INTERNATIONAL AGRICULTURAL MITIGATION RESEARCH: IMPACTS & VALUE OF TWO SLMACC PROJECTS

David A Fleming and Kate Preston

Motu Economic and Public Policy Research,
david.fleming@motu.org.nz and kate.preston@motu.org.nz

SUMMARY HAIKU

GHG research
has significant impact.
Public funds do help.

INTRODUCTION

In this paper, we provide a broader analysis of the impacts and value from agricultural mitigation research in New Zealand, with a focus on two particular Sustainable Land Management and Climate Change (SLMACC) research projects funded by the Ministry for Primary Industries (MPI).

This study has two main objectives, which are to:

- Provide a general analysis of the scientific trends in international agricultural mitigation research and evaluate New Zealand in comparison to the rest of the world in terms of number of scientific publications and citations; and
- Evaluate the impact and value generated by publicly-funded agricultural mitigation research projects in New Zealand – specifically, two research projects funded by SLMACC.

METHODOLOGY

Benefits arising from public research can be difficult to quantify using cost-benefit analysis or similar techniques. This is due to the complications of long and variable lags between innovation and goods reaching the market, and the complexity of causal chains from research to benefits. In addition, the aim of publicly funded research is generally to provide insight or solve issues that in many cases have economic values that are difficult to monetise, or that simply cannot be monetized (e.g. the value of existence of a species). This kind of significant benefit cannot be incorporated directly into a narrow economic cost-benefit analysis.

This research directly complements the work done by van der Weerden et al. (2018), in providing a broader review of all agricultural mitigation projects funded by SLMACC over the last ten years.

To address the first objective we use data from Scopus (one of the largest repositories of scientific papers in the world) to analyse trends in publications and citations from the field of agricultural mitigation across countries and over time. To explore the second objective, we also use data generated from Scopus, as well as from various research reports and papers. In addition, we incorporate insights retrieved from direct communication with involved researchers and stakeholders.

This review was funded by the SLMACC Programme from the Ministry of Primary Industries for financial support. Special thanks to Tony van der Weerden and Arjan Jonker who were our collaborators in the overall review of all the SLMACC mitigation projects.

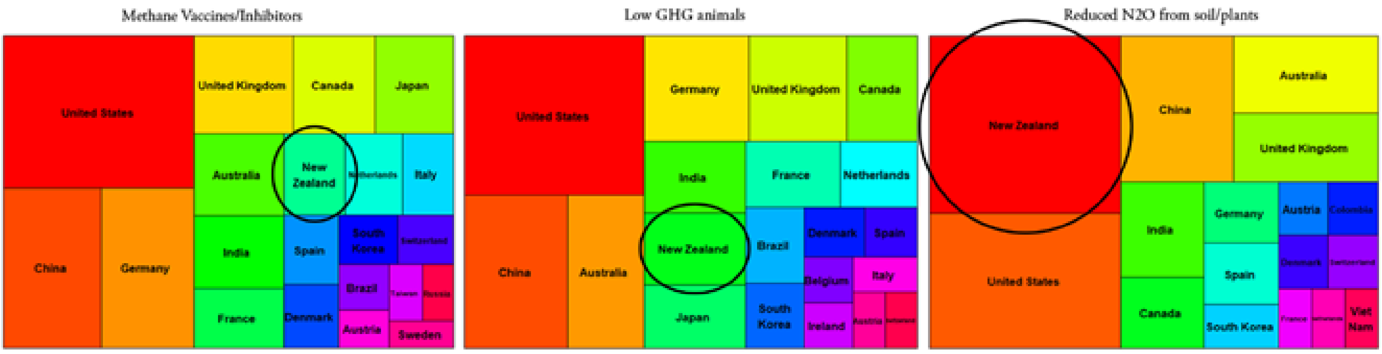
NEW ZEALAND IMPACT ON INTERNATIONAL SCIENTIFIC OUTPUTS AND CITATIONS

For objective one, we subdivided the agricultural mitigation science into five main research clusters:

1. Methane (CH_4) inhibitors/vaccine,
2. Low GHG animals,
3. Low GHG feed,
4. Reduced Nitrous Oxide (N_2O) from soil/plants and
5. Management interventions.

