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A Review of the SLMACC Technology Transfer Projects

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REPORT FOR THE MINISTRY FOR PRIMARY INDUSTRIES

CLIENT REPORT NUMBER: RE450/2018/035

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1. Executive Summary

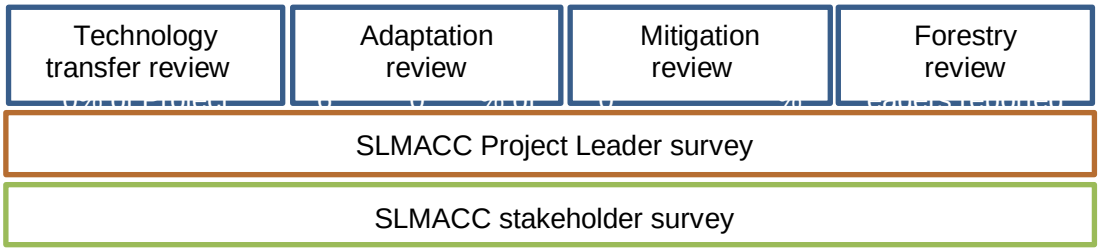
"Farmers can't get all the information themselves, technology transfer is vital"

New Zealand pork farmer (Barugh, 2013, p. 6)

Background

The Sustainable Land Management and Climate Change (SLMACC) research programme was established in 2007, and is administered by the Ministry for Primary Industries. The fund aims to address the impacts of - and adaptation to - climate change, mitigation of agricultural greenhouse gases and improvements of forest sinks. This is one of four primary reports for the SLMACC Review, intended to be read in conjunction with the other three reports, and the survey results report:

1) Adaptation Review (Cradock-Henry, Flood, Buelow, Blackett & Wreford, 2018)
2) Mitigation Review (van der Weerden, Jonker, Fleming, Prescott, de Klein & Pacheco, 2018)
3) Forestry Review (Dunningham, Grant & Wreford, 2018)
4) Project Leader and stakeholder survey results (Payne, Chen, Turner & Percy, 2018)



This report forms part of the review of technology transfer under the SLMACC fund, which has considered the following two aspects:

1. A review of the ten technology transfer projects funded by SLMACC, e.g. the 'Climate Cloud' and 'Train the Trainer'; and
2. The technology transfer activities included in the broader set of SLMACC research projects, i.e. mitigation, adaptation and forestry.

This report presents the findings of the first aspect of the review (the ten technology transfer projects), however, many of the recommendations also apply to technology transfer in the broader set of SLMACC research projects. This review adopted mixed-methodologies, including:

- An in-depth review of ten SLMACC technology transfer projects, analysed using an evaluative criteria rubric;
- Interviews with the project leaders and stakeholders of these ten technology transfer projects;
- A survey of 37 SLMACC project leaders;
- A survey of 148 SLMACC research stakeholders;
- A cost-benefit-analysis of two SLMACC technology transfer projects (Climate Cloud and Train the Trainer).

This report presents the findings of the project reviews, and interviews of project leaders and stakeholders of the ten technology transfer projects. Separate reports present the findings of the surveys[1] and economic impact assessments[2].

Key findings

An evaluative criteria rubric was used to assess the projects against the key aims of the SLMACC fund as well as the outcomes and desired impacts articulated in a programme logic for the SLMACC fund. Overall, the SLMACC technology transfer projects were evaluated as fulfilling the criteria in the rubric to a moderate extent for influence on science, engagement and networks, and promoting learning, awareness and knowledge exchange. Science capacity and capability building was fulfilled to a low extent, while research was found to be highly user-friendly for intended end users. It was not possible to rate the extent to which the technology transfer projects achieved influence and impact, as there was insufficient evidence to rate these criteria.

Evaluative criteria	**Overall rating**
Science capacity and capability enhancement	Low degree
Influence on science	Moderate degree
Engagement and networks	Moderate degree
Learning, awareness and knowledge exchange among end users	Moderate degree
Usability of research for end users	High degree
Influence on stakeholders and impact for NZ	Insufficient evidence

Rating criteria

1	**2**	**3**	**IE**	**E**	**N/A**
Low degree (Never or seldom with clear weakness)	Moderate degree **(Mostly, or sometimes with few exceptions)**	High degree **(Always to almost always)**	Insufficient evidence	Emergent	Not applicable **(e.g. not asked for by SLMACC)**

Outcomes

Overall, results indicated that the ten SLMACC-funded technology transfer projects created effective, accessible resources and events, most of which utilised systems thinking approaches. A majority also practiced some degree of action learning; changing the project over time to improve project impacts. Projects that utilised best practice approaches, such as participatory engagement and embedded action learning, created resources and events that were more fit-for-purpose and met the needs of next and end users[3] to a greater extent than projects that did not use these approaches. Projects that utilised best practice approaches also tended to display stronger

[1] (Payne, Chen, Turner & Percy, 2018).
[2] (Burggraaf, Yang, Turner, Percy & Payne, 2017).
[3] See page 6 for a definition of these terms.

evidence of promoting knowledge exchange, and increasing awareness and knowledge in the topic area. For those projects that incorporated monitoring and evaluation, it was easier to evaluate and provide evidence of outcomes, and longer term impacts.

The technology transfer projects built a limited amount of capacity or capability amongst the project teams, including for early career researchers. This appeared to be because the skills required for the projects were relatively specialised (knowledge specialists or technology transfer specialists), so tended to utilise existing skills. The projects did not tend to generate strong, diverse collaborative networks between stakeholders, researchers and end users. This appeared to be due to the distinct purpose of the projects, which focused predominantly on the delivery of one-off events, or creation of one-off resources. The two case studies of economic impact (Climate Cloud and Train the Trainer) indicated a large positive economic benefit from the SLMACC funding invested in these projects (Burggraaf, Wang, Turner, Percy & Payne, 2017).

Strengths

Four key strengths of the technology transfer projects funded through SLMACC were identified, from the review of key project outputs using the evaluative criteria rubric, and interviews with project leaders and stakeholders. These were:

1) Sophisticated science and professional expertise, resulting in high quality resources and events;
2) Strategic marketing and presentation of resources and events, to improve reception and uptake by farmers;
3) Well-considered event organisation in terms of timing, logistics and delivery; and
4) Creation of fit-for-purpose resources, to be accessible, specific and useful.

These strengths suggest that the project teams of the technology transfer projects are highly experienced and have been conscientious in their development and creation of the resources and events.

Barriers and enablers

This review also highlighted a series of lessons learned, largely identified by project leaders in key project outputs. These factors were classified as ‘lessons’ if they were mentioned across multiple projects. These lessons were not necessarily ‘issues’ in the projects, but were identified as critical barriers or enablers, contributing to ongoing successful technology transfer. Practical lessons to consider in future work include:

- Timing events to maximise attendance (time of year, season, day, in addition timing in relation to the financial, political, social and cultural climate)
- Gaining stakeholder buy-in (e.g. key players in the sector)
- Publicising events well

- Farmer, forester and grower need for practical, realistic and immediate take-home options to implement on their farm, orchard or forest (i.e. mitigation or adaptation options)

There were three further key gaps or needs identified that were considered necessary to address, to improve the development and delivery of technology transfer projects funded under SLMACC. These included a need for:

- **Embedded monitoring and evaluation** in projects' funding contracts, design and activities, to enable action learning (reflecting on actions and adapting them to improve outcomes, as the project progresses).
- **A need for co-design of the resources and events with next-users** (e.g. industry bodies) or end-users (e.g. farmers, foresters and growers) and stakeholders, where appropriate. This would increase the likelihood that the resources and events are fit-for-purpose and meet the needs of the target next- or end-users and stakeholders.
- **A need for use of participatory methods** in the design, delivery *and* uptake of technology transfer events, where appropriate.

The technology transfer projects demonstrated a consistent issue with gaining adequate farmer, grower and forester attendance at events. In some instances, attendance was low despite widespread advertising, well-organised events, and the delivery of highly relevant material to attendees.

Science gaps in technology transfer

The review also identified gaps in the practice of and research on technology transfer in relation to the SLMACC fund specifically, and with regards to climate change adaptation and mitigation in New Zealand more generally. These recommendations are targeted at MPI, but also more broadly at all stakeholders within the technology transfer system.

Policy recommendations

1. **Build in monitoring and evaluation (M&E) at the project level**. Ongoing monitoring is needed to conduct an effective and efficient evaluation (Social Policy Evaluation and Research Unit, 2017).
2. **Shift the focus of SLMACC Technology Transfer Programme to extension** (rather than technology transfer), and encourage use of fit-for-purpose extension approaches based on the MPI extension framework.
3. There needs to be a **shift now toward designing programmes of activities beyond providing information, to addressing the other three drivers of behaviour change** (attitudes, skills and aspirations).
4. **Ensure technology transfer activities, approach and method are fit-for-purpose**. Start with the results you want, the audience it is targeted at, and work backwards to design the delivery activity.

5. **Build in principles of success** that have been demonstrated to lead to impact (not only the technology transfer projects) (Boyce et al., 2017; Turner et al., 2017).
6. **Ensure there is a legacy organisation involved in the project** that will have an on-going role once the project funding stops, to ensure and measure on-going impact.

Research recommendations

1. Review current information and survey farmers, growers and rural professionals to **measure the current extent of**:
    - Awareness of region-specific climate change impacts at the farm-level;
    - Attitudes toward climate change adaptation;
    - Awareness of mitigation and adaptation options available and being considered;
    - Farmer sources of knowledge in relation to mitigation and adaptation options;
    - Farmer knowledge, skill and infrastructure needs to support uptake of mitigation and adaptation options.

    This information is needed to inform the extension approach, to support adoption of climate change mitigation and adaptation practices.
2. **Analyse the climate change innovation system**. Such an analysis would help to determine if or where the right knowledge is not reaching key knowledge users, to maximise uptake of innovation. This analysis could be undertaken using social network analysis. It could ask, for example, who are the key stakeholders (e.g. farmers, growers, processors, policy makers, advisors, scientists), how do they interact, and how is knowledge exchanged among stakeholders within the system?
3. **The language around technology transfer needs to shift** to reflect knowledge exchange beyond the implied linear technology transfer, such as a two–way exchange that includes stakeholder knowledge and engagement. It is recommended that MPI replaces the use of 'technology transfer' as an all-encompassing term, and align language and concepts with the MPI extension framework.
4. Investigate, test and evaluate **new approaches** to engage the wider public, including schools, in the generation and exchange of knowledge around climate change – for example through citizen science activities – to increase awareness and behaviour change.

This information will be useful for the SLMACC programme, industry bodies and rural professionals to identify strategic priorities for the types of information provided in extension activities, as well as science knowledge gaps that need to be addressed to support farmer uptake of mitigation and adaptation options.

Summary

In summary, the technology transfer projects funded by SLMACC:

- Demonstrated effectiveness in the ‘who’ (utilising expert knowledge creators and transfer agents) and the ‘what’ (developing fit-for-purpose content) of technology transfer;
- Need to ensure the ‘how’ of technology transfer is fit-for-purpose (publicising events, recruiting attendees, utilising co-design and participatory approaches and appropriate strategies);
- Need to ensure a shift in focus of extension activities, from relying on technology transfer approaches to raise awareness and presenting information, to providing options for other approaches, such as adoption strategies. These could focus on behaviour change that is practical, realistic and provides immediate take-home options, as farmers that attended events are ready for this;
- Urgently need to systematically embed monitoring and evaluation, to allow for action learning within projects, to ensure progress toward desired outcomes, and provide evidence of overall SLMACC programme outcomes and impacts.

2. Introduction

The purpose of this project was to conduct a review of the technology transfer projects delivered to date under the Sustainable Land Management and Climate Change (SLMACC) Programme. A total of 166 projects have been funded through the SLMACC Programme to date (2007-2017); this included 10 technology transfer projects, targeted predominantly at farmers, growers, foresters and rural professionals. This technology transfer review was part of a wider review across all SLMACC projects (SLMACC Review), including forestry, mitigation and adaptation. As the technology transfer review group were responsible for coordinating the wider review, the findings from a broader survey of SLMACC Project Leaders and SLMACC stakeholders are included as a supplementary report. These finding provide some insight into the extent of research uptake within the forestry, mitigation and adaption projects.

SLMACC

The Sustainable Land Management and Climate Change (SLMACC) Research Programme was established in 2007 and is administered by the Ministry for Primary Industries (MPI). The fund aims to address climate change for the land-based sectors, under the paradigm of sustainable land management (Ministry for Primary Industries, 2013). This includes the impacts of, and adaptation to, climate change; mitigation of agricultural greenhouse gas emissions, and improvements of forest carbon sinks. The fund also addresses cross cutting topics such as modelling, social and economic issues, the development of decision support tools and technology transfer (Ministry for Primary Industries, 2013).

The SLMACC fund aims to contribute to the achievement of New Zealand's broader climate change targets, through funding research to understand the impacts of climate change, thereby improving risk management and increasing the resilience of the primary sector to climate change (Ministry of Agriculture and Forestry (precursor to MPI), 2011). This is being achieved by equipping land managers and their advisors with both information, and technologies, to mitigate and adapt to climate change. These aims and intended outcomes of the SLMACC fund are summarised in pictorial format in the programme logic model featured in the appendix of this report.

An increasing focus is being placed on elucidating and measuring the use and impact of public good research, both in New Zealand and internationally, making this review a timely and important reflection on the use and impact of SLMACC Research (Bozeman, Rimes & Youtie, 2015; Ministry for Primary Industries, 2012; Ministry of Business, Innovation and Employment, 2017).

