two degrees above pre-industrial levels, then the value of CH_4 should be less than the GWP100 value of 28 until global CO_2 emissions have begun to decline steadily towards zero. There is no agreement beyond this on the best value to use; the arguments reflect judgments about politics, economics, and the intersection of policy and science.

Kerr, Suzi. 2016. *"Agricultural Emissions Mitigation in New Zealand: Answers to Questions from the Parliamentary Commissioner for the Environment."* Motu Working Paper 16-16. Wellington: Motu Economic and Public Policy Research.

This work explores how New Zealand should address agricultural GHG emissions. It focuses on the role of mitigating biological agricultural emissions in New Zealand and abroad.

Nitrous oxide (N_2O) emissions cannot go to zero: we need food, and any food that requires inputs of nitrogen will result in N_2O entering the atmosphere. So, the emphasis for N_2O mitigation must be on efficiency. This means Kiwi farmers should focus on producing low-emission nutrition that balances emission reduction with producing enough food. Any remaining N_2O emissions will need to be offset by actively taking CO_2 out of the atmosphere. In contrast, CH_4 emissions could be reduced to zero. However, while reducing short-lived CH_4 emissions will make it easier to achieve the target of limiting warming to two degrees, CH_4 emissions do not need to decline to zero for the climate to stabilise.

Because our agricultural industry is both productive and becoming more climate-smart than many other countries, it is in our interest for agricultural emissions to be included in the climate mitigation strategies of all countries. Our government and farmers could work with developing countries to transform their agricultural sectors.

Shephard, Mark, et al. 2017. *"New Zealand's Freshwater Reforms: What are the Potential Impacts on Greenhouse Gas Emissions?"* Motu Note 26. Wellington: Motu Economic and Public Policy Research.

Independent studies led by Motu Economic and Public Policy Research and AgResearch estimated that land-based gross GHG emissions would be reduced by 2% - 4% after the reforms discussed in the National Policy Statement for Freshwater Management 2014. The two teams took quite different approaches, but some of their results are directly comparable.

No single measure will substantially mitigate the impacts of farming activities on the environment. Improvements in freshwater quality will instead be achieved by the implementation of a range of measures. These include: stock exclusion from streams and wetlands, controlling hill-country erosion, improved stock, effluent and fertiliser management, and, where deemed necessary, the introduction of farm infrastructure that allows for soil protection and the capture of animal excreta during periods when the risk of runoff is relatively high. The greatest GHG emission benefits from the freshwater reforms are likely to come from activities on sheep and beef farms, especially those located in hill country.

Jaffe, Adam. 2017. *"Barriers to Adoption of No-Cost Options for Mitigation of Agricultural Emissions: A Typology."* Motu Note 24. Wellington: Motu Economic and Public Policy Research.

This typology is intended as background for assessing the existence and significance of barriers to adoption of no-cost mitigation options in agriculture. It is based on a literature review, including the extensive literature on barriers to technology adoption more generally.

Its purpose is to identify and categorise possible or potential barriers that might exist, based either on theoretical considerations or analogies to barriers observed in other contexts. Possible barriers are included here whether or not we have identified any evidence of their existence in agriculture, in order to describe the potential universe of barriers that might be investigated in future research.

Timar, Levente. 2016. *"Does Money Grow on Trees? Mitigation under Climate Policy in a Heterogeneous Sheep-Beef Sector."* Motu Working Paper 16-09. Wellington: Motu Economic and Public Policy Research.

Around a third of the country's land area is devoted to sheep-beef farming, and much of this pastoral land could be suitable for reforestation. This paper uses simulations from the Land Use in Rural New Zealand (LURNZ) model to consider mitigation for different classes of sheep-beef farms under climate policy. Farmers in the model can respond to carbon prices by abandoning or afforesting marginal land.

In assessing carbon credits against liabilities, the paper considers only the income a farmer would be able to get with certainty without taking a carbon price risk. Farmers in intensive farm classes tend to bear the costs of emissions because their opportunity cost of exiting pastoral agriculture is high. The dominant land-use response in more extensive systems is land abandonment or afforestation, depending on location.

Less profitable farm classes generally face higher average liabilities in relation to profits, both before and after the land-use response. Results indicate that farmers in North Island hill country may benefit most from afforestation opportunities. In this farm class, income from rewards could offset over half of farmers' emission liabilities.

Ruminating on methane. Land use will change and someone's gotta pay.

Kerr, Suzi. 2017. *"The Role of Land-Use Change."* Presentation to NZAGRC Meeting, Palmerston North

Even if livestock agriculture could technically be achieved with extremely low emissions, and currently it cannot, other land uses may be more profitable for New Zealand farmers once the costs of greenhouse gases and excessive nutrient run-off are fully accounted for. These could be extension of widely used existing land uses - forestry, native regeneration or existing fruit or arable crops - or currently untried or experimental uses.

This talk briefly reviews some evidence on the potential for more forests - including in response to the Freshwater Reforms - and then discusses why we might want to go beyond existing alternatives and what would be needed to facilitate more diverse land use.

Motu receives core grant funding for this programme from the Aotearoa Foundation. Other funding contributors to various programme activities include Air New Zealand, the British High Commission, the Korean Forest Service, Meridian Energy, Ministry for the Environment, Ministry for Primary Industries, New Zealand Productivity Commission, Parliamentary Commissioner for the Environment, Te Pūnaha Matatini, Tindall Foundation and Z Energy.

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