We performed a search in Scopus using key words provided by experts in the area for each cluster. These data show countries with the largest scientific influence in terms of publications around the world. New Zealand appears in the top ten countries across all five research clusters. This leading presence is especially remarkable for the cluster “Reduced N_2O from soil/plants”, where New Zealand is the top country in terms of scientific outputs. The following figure shows findings from three clusters.

Figure 1: Country relevance by cluster



We found New Zealand research organisations among the most influential worldwide in all five clusters. AgResearch produced the largest quantity of research outputs in three out of the five clusters, while Landcare Research, Dairy NZ, Lincoln University and the University of Waikato are also listed within the top 20 most relevant research organisations for the cluster “Reduced N_2O from soil/plants”.

We contrast New Zealand’s scientific impact with Australia and the rest of the world. In general New Zealand’s impact (in the form of citations made to papers published in scientific journals) is increasing over time, with the cluster “Reduced N_2O from soil/plants” having a notably higher citation rate than Australia and the rest of the world.

RESULTS FROM VALUE AND IMPACT ANALYSIS OF TWO SLMACC PROJECTS

We performed impacts and value analysis of one “Low GHG animals” project and one “Management Intervention” project:

1. Sheep, cattle, and methane predictors – MPI code: METH0901
2. Farm management and GHG for pastoral sector (also named: Systems analysis to quantify the role of farm management in GHG emissions and sinks for pastoral sector) – MPI code: C10X0902

In simple terms, Project 1 focused on advanced evidence to identify a trait in ruminants (especially sheep) to naturally reduce the amount of methane they generate; while Project 2 created and improved different models to better predict and understand the link of several farming practices to GHG emissions.

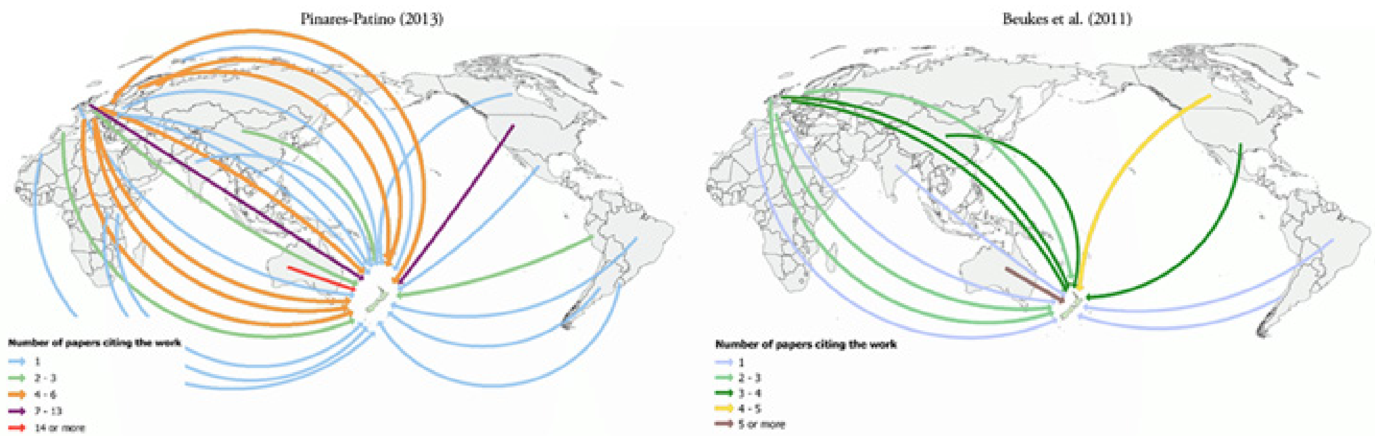
Impact Analysis

We looked at impacts on science and on stakeholders. In science, impact is generally related to the influence generated by a project’s generated knowledge. This is commonly assessed by its number of publications, the quality of the journal of publication and the number (and significance) of citations accrued in a particular period. On the other hand, impact on stakeholders relates to the changes that the research project produced in next or end users. Thus, if research output generates change in practices or influences decision-making, then stakeholder impact is generated.