Technology transfer (or extension)

In the context of this review, technology transfer is defined as the creation, application and subsequent supply of knowledge and technology to next- and/or end-users (Ministry for Primary Industries, 2012). For the purpose of this review, the following definitions of these terms were used:

Next-users: The intermediary stakeholder who intends to use the research or technology indirectly, such as for further extension or to inform their work e.g. the rural professional who then utilises the knowledge to educate farmers, or the policy advisor who reads the knowledge to inform the writing of policy.

End-users: The stakeholder whom the research or technology is ultimately intended for, and who will likely be a direct user e.g. the farmer, who utilises the knowledge to change on-farm practice.

Stakeholders: Any relevant person along the value chain who the research or technology is relevant to e.g. the rural advisor, farmers, growers or foresters, central or local government, etc.

Over the last decade, the model of technology transfer has evolved, from technology transfer entailing linear transfer from knowledge creators to end-users, to a range of approaches through to a consultative or co-innovative, tailored and networked approach to extension (Bozeman et al., 2015; Klerkx et al., 2012; Röling, 2009).

MPI's extension framework (Ministry for Primary Industries, 2015) shows technology transfer as being one of four approaches to achieving behaviour change and impact on a continuum of approaches. These include, adoption, adaption and co-innovation (Figure 1). The approach taken depends on a number of factors, including the complexity of the issue and the level of engagement, support and resourcing that is available or desirable (Casey et al., 2015; Payne et al., 2016), and in many cases aspects of all four approaches are appropriate. The key point is that while technology transfer is appropriate in some situations, it is not a one-size-fits-all method. As recognised in the MPI extension framework (Ministry for Primary Industries, 2015) ideally technology transfer includes an assessment of next- or end-user needs, and an appropriate level of co-design with these next- or end-users, and relevant stakeholders.

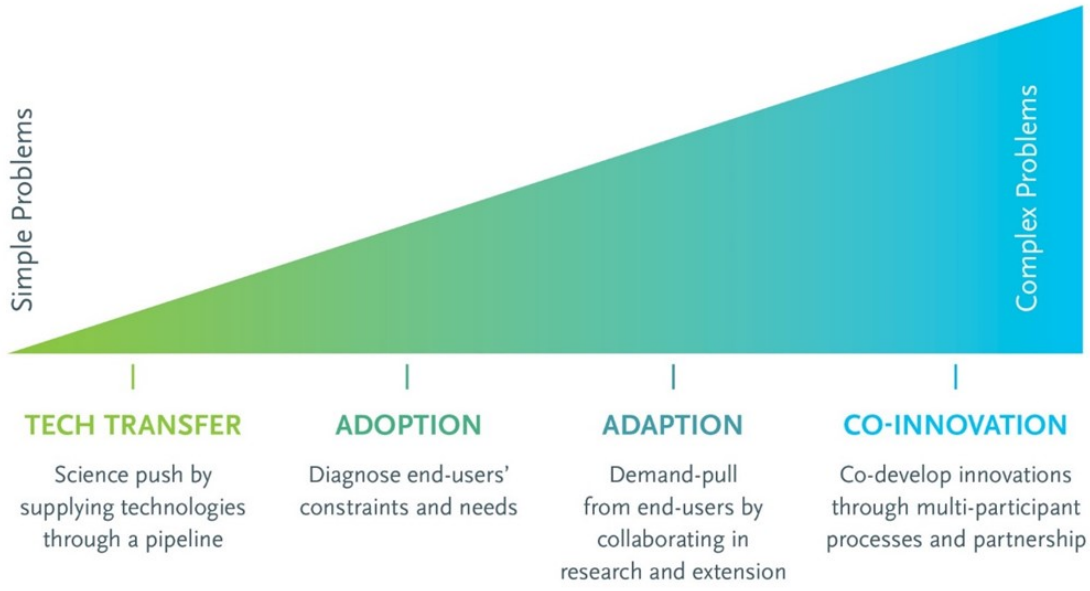


Figure 1: Fit-for-purpose approaches to extension to achieve research uptake, behaviour change and impact. Source: Ministry for Primary Industries (2015)

Despite these shifts in understanding, in New Zealand fit-for-purpose approaches to the extension of research to achieve uptake and practice change are not yet wide-spread (Ministry for Primary Industries, 2012; Turner et al., 2013). This review aims to contribute to addressing this issue.

Technology Transfer Programme

The SLMACC Technology Transfer Programme represents a small component of the broader SLMACC fund, with approximately eight percent of SLMACC funded projects being technology transfer focused. Projects funded under the Technology Transfer Programme can be categorised into three main types:

1) **Demonstration:** Technology transfer events targeted at specific farmer, grower and forester groups within the primary sector, including sheep and beef, forestry, arable and vegetable, kiwifruit and pork. These events provided farmers and growers with hands-on resources to increase awareness of climate change, accurately assess associated risks, provide practical on-farm mitigation options, and increase each industry's resilience.
2) **Resources:** Resources developed for the Demonstration Project events and more broadly, largely targeted at specific industries. These include fact sheets, technical reports, journal articles, video or audio recordings, and presentations. These resources were developed by knowledge specialists in each field, including scientists and extension agents from a large range of organisations and disciplines.
3) **Training:** Training events and resources provided to rural professionals and farm advisors, as intermediaries who can relay knowledge to farmers, foresters and growers. This component was implemented through one large project, called 'Train the Trainer'.

Report structure

This report provides a one-page summary and analysis of each of the ten Technology Transfer Projects funded to date, and scores each project using an evaluative criteria rubric (explained below). Projects in the completed rubric are anonymised, as the purpose is not to make judgements about individual projects, but to make observations about the patterns between the rubric criteria and across the projects. For example, does the presence of one criteria tend to coincide with the presence of another? Examining these patterns will allow recommendations to be made about where resources are best focused for increasing the impact of future technology transfer activities. The strengths and weaknesses of the projects are then identified, followed by lessons learned and areas for future improvements. Finally, the science gaps in technology transfer are identified, and recommendations are suggested.

3. Method and key evaluation questions

To provide ease and consistency of information to MPI across each of the four Review Projects, each review group has been asked to report their findings using a common report structure. This structure is based on four key evaluation questions:

1. **Outcomes**: To what extent have the desired outcomes been achieved from SLMACC projects to date?
2. **Gaps analysis**: What do we know, not know, and need to know about [climate change topics] in New Zealand's primary industries? What are the knowledge gaps that need to be met?
3. **Barriers and enablers**: What are the key barriers and enablers to stakeholders adopting SLMACC findings and recommendations?
4. **Apply learnings**: What actions are recommended to maximise the future value and usefulness of SLMACC funded research for: i) MPI SLMACC and related funds' design and priorities; ii) Government policy and reporting; iii) Science research, and iv) Primary industry direction and behaviour change.

An agricultural innovation systems (AIS) perspective (lens) was taken to the design and implementation of the evaluation methodology in order to take a wider systems view of how SLMACC funded research contributes to climate change mitigation and adaptation outcomes in New Zealand. This wider systems view is needed as responses to complex problems, such as climate change, involve multiple interacting drivers, conflicting goals, trade-offs, feedbacks, non-linear responses and potentially unintended consequences (Schut et al., 2014a,b; Spielman, Ekboir & Davis, 2009). Creating new knowledge, and applying it to address and respond to climate change, may need more than transfer of knowledge from "experts" to "end-users" (Hall et al., 2006; Hueske, Endrikat & Guenther, 2014; Pant, 2012; Röling, 2009).

In the past the technology (or other type of solution) alone is described as the "innovation" and seen as a finished product (Röling, 2009). In the AIS perspective "innovation" involves not only new knowledge from research, but also existing knowledge from many stakeholders, along with complementary changes in technology, markets, regulations and other practices that support the commercialisation and implementation of the knowledge to address and respond to climate change (Röling, 2009; Klerkx et al., 2012; Leeuwis, 2008). An AIS perspective has previously been used to identify opportunities to accelerate the development and implementation of sustainability technologies (Hellsmark et al., 2016), to increase the implementation of farm plans (Rijswijk & Percy, 2015), and for the success of innovation in New Zealand's primary sectors (Turner et al., 2016).

The AIS perspective was implemented in this review through participatory development of programme logic models (Botha et al., 2017). Taking a participatory approach enabled us to co-develop with MPI, science leaders and stakeholders, a wide systems (AIS) understanding of how SLMACC projects have, and could continue to contribute to, climate change mitigation and adaptation in New Zealand (Campbell et al., 2015). As such, the first step in conducting this evaluative review was to co-develop a programme logic model for the SLMACC fund. An evaluative criteria rubric was then created, to operationalise and further describe the key outcomes identified in the logic model. Each of the SLMACC review projects then utilised project-specific methodologies to answer these questions. For the technology transfer review, analyses were underpinned by the activities outlined in Table 1, including a review of project outputs, and phone interviews with project leaders and stakeholders of the research.

Table 1. Key activities undertaken in the technology transfer and wider SLMACC review.

Activity	Purpose	Stakeholders involved
Scoping workshop	To clarify the evaluation work completed to date, and the scope of the review. This allowed all participants to agree on framework, outcomes and criteria for review and analysis	MPI (including evaluation expert), forestry review group (Scion), adaptation review group (Landcare, NIWA), mitigation review group (AgResearch, Motu), technology transfer review group (AgResearch).
Planning workshop	To co-create a: -Programme logic model. -Evaluative criteria rubric. -Stakeholder analysis. This allowed a systems perspective and different viewpoints to be incorporated into the evaluation design.	MPI (including evaluation expert), forestry, adaptation, mitigation and technology transfer review groups.
Project leader survey	To collect evidence to assess against the evaluative criteria rubric (capacity/capability building, stakeholder engagement, knowledge exchange, uptake and use of the research, and impacts). This was to achieve a generic analysis across all SLMACC projects, to understand the impacts and outcomes of the technology transfer activities and other evaluative evidence not obtainable through review of project outputs.	Survey designed by the technology transfer review group, reviewed by MPI (including evaluation expert), forestry, adaptation and mitigation review groups.
Stakeholder survey	To assess awareness and use of SLMACC research by intended end-users, including government (local and central), industry, farmers, foresters, growers and researchers. Of those who have used SLMACC research, assess access methods, perceived usefulness, relevance, and quality, and research gaps. This was to understand the impacts and outcomes of the technology transfer activities and other evaluative criteria not obtainable through review of project outputs.	Survey designed by the technology transfer review group, reviewed by MPI (including evaluation expert), forestry, adaptation and mitigation review groups.
Evaluation of project outputs	To assess technology transfer projects against the evaluative criteria rubric through key project outputs and resources, provided by MPI.	Technology transfer review group

Phone interviews with project leaders and stakeholders	To complete the assessment of technology transfer projects, where evaluative evidence was not obtainable through a review of project outputs. This included capacity and capability building, uptake and use of research, direct and indirect impacts of the research.	Technology transfer review group
Cost benefit analysis of the impact of two case study projects	To provide an estimate of the economic impact realised from SLMACC investment in these projects. This allowed a more in-depth evaluation of impact from a sample of two projects.	Technology transfer review group
Forestry review	To provide additional information synthesised from previous studies to provide evidence of uptake of SLMACC research and activities in the forestry sector.	Scion (subcontract to technology transfer review group)
Sense-making workshop	To present and discuss findings across the review projects, examine gaps and opportunities, develop next steps.	MPI, forestry, adaptation, mitigation and technology transfer review groups.

The relevance and use of each of these tools and methods is briefly described here, followed by a detailed description of the method for the technology transfer review in particular.

Programme logic model

Programme logic models are critical underpinning tools used in monitoring and evaluation, which describe the pathway a programme plans to take to achieve desired outcomes and impacts (Kellogg, 2004; Social Policy Evaluation and Research Unit, 2017). Desired outputs are identified, followed by the short, medium and long term outcomes (Social Policy Evaluation and Research Unit, 2017). Explicitly identifying and capturing these critical components is a process of explaining the high-level logic of how change will happen through the programme. This enables identification of key criteria that track or measure progress toward achieving the outcomes, which can be attributed to the programme of work (Social Policy Evaluation and Research Unit, 2017). Finally, a programme logic model also identifies assumptions and external factors that may influence the programme achieving the intended outcomes, such as political, social, cultural or economic system drivers.

The foundation of the programme logic model for this review was created during a participatory workshop, with the four review groups and MPI, in February 2017. This workshop was designed and facilitated by the technology transfer review group. A base programme logic constructed for the SLMACC research programme in 2012 was referred to during this process. The updated programme logic model was then constructed, circulated and refined, through successive iterations between the four review groups and MPI. The programme logic model for this (overall SLMACC) review can be found in the Appendix.

Evaluative criteria rubric

An evaluative criteria rubric has two inter-connected elements: it identifies the key evaluative criteria for the programme's success (aspects of relevant performance), and assesses the extent or quality of each aspect against an agreed rating scale. The evaluative criteria rubric for this review was constructed by the technology transfer review group and MPI. The rubric was then circulated and refined, among the four review groups, before final approval by MPI. The evaluative criteria rubric for this (overall SLMACC) review can be found in the Appendix.

Project leader survey

The purpose of the project leader survey was to collect evidence to complement the information provided in the technical project outputs and project documentation.

The project leader survey was sent to all project leaders of the 166 SLMACC projects, whether categorised as forestry, adaptation, mitigation or technology transfer. The survey questionnaire was designed to allow each project to assess the extent to which it had achieved each of the six SLMACC evaluative categories in the rubric. There were a mixture of factual and perception based survey questions, designed through an iterative process of circulation and refinement, among the four review groups and MPI.

Key question areas in the survey addressed:

- Networks built (size, diversity of organisations and disciplines, capacity and capability building (particularly for early career researchers), and endurance)
- Degree of stakeholder engagement (during design, research and outputs phases)
- Use of monitoring and evaluation
- Knowledge exchange (methods, effectiveness)
- Uptake and use of the research (evidence using examples)
- Impacts of the research (on awareness, knowledge and behaviour change)

Stakeholder survey

The purpose of the stakeholder survey was to collect evidence not provided in the project outputs or project documentation; in particular changes in knowledge, attitudes, intent and behaviours as a result of SLMACC projects.

The stakeholder survey was sent to the intended next- and end-users of the SLMACC research projects. A majority of these participants were existing contacts in mailing lists related to climate change and sustainable land management, from MPI and Manaaki Whenua-Landcare Research. Additional participants relevant to specific review areas or known to the review teams to be relevant stakeholders were added to these lists. This included organisations or individuals related to:

-Government (local, regional and national)
-Farming
-Growing
-Forestry
-Food (production, processing)
-Agriculture
-Climate change (including adaptation, mitigation and forestry)
-Biomarine
-Biosecurity
-Research funding
-Industry
-Research
-Education

The survey questionnaire was designed to assess the SLMACC projects against the rubric criteria, as well as to provide statistics about reported levels of awareness and use of SLMACC research. The survey questions were designed through an iterative process of circulation and refinement, among the four review groups and MPI.

Key question areas in the survey addressed:

- Awareness and usefulness of key SLMACC resources (2-3 key resources per review area)
- Awareness, access and use of the SLMACC fund or research programme
- Examples of how SLMACC research has been used (knowledge, decisions or actions, future-planning, policy)
- Usefulness, relevance, quality of SLMACC research
- Gaps in knowledge and research about SLMACC.

Both the Project Leader and stakeholder surveys were hosted on the online survey platform SurveyMonkey©. Responses from participants who responded only to the first question of the survey (i.e. the informed consent question) were excluded from the analysis (12 participants).

Evaluation of project outputs

Key outputs from each of the technology transfer projects were provided by MPI. These included final reports, progress reports (fortnightly, monthly, and annually), presentations, resources created through the project (e.g. factsheets), requests for proposals (RfPs), research proposals and participant feedback from the technology transfer events. These materials were sorted into their relevant project categories and analysed (process explained further below).

Project leader and stakeholder interviews

Where additional information was needed, and contact details were available, phone interviews were conducted with SLMACC project leaders, project members, and stakeholders and/or end users. All interviews were conducted by the primary reviewer, via phone, and were between 15 minutes and 1 hour in duration. Some email correspondence between the primary reviewer and stakeholders or informants[4] was used to supplement data from the phone interviews. Notes were taken by the interviewer during the interview, and used to complete the one-page reviews of each project.

Overview of method (individual project analysis)

The tools and methods described here were used in combination to conduct this review. The following process was used:

First, the project outputs were thoroughly examined, for each individual project. This included reading all relevant documents, highlighting sections that related to the relevant evaluative criteria, and making notes of key evidence and issues. Once all outputs had been processed, the reviewer made preliminary assessments about the relevant project. For each of the evaluative criteria one to two sentences were written, regarding the evidence found or justification used for each assessment made. Where further information was needed to make a judgement, relevant individuals (project leaders or stakeholders) or resources were identified, and sought out.

Second, project leaders were identified and contacted for a phone interview, to assist with both corroborating existing evidence and assessments, and provide evidence regarding gaps. For

[4] For example communications staff at relevant organisations (e.g. FAR), who could provide data about the use of the key resources generated by the projects.

example, regarding capacity and capability building, uptake and use of the resources or events within the science community, and research impacts. Project leaders were also asked, where possible, to identify additional stakeholders or end users to interview related to outcomes and impacts achieved in the project. Where a specific resource was cited as being relevant (e.g. an evaluation report), this evidence was requested, and where provided examined.

Once all projects had been reviewed and assessed against the rubric, the primary reviewer proposed a preliminary list of themes that were common across the projects, relating to lessons learned, areas for improvement, and science gaps in technology transfer. All relevant outputs for each project were then re-examined in light of these themes. Projects were examined for:

a) presence or absence of each theme;
b) key quotes pertaining to each theme; and
c) evidence of response to each theme.

Each theme was then reported on, using the data as evidence and examples.

Finally, the project leader and stakeholder survey data were examined in relation to the findings of this review. The data was predominantly analysed using automatic statistics generated by SurveyMonkey©, with supplementary analyses and graphs created using Microsoft Excel®.

Limitations and Disclaimer

The extent to which outcomes and impacts were able to be assessed varied greatly between the projects reviewed. This was due to the varied availability of data or evidence that allowed an accurate assessment of outcomes and impacts. Where multiple sources of data (project outputs, survey data and interview data) were able to be triangulated, high level judgements about achievement of outcomes and impacts have been made. For the majority of projects, a lack of sufficient evidence resulted in identifying some categories as having 'insufficient evidence' to make an assessment about. Moreover, for those projects where assessments were able to be made, it remains difficult to attribute these findings definitively and purely to the relevant project. Given participants would have attended other extension events and had interactions with other advisors, it is highly likely participants of the project also experienced other events concurrently that may have contributed to the effect. It is also critical to note that this review was not exhaustive; in no instance was it possible to interview all project team members, or gain the perspective of a large number of stakeholders who participated in the projects. This was due to:

a) the time elapsed since some projects were completed;
b) a reluctance or inability of project leaders to name specific individuals for the reviewers to contact (e.g. participants or stakeholders);
c) an issue of representativeness of opinion of any individuals who were contacted; and;
d) the time and resource available for this review.

It is therefore requested that readers take the above limitations into account, and interpret the findings of this review cautiously, and indicative, rather than definitive findings about the SLMACC Technology Transfer Programme.

4. Project summaries

This section provides one-page analyses of each of the ten SLMACC technology transfer projects funded since 2007. This includes:

Key project details: Key organisations involved, funding amount provided, named partners, and the main audience for the project.

Project summary: Key aims and objectives, methods and content of the technology transfer activity.

Project components: A description of how the project performed when evaluated against the rubric constructed. Criteria included building of science capacity and capability enhancement, influence on science, engagement and network building, and learning, awareness and knowledge gained among end-users. The usability of research for end-users, influence on stakeholders, and impacts for New Zealand (direct and indirect) were also considered. These criteria can be found in the rubric in Appendix A.

Outcomes: A presentation and evaluation of any evidence that indicated outcomes and/or impacts achieved as a result of the project.

Economic impact assessment: For two projects, the Climate Cloud and Train the Trainer, a summary of a cost benefit analysis is included in a supplementary report.

Summaries are provided for the following ten projects:

Type of project	Project name
Demonstration	Demonstration of Climate Change Issues to Arable and Vegetable Farmers
Demonstration	Demonstration of Climate Change Issues to Sheep and Beef Farmers
Demonstration	Demonstration of Climate Change Issues to Kiwifruit Growers
Demonstration	Demonstration of Climate Change Issues on Deer Focus Farms
Demonstration	Climate Change Technology Transfer Programme: Pork Industry Resources Demonstration
Demonstration	Demonstration Forests Project
Resources	Climate Change Technology Transfer Programme: Resources
Resources	Climate Cloud
Resources	Extension Handbook
Training	Train the Trainer

Demonstration of Climate Change Issues to Arable and Vegetable Farmers (Resilient Cropping)

Key organisation: Foundation for Arable Research (FAR) *Total funding:* $187,300
Named partners: Horticulture NZ, LandWise *Duration:* 2011 - 2013
Main audience: New Zealand cropping farmers (arable and vegetable) *Project code:* 15268

Summary
The Arable and Vegetable Farmers Project or "Resilient Cropping" ran a series of approximately 21 on-farm field demonstrations and seminars, explaining best practice management on farm, to improve the resilience of cropping farmers. Farmer attendee numbers ranged from five to 60 per event. While some high-level suggestions for increasing resilience were shared with farmers, field workshop participants were encouraged to construct and propose their own local solutions. Information resources were also collated and distributed to participants who attended the seminars or field demonstrations. Resilience was considered from both a farm business and environmental sustainability perspective. In addition to FAR, Landwise delivered the extension activities, and the Māori Vegetable Growers Collective collaborated on the project. Topics of the seminars, resources and field demonstrations included soil resilience, new pests due to climate change, market drivers, and water, nutrient and fuel use efficiency. While topics were not region specific, sessions comprised generic modules based on what was most relevant to each region.

Project components
The Arable and Vegetable Farmers Project was careful in scoping the existing knowledge, awareness and perceptions of farmers about climate change prior to the project commencing. Action learning[5] was also incorporated, with changes in the schedules, content delivered and engagement strategies chosen, following audience and stakeholder feedback. The project therefore delivered research that was fit-for-purpose for end users, and demonstrated a degree of participatory research processes. Issues faced by the project included difficult stakeholder relationships and mixed responses from end users, with farmers prioritising more pressing issues (e.g. nutrient management). This limited the collaborative relationships, capacity and capability built through the project, in regard to scientific and stakeholder networks.

Outcomes
The Arable and Vegetable Farmers Project was assessed as a project that presented important material, but the information was not particularly well received by the farmer audience. This was marked by low attendance rates at events, by both farmers and industry partners. This was surmised to be a result of farmers having more pressing issues in the business environment (e.g. nutrient management) and poor awareness of the project within industry bodies.

In addition, there was some resentment from farmers about being educated on managing the effects of climate change, as they believe managing climate variability is a core component of their farm business (Mathers & Bloomer, 2013). Indeed, a pre-project survey indicated that 93% of farmers believed that climate variability *would* affect their business in the future, and 79% had experienced financial loss in two to five of the last five years (Mathers and Bloomer, 2013). The project leader also suggested that the majority of the material presented to farmers was already relatively well known, and attendees were seeking novel information (Mathers & Bloomer, 2013).

[5] Action learning is defined here as using the action learning cycle, which involves repeated cycles of planning, doing, observing and reflecting, and involves adaptive project management, to ensure effectiveness of approach is maintained (i.e. continual improvement).

One key resource produced through this project was a series of 14 factsheets detailing components of the farm system that can be adaptively managed, to promote resilient crop farming. These fact sheets were distributed via email to approximately 1600 FAR levy payers and industry members, and were presented at the 2012 CROPs event, to the 600 people present. Four of these fact sheets were region-specific, and have been requested for use by Regional Councils (Personal communication with the Foundation for Arable Research, 2017).

Demonstration of Climate Change Issues to Sheep and Beef Farmers

Key organisation: Beef and Lamb New Zealand Limited *Total funding:* $584,000
Named partners: AgResearch Limited, MPI, PGG Wrightson, Primary ITO, Federation of Māori Authorities (FoMA)
Duration: 2011 – 2014
Main audience: New Zealand sheep and beef farmers *Project code:* 15233

Summary

The Sheep and Beef Farmers Project developed and delivered seminars to upskill sheep and beef farmers about the impacts of climate change, to assist in adapting to, managing and mitigating climate change. This included 44 seminars, workshops or hui over two years, encompassing the farm, community and regional scales, across New Zealand. The project aimed to raise awareness, and promote knowledge transfer and practice change. Seminars were region-specific, and participants were provided with a risk management planner, to identify farm-specific triggers, consider relevant variables (e.g. infiltration of soil water) and develop actions to address potential implications. Topics covered included productivity, stocking rate, effluent and nutrient management, wintering practices and disease tolerance.

Beyond the seminars, technology transfer avenues included use of demonstration, monitoring and project farms, dissemination of fact sheets and technical information, and advertising via websites and local newspapers. A balance between technical and practical information was maintained by utilising a steering committee and holding regular meetings to reflect on content.

Project components

The Sheep and Beef Farmers Project excelled at creating highly user-friendly and fit-for-purpose workshops for end-users. This was achieved by undertaking region-specific needs assessments of farmers, recruiting knowledgeable technical advisors and continually reflecting on the relevance of the workshop content. Furthermore, workshop content acknowledged wider system drivers of the farm unit, including the market, consumer perspectives, policy and regulation. Workshop participant feedback sheets indicated 75% of attendees were farmers, in addition to rural professionals, Regional and Local Council staff, and others (Beef and Lamb NZ, 2013). Feedback also indicated that 91% of participants found that the presenters delivered the material in an easy to understand and informative manner (Beef and Lamb NZ, 2013). The project included a detailed communications plan to publicise events and raise awareness about climate change. Central control sheets were also used as a repository method, for design and implementation, risk management, and milestone achievement (Beef and Lamb NZ, 2012).

Outcomes

This project created and brought together networks among science, industry, local iwi groups and government representatives. Importantly, the project initiated one of the earlier industry-led discussions around acknowledging climate change, making a concerted effort to increase awareness about climate change among farmers. Attendees evaluated the project as increasing awareness and knowledge, with 93% of respondents indicating they learned something useful. A further 85% believed they learned something valuable to take back to their own business (Beef and Lamb NZ, 2013). Pre and post workshop feedback sheets also indicated significant increases in the perceived seriousness of climate change, knowledge of mitigation strategies and ability to adapt the farm business (Beef and Lamb NZ, 2012). For the project leader, the project was “pivotal”. “Increasing the acceptability of the discussion about climate change” was a key

impact of the project, therefore “it was about turning the key on, not making it go at 100 kilometres”. As such, the project leader felt “the end [of the project] was just the beginning”. Indeed, the Sheep and Beef Farmers Project contributed to the development of a critical resource in popular use today; the Land and Environment Plan (LEP, now modified into the Farm and Environment Plan (FEP)).