Project 1 produced a peer-reviewed paper that accrued a very high number of citations (Pinares-Patino, 2013). After standardising the paper’s citations by discipline, publication year and publication type (using the Scopus Field Weighted Citation Index), the citation impact of Pinares-Patino (2013) was 11 times higher than the average paper worldwide. This value shows a very high scientific impact produced by this paper, which received interest from organisations across 29 different countries.

Project 2 produced six peer-reviewed papers acknowledging SLMACC as the funding source. All were published in high-impact journals. Of these papers, Beukes et al. (2011) received the largest number of citations. This paper’s Field Weighted Citation Index reveals a citation impact four times higher than the average paper worldwide. This also shows a high impact, with citations from 15 different countries.

Figure 2: Where Citing Authors Come From



Note: Colours show number of citations with red and purple arrows showing the largest numbers and light blue the lowest.

With respect to stakeholder impact, it is important to differentiate the impact generated for end-users (farmers) as well as for researchers and organisations.

Researcher and organisation impact: Both projects contributed to further development of research. Project 1 provided researchers with basic key information for selecting low emission animals, generating important data and helping this area of research get close to developing a formal mitigation option in the form of low emission sheep. The modelling and results of Project 2 have provided a better understanding for addressing GHG emissions from available farm practices (management interventions).

Farmer impacts: For both projects, the impact on end users at this point in time is still negligible. This is mainly because farmers lack incentives to address GHG emissions on-farm. Low emission sheep are close to becoming a formal tool to reduce GHG emissions, and the farming practices studied in Project 2 can be enhanced to reduce emissions on-farm. However, the extent of the adoption of this research in the short-to-medium term is still unclear given New Zealand's uncertain policy framework in regards to curbing biological emissions.

Value analysis

We estimate the potential economic use value of the realisation of mitigation option/practices the two SLMACC projects helped to build, assuming that a future carbon price is imposed on agricultural emissions. We base our estimates on recent modelling conducted in New Zealand of low emitting animals (e.g. selective breeding, a mitigation option related to Project 1); and reduced nitrogen use and dairy de-intensification, practices related to Project 2). These are modelled and described in Reisinger and Clark (2016) and in recent NZAGRC modelling (Reisinger et al. (2018).

Assuming emission prices are \$31.17 per ton of CO_2eq in 2030 and \$44.23 in 2050, for the selective breeding mooted in Project 1, we estimate potential savings for farmers using low-emission sheep in their flock between 2030 and 2050 of between:

- \$159 and \$462 million nationally, or
- \$561 - \$1,630 per farm per year (assuming no change in the number of farms), or
- \$5.70 - \$19.30 per sheep.

If the price on emissions increases to \$100 per ton of CO_2eq by 2050, the savings would be between \$13 and \$44 per sheep.

If expanded to the beef and dairy sectors, the total annual savings to New Zealand by 2050 could be four to seven times greater than the savings considering sheep only.

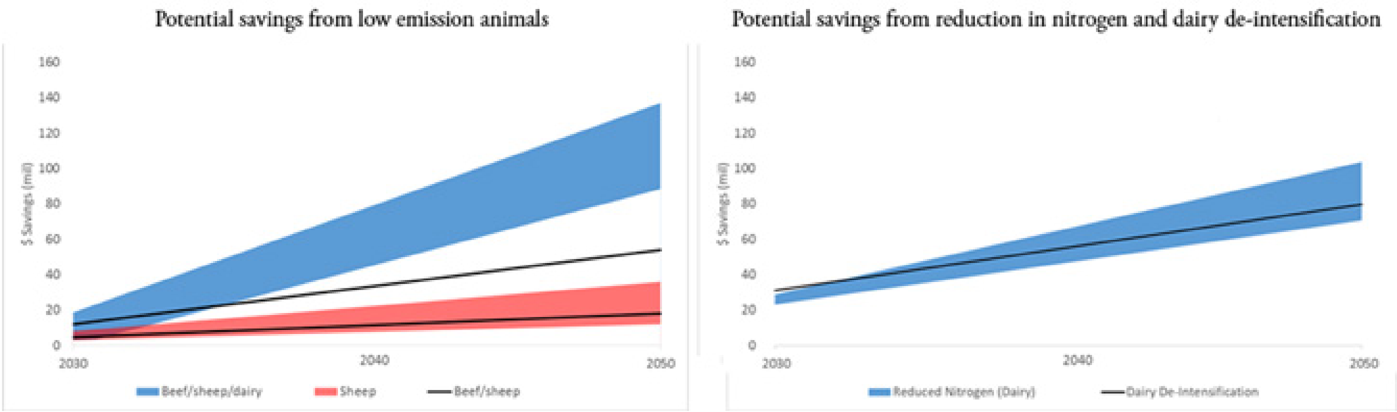
Assuming similar emission price trends, for Project 2, we estimate potential cumulative savings from 2030 to 2050 for dairy de-intensification could be between:

- \$984 and \$1,389 million for dairy de-intensification nationally, or
- \$4,559 per farm (assuming no change in the number of farms), or
- \$127 - 151 per cow (considering projections in the number of dairy cows to 2050).

For reduction of nitrogen inputs we estimate potential cumulative savings from 2030 to 2050 could be

- \$1,163 million nationally, or
- \$3,858 - \$5,446 per farm per year (assuming no change in the number of farms), or
- \$108 - 180 per cow (considering projections in the number of dairy cows to 2050).

Figure 3: Potential savings between 2030 and 2050 from mitigation related technologies



Note: Value estimates are obtained by considering the modelling output for the "Low GHG animals (selective breeding)" and "Reduced nitrogen and dairy de-intensification" options as shown in the reports of Reisinger and Clark (2016) and Reisinger et al. (2018).

Looking at other environmental values, the ranges of avoided annual emissions by 2050 are predicted to be around:

- 273 - 3,100 kt CO_2-eq for Project 1, and
- 3,393 - 3,140 kt CO_2-eq, for Project 2.

Although these amounts are a tiny fraction of all New Zealand emissions, the difference could be more substantial if New Zealand research was taken up by farmers internationally. In an ideal scenario, where the world fully adopts low emission sheep, the globe could experience a potential reduction of up to 425 billion tonnes of CO_2eq in a year. This is around five times all New Zealand's gross CO_2eq emissions in 2013.

The development of both low emission animals and the linkages of management practices to lower emissions are the result of the coordinated efforts of several organisations and research projects. This means that it is not possible to attribute the whole estimated economic and environmental values to SLMACC. It can be argued, however, that an important part of the potential values shown here are now envisioned partially because of the contribution from SLMACC's programme.

CONCLUSION

Evaluating the benefits of publicly funded research is always a challenging task, because of the long and uncertain lags between research and impact, the conditionality of impact on external factors, the difficulty of quantifying non-economic benefits, and the difficulty of knowing how possible impacts differ from the counterfactual of no public research. The current analysis faces all these challenges, and so we cannot produce air-tight quantification of the benefits of SLMACC research.

We have, however, demonstrated that the key building blocks of significant impact have been obtained.

1. It is clear that public funding has contributed importantly to New Zealand positioning itself as a leading global contributor to agricultural mitigation research. While this is not sufficient to prove significant broader benefits, it is certainly a necessary condition and a major accomplishment in and of itself.
2. The prominence of the research, combined with the low likelihood of research occurring on this scale sans public support, suggests strongly that the results would not have been obtained without public funding.
3. The realization of benefits will depend on the evolution of farming practices and climate change policy settings. However, the advances in genetic markers for low CH_4 animals and identification of emission-reducing management practices have the potential for significant GHG emission reductions. At likely carbon pricing levels the value of these reductions would be in the hundreds of millions of dollars.

The use of on-farm mitigation options will generate important economic savings for the agricultural sector and reduce the carbon footprint of farms. These results are conditional on several factors such as future policy implementation, adoption rates, and the practical availability of mitigation options and practices for different farm landscapes. However, the impacts, economic and environmental values attached to mitigation research cannot be overlooked. They provide important insights to the benefits of public investment for the development of a more sustainable agricultural system for New Zealand.

FOR MORE ON THE NEW ZEALAND EMISSIONS TRADING SCHEME,

HTTP://MOTU.NZ OR CALL US ON 04 939 4250