Demonstration of Climate Change Issues to Kiwifruit Growers

Key organisation: Earthwise Consulting Limited *Total funding:* $84,420
Named partners: Zespri, Bay of Plenty Regional Council *Duration:* 2011 – 2013
Main audience: New Zealand kiwifruit growers *Project code:* 15275

Summary
The Kiwifruit Growers Project involved targeted adaptation and resilience events, held in three different participatory workshop forms, with kiwifruit growers and land managers in fifteen catchments and regions across New Zealand. Each of the 23 events was tailored to the region involved. The project was about engaging with kiwifruit growers in all kiwifruit growing regions of New Zealand, to develop their understanding of climate resilience and what is required to enhance it, at both the orchard and catchment scale. Other land owners with more than 50 ha were also targeted at the catchment scale. Workshops comprised of presentations, followed by grower-led discussion sessions, and at the orchard scale, group work sessions where participants created posters to advertise resilience. Content focused on crop protection, cultivar and crop diversity, natural predators, soil management, water security and drainage. The Kiwifruit Growers Project worked with industry and a Regional Council to investigate value creation and the proactive changes needed to create a resilience narrative for growers and the wider catchment.

Project components
The Kiwifruit Growers Project demonstrated best practice approaches in conducting research, using participatory and structured stakeholder engagement. The content of the stakeholder engagement sessions appeared to be of high quality, tailored to specific regions, and considered the diversity of orchard systems and multiple relevant scales. The workshops were advertised extensively to promote the events, and demonstrated adaptive project management in response to initial poor turnouts. The project also sought alternative avenues for dissemination of the information generated, due to the underwhelming exposure gained through the chosen processes. Overall, the Kiwifruit Growers Project was well designed and monitored.

Outcomes
Unfortunately attendance rates at the kiwifruit workshops “were consistently low”, with between three and ten participants per workshop, suggesting a reduction in achieved impact (Kenny, 2012b, p. 3). This appeared to be due to two factors; a) a degree of saturation with the topic at the time and b) the PSA outbreak and resulting response. Growers “were focused on survival due to the unknowns around the virulence of the disease”, and attendance at similar industry events not directly related to the PSA disease was also low for kiwifruit growers, reflecting growers’ priorities at the time (Personal communication with Alistair Mowat, 2017). Nevertheless, grower feedback from post-workshop surveys suggests the workshops were highly valued, with ‘expertise of facilitators’ rated as close to excellent, and high ratings of the value of the workshop (over 4 out of 5; Kenny, 2012b). The lowest rating was given to ‘your learning experience’ (3.8 out of 5; Kenny, 2012b), suggesting kiwifruit growers already had relatively high levels of existing knowledge prior to the workshop.

Growers that did participate in this project are now appealing to industry governance to invest in climate change activities (Personal communication with Mowat, 2017). This suggests there has been considerable delay in the realisation of impacts associated with this project. Zespri found the work highly valuable, and may utilise the work completed in the project for future technology transfer activities, and as a basis for new research activities (Personal communication with Alistair

Mowat, 2017). In particular, region specific vulnerabilities and resilience actions identified by growers are ideal resources for dissemination.

"Overall, I believe Earthwise Consulting Ltd and MPI have made a valuable contribution to the New Zealand kiwifruit industry through the SLMACC investment, with further benefits of the work being realised as the industry rebuilds its future sustainability capability and focus".
(Alistair Mowat, Innovation Leader at Zespri at the time, 2017).

Demonstration of Climate Change Issues on Deer Focus Farm

Key organisation: AgResearch Limited
Named partners: Deer Industry New Zealand (DINZ)
Main audience: New Zealand deer farmers

Total funding: $25,000
Duration: 2008 – 2011
Project code: 15019

Summary

The goal of the Deer Focus Farms Project was to introduce the topic of climate change and GHG emissions to deer farmers, through the delivery of presentations and resources at focus farms. A total of three field day presentations were held at DINZ Deer Focus Farm field days. There was a particular focus on the on-farm implications of climate change, including the opportunities for the farming business. This was demonstrated by first presenting each farm's current livestock production and greenhouse gas (GHG) emissions figures, in addition to two possible changes that could be made to the farm system, to increase productivity and profitability. These changes were modelled in Farmax®, and considered variables such as stocking rates, emissions (methane, nitrous oxide, carbon dioxide), mortality rates, animal performance, weaning rates, finishing, mating, planting, and financial return. Following the formal presentations, the facilitator engaged farmers in an applied discussion during the farm tours. Two articles discussing case study findings were also published in the 'Deer Industry News' and 'Stagline-Online', which have high readership among New Zealand deer farmers. These outlets were chosen as an alternative to a field-day event.

Project components

The Deer Focus Farms project developed a targeted strategy to maximise the impact of the technology transfer activities conducted. This included combining presentations with large, established industry events, which resulted in between 40-140 farmers at each presentation (Wall et al., 2011). Supplementary materials developed for distribution to farmers were presented in a "proven 'Farm Case Study' format" which had been previously used for an SFF project (Wall, Dynes, Stevens and Brown, 2011). Furthermore, in anticipation of potential resistance to the topic of climate change and GHG emissions, the focus was shifted to presenting farmers with the opportunity to maximise their farm production efficiency, and therefore profitability. The reduction of on-farm GHG emissions were therefore presented as an incidental benefit, although as a critical variable in making their farm business sustainable in the long term, under the Emissions Trading Scheme. This strategy was developed in close consultation with the facilitators of the industry events at which the material was presented, and appeared to result in a positive response from attendees (Wall et al., 2011). As the primary aim of the project was to provide information, large collaborative networks were not generated, although this project assisted with building and strengthening the relationship between AgResearch and DINZ. The project also provided capacity building in the area of modelling, for one early career researcher.

Outcomes

According to within-project evaluation, the Deer Focus Farms Project introduced the topic of climate change and GHG emissions to at least 10% of deer farmers in New Zealand (Wall et al., 2011). This was achieved by choosing two outlets; well-attended industry events, and well-read media outlets for published articles. One case study from the project has also been featured on the Deer Industry New Zealand website (as a link) for five years, with a total of 113 viewings to the article over this period (Personal correspondence with Deer Industry New Zealand, 2017). In general, the project's events were received well by farmers, who indicated that the diverse, practical and region-specific on-farm changes suggested assisted with the usefulness of the event (Wall et al., 2011). The feedback from farmer attendees was also likely to have been positive

because the topic was framed strategically as an opportunity as opposed to regulatory pressure or consequences for past behaviour. Research suggests that of New Zealand deer farmers who attend at least one field day, 95% made at least one change to their deer farming system as a result (Payne, Stevens & Casey, 2009). It is unclear, however, the extent of on-farm behaviour change (e.g. adoption of climate change mitigation strategies) which occurred as a result of this project.

Pork Industry Resources Demonstration

Key organisation: New Zealand Pork Industry Board *Total funding:* $70,928
Duration: 2011 – 2013 *Main audience:* New Zealand pork farmers
Project code: 15054

Summary
The Pork Industry Resources Project aimed to compile and present materials about climate change and GHG emissions, related to the pork industry. A series of four regional information days were held, with a total of 23 pork farmers attending (19% of national producers operating at a commercial scale; Barugh, 2013). The information days were three hours in duration, covering GHG emissions and their profiles on New Zealand (NZ) pig farms, the impact of climate change on NZ pork production, resource use efficiency and regulatory incentives for climate change mitigation. These topics were explored through New Zealand and Australian case studies at the farm and industry levels, and concrete mitigation strategies for farmers to consider. Presentation content consisted largely of existing materials, and was delivered in-person and via video, from a diverse range of expert presenters. Organisations represented included Massey University, Australian Pork Limited, NIWA and the University of Queensland.

Project components
The Pork Industry Resources Project collated user friendly materials for pork farmers, with content being highly diverse and designed to increase awareness and knowledge. The provision of case studies and clear mitigation options for behaviour change on-farm improved the utility of the technology transfer activities. The research was of a high scientific and academic quality, although end users were not involved in participatory processes to determine the desired content of the workshops. As the project was resource-development and extension focused, collaborative networks, capacity and capability building were not notable outcomes. The project considered the workshop content in the broader political, social and climate change system, in regard to compulsory reporting and regulation for farmers, and support for pork producers to make changes on-farm in response to climate change.

Outcomes
Attendance rates at the Pork Industry Resources Project information days was lower than expected, with between one and five farmers attending at three of the four events held. This was thought to be due to limited advertising of the events and possibly due to the poor financial climate for pork farmers at the time, resulting in lower prioritisation of climate change events. However, farmers who did attend indicated that the content was at a highly appropriate level (neither too complex nor too simple), and the presenters and length of the information days were appropriate (Barugh, 2013). In the time since the project concluded, the project leader has reported being contacted by approximately three farmer attendees, who had reportedly implemented practices on-farm as a result of the presentations, in particular, bio-gas systems. This serves as another anecdotal example of delay of project impacts which occurring post-project (as in the Kiwifruit Growers project). Two academic presentations also occurred through the project; one at an international conference and one at a New Zealand-based conference. When workshop participants were asked their preferred methods for future technology transfer events, participants were most positive about publishing materials on the NZPork website, or in the monthly information bulletin Pork Outlook. Participants also indicated that they were only likely to attend a regional seminar if the information to be presented was relevant to them, and they were not likely to attend a seminar prior to a conference event (Barugh, 2013).

Demonstration Forests Project

Key organisation: Scion *Total funding:* $185,000
Duration: 2011 – 2013
Main audience: Forestry land managers (NZFOA, NZFFA, FFR, FICA, and FOMA)
Project code: 15159/11725

Summary

The Demonstration Forests project was targeted at the forestry sector, including forestry land managers and their advisors. The project aim was to develop this group's understanding of climate change risks, impacts and adaptation strategies, and ensure they had access to relevant associated information. Activities were presented through five 'engagement pathways', including webinars, workshops at existing events (e.g. Steeplands workshop by Future Forests Research), e-workshops, resources, and a website (Dunningham, 2013). Content covered climate change risk and adaptation, specifically including carbon forestry, fire, extreme weather events, pests, and the effects of climate change on community resilience (Dunningham, 2013). A total of eight resources were created, two e-workshops were run, six in-person workshops or speaker events were also run (some available online), at least three webinars conducted, and a sub-site within the Climate Cloud was created to store the associated information.

Project components

The Demonstration Forest Project was designed on an information deficit model, where perceived low levels of awareness of climate change and associated risks were seen as a barrier to action. Content presented was based on existing research and therefore the project team acknowledged there were gaps in science knowledge that they were not able to address (e.g. questions about scale of impacts; Dunningham, 2013). Needs assessments were undertaken prior to the project activities commencing, including examining a relevant study, and holding consultative workshops to determine a) existing level of knowledge b) information needs and c) preferred methods of technology transfer, among the intended audience. In addition to a thorough communications plan, this assisted with ensuring the resources and events delivered through the project were accessible, fit-for-purpose, and suitably delivered. Finally, the project demonstrated action learning, with piloting of workshops, planned evaluation of these workshops and ongoing reflection of method and content (Dunningham, 2011; Dunningham, 2013; Moore & Dunningham, 2011).

Outcomes

Engagement rates with six chosen pathways varied, with around 5-10 participants at each webinar, and between 100 and 200 views of webinars on YouTube. Attendance at e-workshops was better, with a minimum of between 10 and 30 attendees. The resources created were distributed internally to Scion staff at events, with over 400 copies of the eight resources printed (at least 200 confirmed distributed), and 100 copies of the Forests Adaptation Chapter distributed (Dunningham, 2013). Hard-copy resources were perceived as being more effective ("welcomed"; Dunningham, 2013, p. 10) than extension events, as they directly filled an information need and were easily available again when needed. The variable engagement throughout the project was seen to be the result of an interaction of factors; topics, timing (e.g. day webinars were less well attended), and focus on providing information versus providing mitigation and adaptation strategies. The forestry sector was also considered to be a unique context where impacts may feel less imminent because of long crop rotations, which results in a lack of urgency and interest from forestry companies (Dunningham, 2013).

Climate Change Technology Transfer Programme: Resources

Key organisation: AgResearch Limited
Total funding: $1,850,000 (including Climate Cloud build)
Named partners: Scion, PGG Wrightson, Massey University, NIWA, Landcare Research Limited, Fruition Horticulture (BOP) Limited, DairyNZ, Beef and Lamb New Zealand Limited, Foundation for Arable Research, Horticulture New Zealand Limited
Duration: 2011-2018
Main audience: a) Farmers, foresters and horticulturalists; b) farm advisors, extension officers, sales people and professional consultants; and c) focused service providers such as bankers, insurance providers, and those who operate within science, policy, or the regulatory environment.
Project code: 15053

Summary

The Technology Transfer Resources Project was designed to be the primary resource development team for the Demonstration Projects for Farmers and Growers. The project developed a collection of around 54 resources on climate change, primarily designed for land managers and their advisors, though also for use by farmers and growers and a wider political, social, scientific and general audience. This project also provided resources for the technology transfer activities of the other nine projects highlighted in this report. Resources included 28 information sheets compiled by NIWA about climate change science, effects, policy and key questions and answers (Dunningham and Brown, 2014). Other resources included a 'Resilient Farm Systems and Climatic Variability' planning template, workshop/presentation evaluation templates and videos of New Zealand farmers talking about changes on-farm they are considering. These resources were peer reviewed, available in a range of formats (executive summaries, fact sheets, academic articles, videos) and vary in complexity. The resources are designed to fill gaps in the available literature about climate change and sustainable land management for the land based sectors, and are then added to the Climate Cloud, which is operating as a parallel and connected SLMACC project. The resources are then integrated into sector programmes, through working with sector groups. The project also contributed to a meta-data searchable dictionary in the form of the Climate Cloud, to extend these resources.

Project components

The Technology Transfer Resources Project used a high degree of stakeholder and end user consultation, with embedded action learning and careful resource construction. This included a resource needs analysis, involving consultation with rural professionals, sector groups, industry and the SLMACC Technology Transfer Project Contract Managers, to ensure appropriateness of the material generated. This included working with Māori key informants to identify Māori contacts and advisors who could identify gaps in resources available. Oversight of the project was informed by the Climate Change Technology Transfer Sub Group (CTTSG). Based on stakeholder need, a brief of each resource was then prepared, circulated and refined, before the resource was developed and subjected to independent peer review, and finally approval by MPI. Resources were therefore developed as specific, fit-for-purpose materials that were accessible to the targeted end user group, and embedded in the farm system and wider climate change system context. Although capacity and capability building was described as relatively low in the project, the project did involve large interdisciplinary and cross-organisation collaborative networks.

Outcomes

An important component of the Technology Transfer Resources Project was the measurement of the effectiveness of the resources they created. This relied on the users of the resource (largely

from the Demonstration projects) systemically collecting data about end user use and feedback about the resource, such as resource quality and accessibility. This data was “limited in content and objectivity” and the feedback was therefore considered to be anecdotal rather than rigorous (Rhodes, Brown and Dynes, 2013, p. 5). Nevertheless, this anecdotal evidence about the resources was highly positive, and the resource users indicated an intent to continue to use the materials (Rhodes, Brown and Dynes, 2013). This project is currently ongoing.

Climate Cloud

Key organisation: Scion
Total funding: $38,860 (cost of building Climate Cloud included under Resources project).
Named partners: PGG Wrightson, NIWA, AgResearch Limited *Duration:* 2011 – 2018
Main audience: Land Managers and Advisors, Rural Professionals and Advisors
Project code: 405233, 405234, 405235, 405240

Summary

The Climate Cloud is an online digital repository or library, which collates and catalogues climate change information related to New Zealand's primary sector. The resources available are predominantly from New Zealand authors, although international government reports and resources are also provided. New Zealand resources were sourced from MPI, Ministry for the Environment (MfE), Crown Research Institutes (CRIs), government resources and sector resources (e.g. from DairyNZ, Zespri, Beef + Lamb NZ). The primary aim of Climate Cloud is to provide evidence based climate change resources that are easy and efficient to access; a 'one-stop shop'. The resources on Climate Cloud are in diverse formats; including written articles, reports, executive summaries and factsheets, as well as links to audio and video files (Dunngingham and Brown, 2014). There are a total of 1,463 resources currently available on the platform.

Resources are designed for multiple audiences; currently 25% of resources are appropriate for advisors, 18% for farmers and other land users, 16% for the public, 9% for Regional Councils, and 17% for scientists. There are also 228 resources likely to be useful for Māori and 424 for teachers (Dunningham, 2016). In terms of topic, most materials are relevant to general farming, pastoral farming, natural ecosystems and forestry. The areas with least resources are fisheries, poultry, pork, building, aquaculture and electricity. Figure 2 overleaf shows the distribution of resources by subject (Dunningham, 2017). Currently, resources are being added at a rate of approximately 12 per month (Brown, Dunningham, Horita, 2017).

Horticulture, meat and fibre, dairy and forestry subsites are most frequently visited parts of the website. Most website users are based in New Zealand (78.4%), with another 7.5% in the United States and 2.4% in Australia (Brown et al., 2017). The United Kingdom and China each represented less than 1% of Climate Cloud users (Brown et al., 2017). The largest user groups are aged between 25 and 44, and slightly more males to females (55.7%).

Project components

The Climate Cloud provided opportunities for capacity and capability building for both early career researchers and established scientists, in cataloguing resources, determining quality, obtaining permissions and summarising resources into more accessible formats. The process of website development involved running focus groups with end users to gain feedback on early iterations of the website, and consistent and ongoing consultation with MPI to maximise the utility and potential applications of the Climate Cloud. These participatory engagement processes have facilitated action learning, and subsequent ongoing development of the site. This included a transition of the site from an online repository of resources, to a library of placeholders (executive summaries of resources), to sorting of resources by sector areas. Social media has also been utilised to extend outreach, from purely 'pull' (where users have to visit the site), to 'push' tactics (where users are invited to visit the site through prompts on social media). The diversity of the resources available on Climate Cloud and their translation into summary documents for users has resulted in a range of specific, usable resources appropriate for diverse settings such as policy, research, science and

stakeholder communities. The provision of further materials for farmers on the site is limited to the generation of these materials to begin with, as the Climate Cloud project does not undertake the development of original resources.

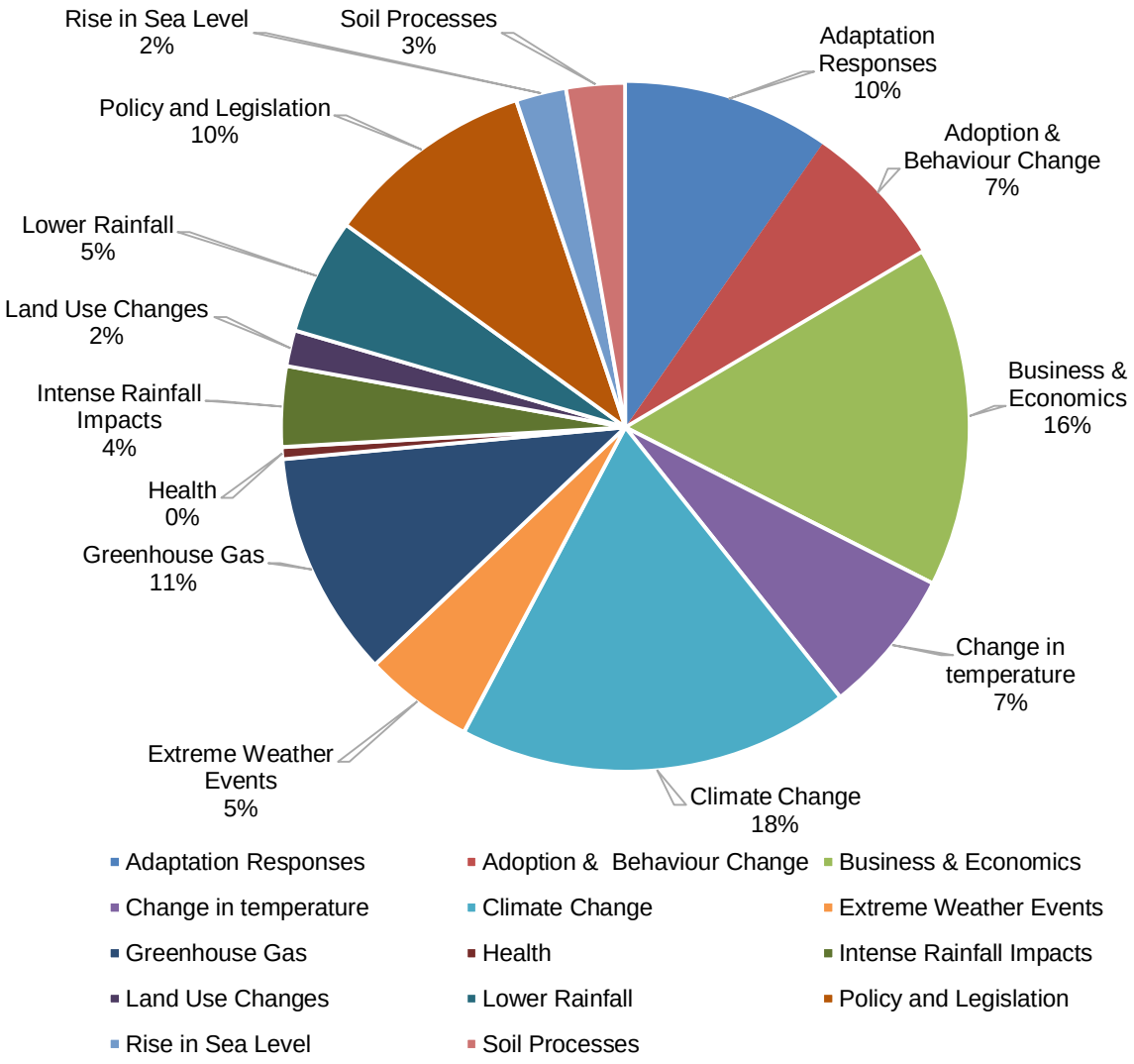


Figure 2. Climate Cloud resources by subject (resources can have multiple subjects). Note that mitigation resources are included on Climate Cloud, captured under various subcategories (e.g. greenhouse gas) (taken from Dunningham, 2017).

Outcomes

Based on the stakeholder survey conducted as a broader component of this review, 22% of stakeholders were aware of the Climate Cloud site. Given that the stakeholders surveyed were the target demographic for the site and 78% of users of Climate Cloud are New Zealand based, this percentage appears lower than expected. Nevertheless, Climate Cloud was rated as more than moderately useful by these stakeholders (5.7 out of 7), with a majority responding that the website was moderately useful or more than moderately useful (25 stakeholders responded to this question).

The number of views of the website is 445 views per day, with 64% of these viewers being daily unique visitors. This brings the total visits to Climate Cloud to over 80,000 views over six months (Brown et al., 2017). These user figures are rising, with a 26.5% increase in total page views and

a 48.4% increase in the number of referrals to the site, between June 2015 and June 2016 (Dunningham, 2016). Currently, time spent on the website by users is relatively brief, with the average time spent being less than 22 seconds. Although online search robots may be contributing to this short visitation time on the site, this may also indicate a need to improve the physical appearance of the site. A further concern is the frequency of the use of the ‘search help’ subsite, with is the third most-visited subsite, equal to the dairy subsite. This suggests improvements are needed in regard to ease of information searching and retrieval, and search engine optimisation for the Climate Cloud.

Over the Fence: Extension Handbook

Key organisation: AgResearch Limited *Total funding:* $98,000
Named partners: PGG Wrightson *Duration:* 2011 - 2016
Main audience: Sustainable Farming Fund (SFF) applicants or recipients, and those responsible for designing and delivering extension programmes.
Project code: 408662

Summary
The 'Over the Fence' Extension Handbook was created for those developing and delivering extension projects. This includes farmer, grower and forester-led projects, such as Sustainable Farming Fund (SFF) projects and the Primary Growth Partnership (PGP) programmes administered by MPI, where the focus is on applied research. The Extension Handbook is about creating highly effective extension projects, not only in meeting the milestones and KPIs to the funder, but in incorporating and embedding good practice monitoring, extension and action learning throughout a project. These aspects of good practice tend to positively affect higher rates of engagement, and understanding of benefits and willingness to change, resulting in higher rates of successful implementation. The Extension Handbook addresses the principles of extension, including problem complexity, project design, participant knowledge and roles, and behaviour change. The latter portion also considers common barriers to adoption, monitoring and evaluation, and case study examples.

Project components
The Extension Handbook is user-friendly in terms of utilising accessible language, simple case studies, and providing specificity. This was likely facilitated by a clearly identified target end user group, and careful consideration of the ultimate intended outcomes and impacts of the project. Furthermore, the Handbook arose from a clearly identified need, for better designed extension projects within Primary Growth Partnerships (PGPs). Rather than generating new knowledge in the topic area, the Handbook provides stakeholders with a useful synopsis of existing research and tools. Combined with a promotion approach to knowledge exchange and practice change, the Handbook facilitates learning, awareness and knowledge gain among end-users. As the project goal was to produce one handbook, the project itself did not built large collaborative networks or engage with stakeholders, but promoted these approaches for end-users.

Outcomes
The Handbook has been downloaded from the MPI website a total of 4,293 times over 22 months (December 2015-October 2017), averaging 44.9 downloads per week. A total of 1,200 copies have been printed (it is not known how many of these have been distributed). Based on the stakeholder survey, awareness of the Handbook was low to moderate, with 29% of respondents being aware of the resource. Respondents who had used the handbook rated it as more than moderately useful; with a mean rating of 5.7 out of 7 (where 7 is very useful). Stakeholders responses to usefulness of the Handbook varied from 2 out of 7 (5.8%) to 7 out of 7 (14.7%), with a total of 34 stakeholders responding to the question. The Handbook is now provided to applicants of the SFF fund, with a template to complete, to ensure all applicants consider the extension component of their project. This urges research to go beyond producing outputs and into considering outcomes and impacts as part of good practice planning and design.

Spill over impacts of the Extension Handbook include use of the extension template in the Kaikoura Earthquake recovery effort (based on interview with the Project leader, 2017). International researchers in farmer extension have also approached New Zealand researchers as experts in extension after reading the Handbook, which could lead to future research collaboration (interview with Project leader, 2017).

One contributor to, and user of, the handbook noted that although it is a very important output and has provided a good ‘go to’ source of information about extension generally, the length of the book may limit its use with a wider audience, such as with farmers. This concern was supported by a key industry body who requested a shortened version. It was suggested that a website may be a good follow-up output, to provide a more effective, accessible, supportive and dynamic mechanism to enhance uptake of the information. This would thereby provide better wrap-around support for extension service provision and practice.

Train the Trainer

Key organisation: AgFirst Consultants New Zealand Limited *Total funding:* $450,000
Named partners: P A Handford & Associates Limited *Duration:* 2011-2014
Main audience: Rural Professionals *Project code:* 15055

Summary
The Train the Trainers Project aimed to demonstrate to Rural Professionals a process for assessing farm system and business resilience risks, at the property level, and how this risk profile changes when changes are made on-farm. This was achieved by providing region-specific information (factsheets and presentation content), to improve their client farmers' ability to adapt to and mitigate climate change on their farm. Presentations included a range of local guest speakers such as farmers and Regional Council Staff, discussing locally relevant issues (e.g. impacts on horticulture in Nelson). A total of 398 rural professionals attended the training sessions between 2012 and 2014, including fertiliser and seed reps, bankers, extension agents, regional council staff and farm consultants (Clelland & Praat, 2012; Kloeten & Praat, 2014; Waugh & Praat, 2013). This represents a total of 19% of the estimated 2,100 rural advisors in New Zealand (Ministry for Primary Industries, 2012). Additional presentations were also made to 50 year-12 and -13 agricultural students in Hamilton. A rural professional email distribution list was used to target workshop participants, particularly targeting regions where pastoral and horticultural farming are important components of the local economy.

Project components
The Train the Trainer Project demonstrated an adaptive process to the development of the workshops, with pilot workshops conducted, and an industry advisory group overseeing the project. The workshops were adapted over time to provide more regional-specific data, and teach the application of this data for example through biological modelling, to improve farm business resilience. The individualisation of local events to include well-respected local speakers, issues and data ensured the material was highly relevant for attendees. Potential positive impact of the workshops was also increased by providing additional take-home resources, to act as a reference for attendees.

Outcomes
Workshop participants completed pre and post-workshop questionnaires to measure knowledge increase. This unpacked knowledge about region-specific impacts, how to assess farm business resilience and understanding of the role they may play, as rural professionals, in supporting farmers to adapt. Participants demonstrated an average of one point increase on five-point scale, with the greatest learnings about knowledge of 'projects and potential impacts for your region' and 'the role of biological modelling in assessing risk and resilience' (Kloeten & Praat, 2014). Workshop quality, entailing coverage of relevant topics, knowledge of presenters, length of workshop and overall rating was rated similarly positively, with an average of 4.1-4.2 out of 5 (Kloeten & Praat, 2014). Participant knowledge was also assessed and was found, on average, to improve from 2.8 to 3.8 out of 5 (Clelland & Praat 2012, Waugh & Praat 2013, Kloeten & Praat 2014). In 2013, 70% of attendees had not attended a Train the Trainer workshop, and in 2014 this figure was 57% (Kloeten & Praat, 2014). This suggests the project was successful at encouraging repeat attendance, as well as recruiting new participants (Kloeten & Praat, 2014).

4.1 Project overview

The following section provides a brief summary of the basic information collated regarding the ten technology transfer projects reviewed, including organisations most commonly involved, and total funding spent. The core organisations involved across the SLMCC technology transfer projects were AgResearch and PGG Wrightson, in addition to CRIs and industry bodies. A wide range of organisations were involved in only one project, presumably due to their specialist knowledge or role in these projects. The SLMACC technology transfer projects have collectively received $3,573,508 of funding, spread over 10 projects, as displayed in Table 3. Of these, five projects have been targeted at specific sectors (deer, pork, kiwifruit, arable/ vegetable and sheep and beef farmers); with the remainder being cross-sector. There are gaps in sectors that have not received specific technology transfer programmes, however, these may be addressed through other funding mechanisms (for example the Dairy PGP programme around Train the Trainers). At a fund level, a more strategic approach to engaging the sectors and next and end users who have not been involved in this fund could be considered.

Table 2. Key organisations involved in the SLMACC technology transfer projects.

Organisation	Number of projects as a named partner
AgResearch Limited	4
PGG Wrightson	4
Scion	3
Foundation for Arable Research (FAR)	2
Horticulture New Zealand Limited	2
NIWA	2
Beef and Lamb NZ Limited	2
LandWise, MPI, Primary ITO, Federation of Maori Authorities (FoMA), Earthwise Consulting Limited, Zespri, Bay of Plenty Regional Council, Deer Industry NZ, New Zealand Pork Industry Board, AgFirst Consultants Limited, P A Handford & Associates Limited, Massey University, Landcare Research, Fruition Horticulture (BOP) Limited, DairyNZ	Each 1 count

Table 3. Funding provided to SLMACC technology transfer projects.

Project name	Direct funding provided by SLMACC
Demonstration of Climate Change Issues on Deer Focus Farms	$25,000
Pork Industry Resources Demonstration	$70,928
Demonstration of Climate Change Issues to Kiwifruit Growers	$84,420
Extension Handbook	$98,000
Demonstration of Climate Change Issues to Arable and Vegetable Farmers	$187,300
Demonstration of Climate Change Issues to Sheep and Beef Farmers	$584,000
Climate Change Technology Transfer Programme: Resources	$1,850,000 (including building Climate Cloud)
Demonstration Forests Project	$185,000
Climate Cloud	$38,860
Train the Trainer	$450,000

Total funding	**$3,573,508**

Audiences (Figure 5).

Type of audience	**Number of projects naming the end-user**
New Zealand farmers or growers (arable and vegetable, sheep and beef, kiwifruit growers, deer farmers, pork farmers, foresters)	7
Rural professionals or rural advisors	3
Designers and deliverers of extension programmes	2
Land managers	2
Rural service providers (e.g. bankers, insurance providers)	1
Scientists, policy advisors or those in regulatory role	1

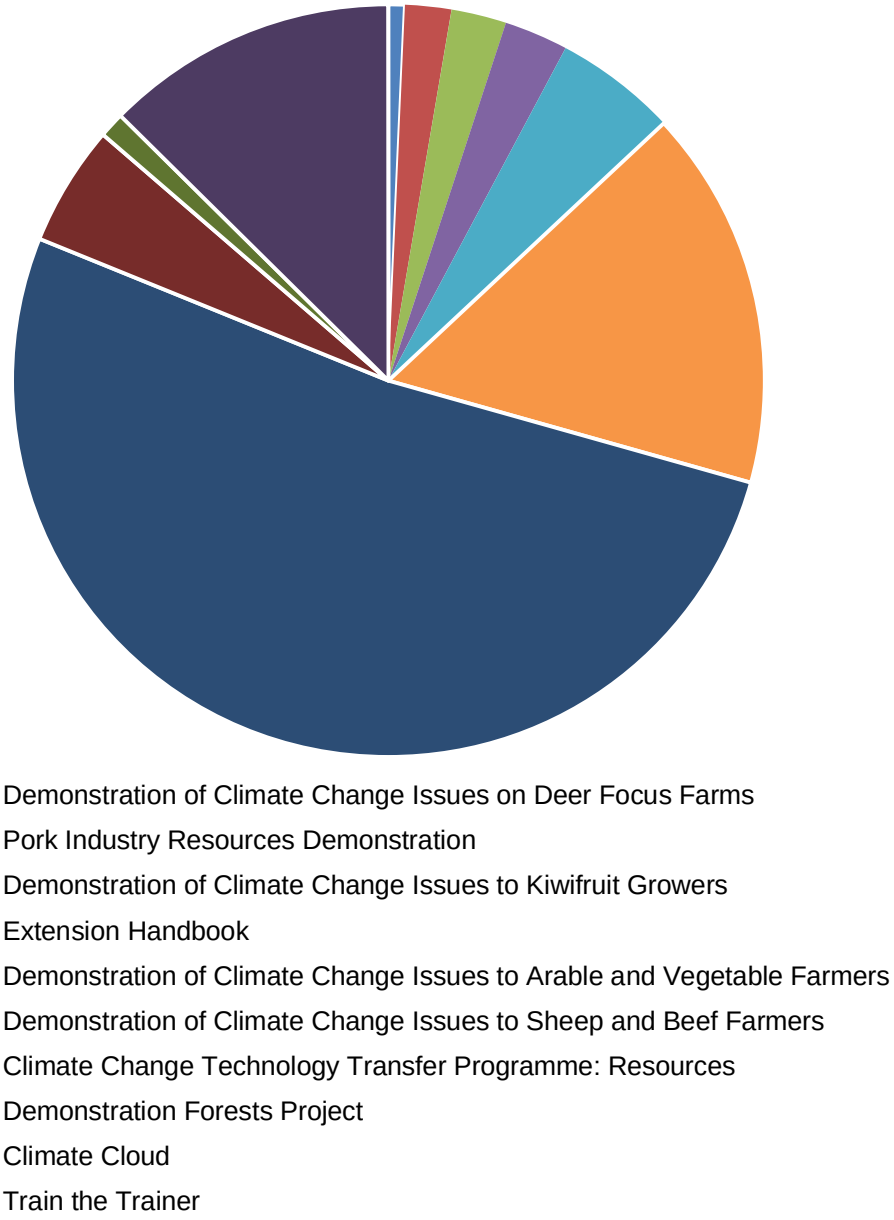


Figure 4. Graph of the distribution of funding among the SLMACC Technology Transfer Projects.

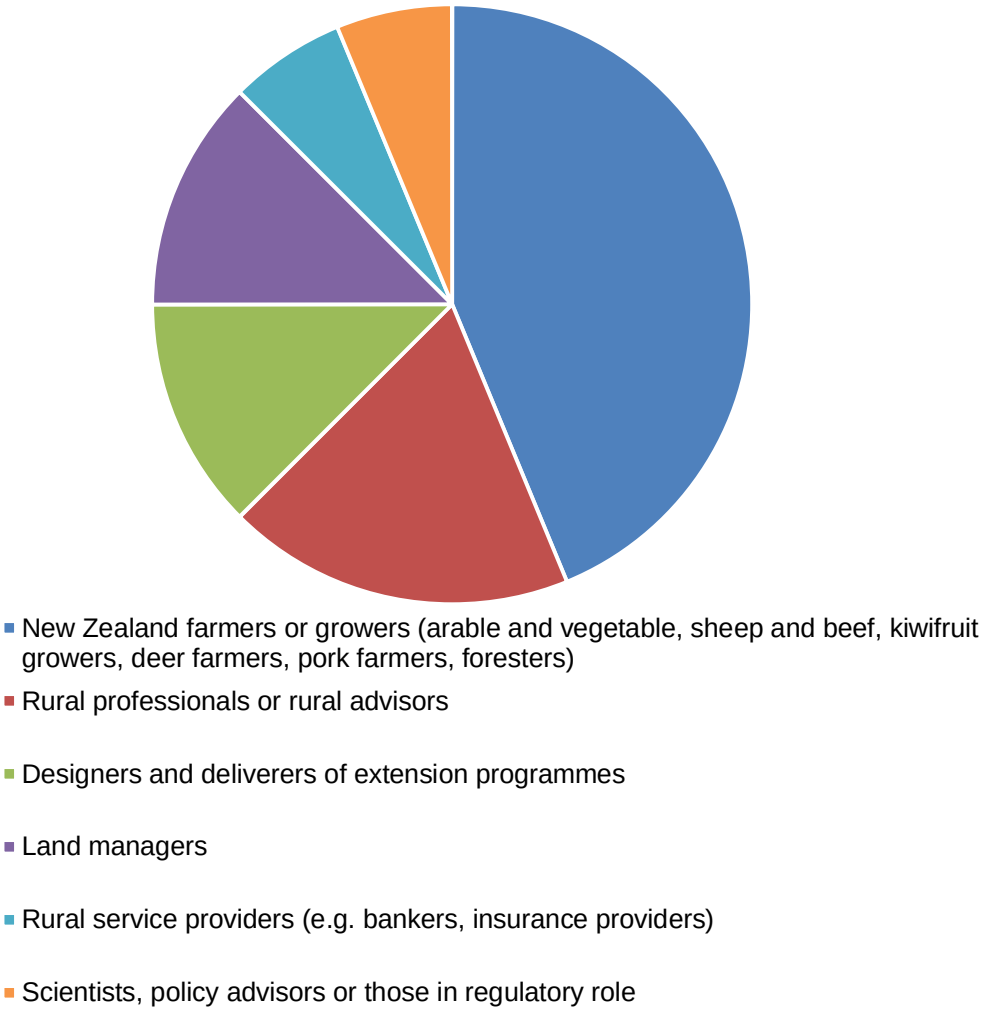


Figure 5. Graph of the type of audience of the SLMACC Technology Transfer Projects.

A complete evaluative criteria rubric is provided on the following pages, for all technology transfer projects. Projects are presented anonymously (including in a different order to their presentation in the sections above) in the rubric below, as the purpose of this review is not to judge individual projects, but to look across all technology transfer projects and identify lessons learned, areas for improvement and science gaps in technology transfer. The numbers that populate the rubric were assessments made by a single researcher, using the resources available (project outputs, project leader and stakeholder interviews and project leader and stakeholder surveys). As such, it would not be valid to complete any detailed quantitative analysis of the patterns presented. It is however, possible to make several high-level observations of patterns that appear among these technology transfer projects; these are presented following the rubric. These preliminary insights should be triangulated against additional data before being viewed as conclusive. *Note. A copy of the base evaluative criteria rubric can be found in the Appendix.*

5. Outcomes: To what extent have the desired outcomes been achieved from SLMACC projects to date?

	Project 1	*Project 2*	*Project 3*	*Project 4*	*Project 5*	*Project 6*	*Project 7*	*Project 8*	*Project 9*	*Project 10*	*Average*[6]
1. SCIENCE CAPACITY AND CAPABILITY ENHANCEMENT											
Builds capacity for NZ to research in topic area (e.g. climate change and sustainable land use), at all levels	2	IE	2	2	2	1	2	1	3	1	1.8
Improves capability and skills amongst emerging or early career researchers	2	IE	1	1	2	1	2	1	1	IE	1.4
Category average	**LOW**										
2. INFLUENCE ON SCIENCE											
Promotes collaboration among research providers, and/or between different disciplines	1	2	2	1	1	2	2	3	2	2	1.8
Generates high quality research related to topic area (e.g. change or sustainable land use), which is credible and legitimate (e.g. citations, impact factor) with relevant stakeholders (e.g. International Panel on Climate Change)	2	2	2	1	2	2	2	3	3	1	2.0
Utilises robust, best practice research methods (poor may use random or unexplainable method and excellent may use novel methods or techniques, sound results)	2	3	3	2	2	2	2	3	3	3	2.5
Results in uptake and use of research within science community (excellent would result in strong uptake and use of research within science community)	3	IE	2	1	IE	2	2	IE	3	IE	2.2
Category average	**MODERATE**										
3. ENGAGEMENT AND NETWORKS (if applicable)											
Builds collaborative networks of key stakeholders and/or end users (poor may include homogenous networks which disperse following project and excellent networks are heterogeneous (e.g. different epistemologies, type of expertise, values) and enduring	1	2	3	1	2	2	2	2	2	2	1.9
Uses participatory research process appropriate to level of engagement needed to achieve outcomes (based on MPI Extension Framework). e.g. where end users have opportunity to shape research approach, sources of knowledge and outcomes	2	3	3	2	2	2	2	3	3	3	2.5

[6] Colour coding for averages within the rubric is according to the closest full number, where .5 is rounded down.

Uses structure or processes to guide stakeholder engagement (poor may have no clear processes for stakeholder engagement and excellent may use processes like a community of practice)	1	3	3	2	2	2	2	3	3	3	2.4
Practices action learning (if applicable)	2	3	3	3	1	2	3	3	3	3	2.6
Category average	**MODERATE**										
4. LEARNING, AWARENESS AND KNOWLEDGE GAIN AMONG END USERS											
Generates new knowledge in topic area (e.g. climate change or sustainable land use)	2	2	2	1	2	1	1	3	1	1	1.6
Promotes knowledge exchange (particularly dissemination of research findings)	3	2	3	2	3	2	3	3	3	3	2.7
Builds increased awareness and knowledge in topic area (e.g. climate change or sustainable land use)	2	3	3	1	2	3	2	IE	3	IE	2.4
Promotes practice or behaviour change among intended end or next user groups	2	2	3	2	3	2	2	2	3	2	2.3
Category average	**MODERATE**										
5. USABILITY OF RESEARCH FOR END USERS											
Generates specific, usable, fit-for-purpose knowledge and research for policy and trade/negotiation, research, science and stakeholder communities	2	3	3	2	3	2	3	3	3	3	2.7
Aligns research with the needs of next or end users of the research, and is responsive to next or end user needs and knowledge gaps (poor may lack alignment and excellent may involve iterative research to meet user needs)	2	3	3	2	3	2	2	3	3	3	2.6
Acknowledges context and effects of the research knowledge or recommendations on the broader climate system or topic area	2	3	3	2	2	2	N/A	3	3	2	2.4
Creates accessible, available outputs	2	2	3	2	3	2	2	3	2	3	2.4
Category average	**HIGH**										
6. INFLUENCE ON STAKEHOLDERS AND IMPACT FOR NZ											
[How the research is designed and delivered] maximises how wide-reaching the research influence is (inter/national, across relevant sectors and functions, e.g., policy, industry and community attitudes and behaviours)	3	2	3	2	3	2	3	2	3	2	2.6
Results in uptake and use of research by stakeholder groups (policy, government, industry or community)	3	E	E	IE	IE	2	2	3	2	IE	-
Influences stakeholders positively in their awareness/ consideration of decision-making, and/or action around topic area (e.g. climate change or sustainable land use) (e.g. policy, government, industry or community)	IE	3	3	IE	2	IE	IE	IE	2	IE	-

Achieves significant direct impacts or benefits for NZ (poor would be no impact, good incremental, excellent would be wide ranging or more immediate impact)	2	2	IE	1	IE	IE	IE	IE	IE	IE	-
Achieves significant direct spill-over impacts or benefits for NZ (poor would be no impact, good incremental, excellent would be wide ranging or immediate impact)	3	2	IE	2	IE	IE	IE	IE	IE	IE	-
Category average	**INSUFFICIENT EVIDENCE**										

Rating criteria

1	**2**	**3**	**IE**	**E**	**N/A**
Low degree (Never or seldom with clear weakness)	**Moderate degree** (Mostly, or sometimes with few exceptions)	**High degree** (Always to almost always)	Insufficient evidence	Emergent	Not applicable (e.g. not asked for by SLMACC)

Notes. Rubric averages were calculated by row, with ratings of 1-3 out of a possible 3. Averages are calculated on ranges of low/limited 1.0-1.6, moderate 1.7-2.3, and high 2.4-3.0. Cells which were assessed as having insufficient evidence (IE) to make a rating or were emergent (E) were excluded from the calculation of these averages (not counted as divisible in the total number of cells).

As evidenced by project ratings against the evaluative criteria rubric above, and the averaged scores in Table 4 below, SLMACC technology transfer projects:

- Utilised a moderate amount of participatory research processes and a moderate to high degree of action learning.
- Appeared to be effective at locating the content of the resources and events within the farm system and wider system context.
- Tended to be moderately to highly effective at creating accessible, available and fit-for-purpose resources and events for next and end users.
- Tended to be moderately to highly effective at maximising the potential influence of their research, by creating resources and events that were relevant to multiple audiences (e.g. policy, industry and farmers, growers or foresters), though there was insufficient evidence to rate most projects across outcome and influencing related criteria.
- Tended to score low on capacity and capability building, with limited capacity building provided for early career researchers.
- Did not appear to be strong at generating diverse collaborative networks, between research providers and disciplines, or between key stakeholders and end users.

Key patterns across the rubric were:

- Generally, projects that scored higher in earlier research stages (research design, methods and process) tended to also score higher in the latter research stages (have a wide-reaching influence, influence stakeholders positively and promote behaviour change).
- Projects that utilised best practice approaches such as participatory methods, structured stakeholder engagement and action learning tended to also create fit-for-purpose resources and events.
- Projects that utilised best practice approaches also tended to display stronger evidence of promoting knowledge exchange and building increased awareness and knowledge in the topic area.
- Use of best practice approaches also appeared to coincide with the creation of resources and events that met the needs of next or end users to a greater extent, and tended to utilise a wider systems approach.

These observations are further explored and supplemented by evidence and examples, in the following sections.

Table 4. Average scores in the evaluative criteria rubric across the SLMACC technology transfer projects.	Average
1. SCIENCE CAPACITY AND CAPABILITY ENHANCEMENT	LOW
Builds capacity for NZ to research climate change and sustainable land use, at all levels	1.8
Improves capability and skills amongst emerging or early career researchers	1.4
2. INFLUENCE ON SCIENCE	MODERATE
Promotes collaboration among research providers, and/or between different disciplines	1.8
Generates high quality research related to climate change or sustainable land use, which is credible and legitimate (e.g. citations, impact factor) with relevant stakeholders (e.g. International Panel on Climate Change)	2.0
Utilises robust, best practice research methods (poor may use random or unexplainable method and excellent may use novel methods or techniques, sound results)	2.5
Result in uptake and use of research within science community (excellent would result in strong uptake and use of research within science community)	2.2
3. ENGAGEMENT AND NETWORKS (if applicable)	MODERATE
Builds collaborative networks of key stakeholders and/or end-users (poor may include homogenous networks which disperse following project and excellent networks are heterogeneous (e.g. different epistemologies, type of expertise, values) and enduring)	1.9
Uses participatory research process appropriate to level of engagement needed to achieve outcomes (based on MPI Extension Framework). e.g. where end users have opportunity to shape research approach, sources of knowledge and outcomes	2.5
Uses structure or processes to guide stakeholder engagement (poor may have no clear processes for stakeholder engagement and excellent may use processes like a community of practice)	2.4
Practices action learning **(if applicable)**	2.6
4. LEARNING, AWARENESS AND KNOWLEDGE GAIN AMONG END USERS	MODERATE
Generates new knowledge about climate change or sustainable land use	1.6
Promotes knowledge exchange (particularly dissemination of research findings)	2.7
Builds increased awareness and knowledge about climate change or sustainable land use practices	2.4
Promotes practice or behaviour change among intended end or next user groups	2.3
5. USABILITY OF RESEARCH FOR END USERS	HIGH
Generates specific, usable, fit-for-purpose knowledge and research for policy and trade/negotiation, research, science and stakeholder communities	2.7
Aligns research with the needs of next or end users of the research, and is responsive to next or end user needs and knowledge gaps (poor may lack alignment and excellent may involve iterative research to meet user needs)	2.6
Acknowledges context and effects of the research knowledge or recommendations on the broader climate system or topic area	2.4
Creates accessible, available outputs	2.4
6. INFLUENCE ON STAKEHOLDERS AND IMPACT FOR NZ	IE

[How the research is designed and delivered] maximises how wide-reaching the research influence is (inter/national, across relevant sectors and functions, e.g., policy, industry and community attitudes and behaviours)	2.6
Results in uptake and use of research by stakeholder groups (policy, government, industry or community)	-
Influences stakeholders positively in their awareness/ consideration of decision-making, and/or action around climate change or sustainable land use (e.g. policy, government, industry or community)	-
Achieves significant direct impacts or benefits for NZ (poor would be no impact, good incremental, excellent would be wide ranging or more immediate impact)	-
Achieves significant direct spill-over impacts or benefits for NZ (poor would be no impact, good incremental, excellent would be wide ranging or immediate impact)	-

Note. – is used where there is insufficient data to calculate a valid average.

Rating criteria

1	2	3	IE	E	N/A
Low degree (Never or seldom with clear weakness)	**Moderate degree** (Mostly, or sometimes with few exceptions)	**High degree** (Always to almost always)	Insufficient evidence	Emergent	Not applicable (e.g. not asked for by SLMACC)

Note. Averages are calculated on ranges of low 1.0-1.6, medium 1.7-2.3, and high 2.4-3.0.

6. Enablers: What are they enablers to stakeholders adopting SLMACC findings and recommendations?

Four key enablers or strengths were identified as common to all of the SLMACC technology transfer projects, and have previously been identified in the Over the Fence Handbook (Casey et al., 2015) as important components of successful technology transfer and more broadly extension events:

- Sophisticated science and professional expertise resulting in high quality resources and events;
- Strategic marketing and presentation of resources and events to improve reception and uptake by farmers;
- Well-considered event organisation in terms of timing, logistics and delivery; and
- Creation of fit-for-purpose resources, to be accessible, specific and useful.

6.1 Sophisticated science and professional expertise

"[The presenters], who are also members of the resource group, have proven to be invaluable experts and facilitators all in one. They were able to bring sound technical insight to the discussion and provide a well-grounded practical session."

(Beef & Lamb NZ, 2014, p. 6)

The technology transfer projects demonstrated consistent, high-skilled expertise of those developing and delivering the technology transfer activities. This is evidenced by participant feedback, quality of the material presented, and professional experience of those recruited (e.g. Barugh, 2013; Kenny, 2012b; Kloeten & Praat, 2014). For example, the demonstration events to pork farmers included five speakers; a NIWA scientist, professor in animal science, chemical engineer, environment officer and an environment manager from an Australian pork organisation. As always, in recruiting highly technical expertise, there is a risk of over-complication and inaccessibility of the material presented. However, farmer attendees indicated that the content from these presentations was pitched at the right level (Barugh, 2013). Similarly, in the Train the Trainers project, rural professional attendees indicated the presenters were highly knowledgeable (rated 4.4/5), while "[the] relaxed tone of the workshop encouraged audience participation, [and] presenters interacted well with the audience" (Kloeten & Praat, 2014, p. 13). This is highly positive, as research has found that trust in those providing knowledge is a critical factor in aiding farmers to adopt desirable farming practices (Klerkx & Proctor, 2013), including practices related to climate change (Fleming & Vanclay, 2010).

6.2 Strategic marketing, messaging and presentation

"Early in the piece, it was decided by the project team that a positive approach would be a focus on resilience, rather than climate change, so the project was branded: "Resilient Cropping"

(Mathers & Bloomer, 2013, p. 4)

"The psychology of climate change communication [was considered], namely framing climate change within an appropriate context…and linking [it] to a current issue rather than something that is happening in 90 years time"

(Dunningham, 2013, p. 5)

Projects also demonstrated well thought-out messaging, tactical marketing and strategic presentation of material. Project teams appeared highly cognisant of how their events or resources

would be received, and thought carefully about how these were framed. This included project teams undertaking preliminary region-specific needs assessments to ensure messaging was relevant (Beef & Lamb NZ, 2014). This resulted in events being pitched as 'promoting business and farming resilience' (Kenny, 2012b; Kloeten & Praat, 2014; Mathers & Bloomer, 2013) and 'maximising farm production efficiency' (Wall et al., 2011), rather than climate change-focused events. This helped to maintain the focus on the connection between climate change and financial viability of the farm business.

Presenting the impacts of climate change directly carries the risk of promoting debate about human responsibility and the role humans play in climate change (Fleming & Vanclay, 2010). Research also suggests that discussing the urgency of need for actions, and reasons for action, are also less effective than providing realistic options to increase resilience to climate change (Fleming & Vanclay, 2010). This was supported by a workshop attendee's comment, a rural professional from Gisborne; "there are lots of sceptics re: climate change. Better to focus on building more sustainable robust business for business reasons alone" (Kloeten & Praat, 2014, p. 14). Evidence from farmer feedback suggested the events were effectively pitched, to ensure focus on the material most likely to be effective with farmers. It should be noted that the attitudes towards climate change may have shifted over the past five years since some of the comments were made. However, providing evidence to support any such shift is outside the scope of this review.

6.3 Well-considered event organisation

"Considerable effort was expended in designing and timing the in-field discussions to attract maximum exposure for the project"

(Mathers & Bloomer, 2013, p. 10)

A majority of projects demonstrated mindful, region and industry specific event organisation. Project teams carefully designed the logistics of the industry events, collectively considering timing (of year, week, day and season) and balance of interactive versus presentation style workshop events (Barugh, 2013; Kenny, 2012; Wall et al., 2011). The Pork Resources Project went so far as to ensure there was ample parking available, as their experience suggested farmers would arrive immediately before the event began (Barugh, 2013). As evidenced by participant feedback, this highly conscientious approach to event organisation and design resulted in well-received events.

6.4 Fit-for-purpose resources

"The resource given to farmers was well put together. Easy to read and comprehend."

(Beef & Lamb NZ, 2013, p. 11)

"Each seminar was tailored for the specific region, [and] included current…scientific information…policy and regulation initiatives, market and consumer drivers…[and] practical demonstration of best practice techniques"

(Beef & Lamb NZ, 2014, p. 11)

Projects demonstrated creation and use of region-specific, industry-specific and current resources. For example, the Kiwifruit Growers Project provided data on climate change variability tailored to each region in New Zealand; with examples (Kenny, 2012b). Projects also demonstrated versatility and responsiveness to participant feedback in relation to the resources. For example, the Train the Trainer Project found that "feedback from participants in Napier and Nelson has [suggested the resources are] too focused on the pastoral sector". In response, the project team "completed

some horticultural models…to look at the impact of the changing climate on the horticultural industry" (Kloeten & Praat, 2014, p. 12). This highlights the value of including ongoing monitoring and evaluation in projects, and adapting project activities to address any issues identified from the ongoing M&E (Casey et al., 2015; Botha et al., 2017).

Utilising the Technology Transfer Resources Project to provide the Demonstration Projects with resources also served to increase the quality, relevance and consistency of the resources. Notably however, the Arable and Cropping Project found that some resources that were expected to arrive from the Resources Project "did not eventuate" (Mathers & Bloomer, 2013, p. 9). Similarly, the Train the Trainer Project experienced delays, inconsistencies and non-delivery of data from the Resources project. Nevertheless, these issues appeared to be largely due to differing expectations surrounding timeframes and what could be provided (Kloeten & Praat, 2014; Mathers & Bloomers, 2013). Overall, across the projects it appeared that the quality of the material provided to next- and end-users was very high.

7. Barriers: What are the key barriers to stakeholders adopting SLMACC findings and recommendations?

This barriers or 'lessons learned' section is comprised of observations from the reviewers, after cross-examining the technology transfer project reports and identifying commonalities in learnings that occurred throughout the projects. These lessons were largely identified by the project leaders themselves in the first instance, and were included here if mentioned in more than one project. Lessons are listed according to the number of projects they are relevant to, with those relevant to a larger number of projects listed first. These lessons are predominantly drawn from the Demonstration Projects and the Train the Trainer Project. This is due to the diversity in project operation and the format of outputs of the other projects, which prohibits drawing high level conclusions across these projects.

These lessons learned represent factors that were well-considered and successfully addressed in some projects, but less so in others. Nevertheless, these were repeatedly stated as highly important by the project teams.

The four lessons learned, which reiterate the recommendations for extension outlined in the Over the Fence Handbook (Casey et al., 2015) are:

1. Farmers and growers want practical, realistic and immediate take-home options for their farm, orchard or crop
2. Timing of events is critical
3. Stakeholder buy-in is important
4. Publicising events effectively is critical

7.1 Farmers want practical, realistic and immediate take-home options

"Farmers really wanted to know what they could do, concentrating mostly on the short term"
Farmer workshop participant (Beef & Lamb NZ, 2014, p. 12)

"The most successful engagement format was where climate change formed part of a workshop and where the workshop focused more on options for mitigating or adapting to current and future climatic effects"
(Dunningham, 2013, p. i)

The most frequently raised lesson learned (mentioned in five technology transfer projects) was the critical need for practical, useful, take-home information for farmers and growers. Event attendees "wanted more hands-on examples" (Beef and Lamb NZ, 2014, p. 12), "something they could do on their farms" (Wall et al., 2011, p. 4), "something tangible to take away and…pin on the 'smoko' room wall" (Barugh, 2013, p. 6). In the Demonstration Projects, farmers repeatedly expressed that to make their time worthwhile, they wanted new ideas and resources, which had immediate relevance to their current farm system. This necessitates providing information that is context- and region-specific, to "make the risk real with examples of real life" (Beef & Lamb NZ, 2014; Kloeten & Praat, 2014, p. 13). This information also needs to be relevant for diverse farm systems. A majority of the technology transfer projects were able to cater to some extent to this need, nevertheless this remained a critical component of making the events worthwhile (Barugh, 2013; Beef & Lamb NZ, 2014; Kloeten & Praat, 2014; Mathers & Bloomer, 2013; Wall et al., 2011). One project leader acknowledged that "whilst important messages [such as climate change] do not

become weakened from continuous presentation, it is also important to offer farmers new perspectives" (Mathers & Bloomer, 2013, p. 13). This project leader acknowledged that the majority of information presented to arable and vegetable farmers through their event was already known to farmers, and this was suspected to be a contributing factor in the poor reception of the event (Mathers & Bloomer, 2013).

This lesson is positive, as it implies that farmer acceptance of climate change is already high, if attendees are arriving at events open to hearing about mitigation options to implement on their farm. This is supported by one baseline survey of horticulture, arable and crop farmers conducted in 2011, which found that 93% of farmers believed climate variability would affect their business in the future (Mathers & Bloomer, 2013). These farmers had recognised the risks that were associated with a changing climate and had identified and begun to address the factors associated with risk on farm (e.g. poor drainage, insufficient irrigation; Mathers & Bloomer, 2013).

This willingness to hear and consider actions for change in a majority of technology transfer projects suggests a shift from the early stages to the latter stages of behaviour change (Cameron, Davies, Boyce & Neill, 2003; Casey et al., 2015). That is, farmers have demonstrated a shift in their general beliefs and worldviews, toward accepting climate change as real, shifting from pre-contemplation (being unaware) to contemplation (giving consideration), and preparation (weighing up) (Casey et al., 2015; Mathers & Bloomer, 2013). Attendance at the technology transfer events then suggests a shift toward the action stage of behaviour change, where participants are ready and willing to make changes (Casey et al., 2015). This shift in readiness for change was demonstrated in the Kiwifruit Project, where "the lowest [workshop feedback] score…was for learning experience. This is attributed to the fact that most participants are already well informed about climate change" (Kenny, 2012b, p. 9).

This finding suggests that future technology transfer activities for New Zealand farmers need to be cautious about spending too much time on awareness raising activities (Fleming & Vanclay, 2010). The focus now needs to shift to predominantly on providing farmers with immediate and realistic take-home mitigation and/or adaptation options.

Key considerations for these take-home options for farmers are (from Casey et al., 2015; Fleming & Vanclay, 2010; Panell et al., 2006):

- Affordability (time, money)
- Acceptability (social licence)
- Availability (must be timely)
- Practicalities (existing infrastructure)
- Convenience (ease to implement)

It would be useful to review current information and survey farmers, growers and rural professionals to measure the current extent of:

- Awareness of region-specific climate change impacts at the farm-level;
- Attitudes toward climate change adaptation;
- Awareness of mitigation and adaptation options available and being considered;
- **Farmer sources of knowledge** in relation to mitigation and adaptation options;

Farmer knowledge, skill and infrastructure needs to support uptake of mitigation and adaptation options. This information will be useful for the SLMACC programme, industry bodies and rural professionals to identify strategic priorities for the types of and information provided in extension activities, as well as science knowledge gaps that need to be addressed to support

farmer uptake of mitigation and adaptation options. For example, what proportion of the target population of farmers and growers in different sectors and regions have attitudes aligned to climate change adaptation and are at what stages of practice change (pre-contemplation to contemplation to preparation).

7.2 Timing of events is absolutely critical

"[Events] need to be scheduled to fit in an increasingly crowded extension events calendar"
(Mathers & Bloomer, 2013, p. 13)

"The sessions…coincided with the apple harvest which precluded some growers [from attending] in these regions"
(Kenny, 2012a, p. 2)

Attendance rates across the technology transfer projects were highly variable, with as few as one and as many as 140 attendees per event (Barugh, 2013; Kenny, 2012b; Kloeten & Praat, 2014). Key determinants appeared to be the financial climate ('bad years' for farmers), and political and cultural climates; 'pressure' times for end users, such as significant financial downturns in the relevant industry) (Barugh, 2013; Beef & Lamb NZ, 2014; Kenny, 2012b; Mathers & Bloomer, 2013). Alignment with other large industry events is likely to be a highly effective way of boosting attendance rates (Wall et al., 2011). One project leader noted that it would have been beneficial to combine two separate events; "with hindsight it would have been better for the [field days] and [climate change seminars] to be promoted as one, rather than separately" (Kenny, 2012a, p. 2).

The majority of technology transfer projects were highly aware of the importance of timing, with one project refining events down to "late afternoon/early evening…possibly earlier in winter and later in summer with a break in the middle to allow a 'stretch'" (Barugh, 2013). In attempts to optimise timing of events, projects also sought industry buy-in, promoted events extensively, consulted with farmers, and aligned workshops with existing industry events (Barugh, 2013; Kenny, 2012b; Mathers & Bloomer, 2013). Nevertheless, being able to implement an event at an appropriate time is contingent not only on project timeframes but on delivery milestones being flexible, to allow delay in delivery if necessary. This is an important consideration in technology transfer contracts moving forward, to ensure flexibility can be incorporated to allow the project team to respond to unanticipated circumstances and lessons identified from ongoing monitoring and evaluation (M&E) of projects (Botha et al., 2017).

It is also important to first confirm that an extension event is the most effective channel of knowledge exchange, as in some cases (e.g. Barugh, 2013), it was suggested there were other more appropriate knowledge exchange mechanisms to reach farmers. Over the Fence (Casey et al., 2015) includes guidance on different mechanisms of knowledge exchange and when each are more appropriate.

7.3 Stakeholder buy-in is highly important

"Without skin in the game, their engagement was extremely weak…this lack of industry engagement was disappointing and it prompted the cancellation of the proposed seminar topics"
(Mathers & Bloomer, 2011, p. 13)

Four technology transfer projects mentioned the importance of having partnership sector buy-in. One project leader suggested that at least one person representing each organisation or industry

should be passionate and energetic about the project (Mathers & Bloomer, 2013). Ideally this person would also be an effective 'influencer' in the area. This serves many functions, including providing contacts to key personnel in each region, who can rally attendees and publicise the event (Beef & Lamb NZ, 2014; Wall et al., 2011). For example in the kiwifruit project, a local organisation in Kerikeri was able to promote the workshop event, and attendance was increased five-fold (from an average of 7 participants to 37; Kenny, 2012b). Stakeholder buy-in also demonstrates to local farmers or other potential event attendees that the topic is considered to be locally relevant and important at the time, and attending the event is a worthwhile investment of their time. Stakeholders along the value chain have a role in enabling the effective technology transfer to occur, and stakeholders are critical in this value chain (Ministry for Primary Industries, 2012). Stakeholder analysis as part of the design of technology transfer projects will help ensure these stakeholders are identified and how their interests may align with the project to be able to support the success of the project (Beyond Results, 2017; Percy et al., 2015).

7.4 Publicising events effectively is critical

"A number of growers commented that there was very little local publicity of the sessions"
(Kenny, 2012a, p. 2)

"Publicity is not good for these events, use snail mail"
New Zealand pork farmer (Barugh, 2013, p. 6)

Although intuitive, the effective publicising of events was a critical issue for at least three technology transfer projects (Barugh, 2013; Kenny, 2012a; Mathers & Bloomer, 2013). Despite these projects using multiple waves of publicity per event, it tended to be through a single channel (e.g. one industry newsletter) (Barugh, 2013; Kenny, 2012b). In contrast, the Deer Focus Farms Project combined with an industry event to achieve high attendance rates, thereby using existing industry advertising (Wall et al., 2011). Interestingly, the Train the Trainer Project sent out customised emails to over 600 Rural Professionals, although this did not appear to increase attendance rates (Kloeten & Praat, 2013).

In summary, it appears that effective and efficient publicising of events should involve advertising through multiple, well-read channels (emails, newsletters, flyers, word of mouth, industry networks) and/or work-in with industry event planning.

8. Gaps analysis: What are the knowledge gaps the need to be met?

This future improvements section comprises high level observations regarding gaps in knowledge of technology transfer. Specific recommendations for MPI and recommendations for further research can be found in Section 10.2 (page 60). These topics were not issues identified by the project leaders themselves, but were broader issues apparent when examining the projects as a suite of activities.

There were three broad areas for improvement identified:

1. A need for embedded monitoring and evaluation to facilitate action learning within the project, to guide adaptation to changing circumstances and hence increase the potential impact of projects. This is also critical at the SLMACC fund level, to inform future evaluations and hence provide stronger evidence of the impacts of the fund; and inform planning and decision-making at the fund level.
2. Use of participatory extension methods to extend the reach of the work.
3. Co-design of resources and events to increase the uptake of the messages and actions.

8.1 Embedded monitoring and evaluation (M&E) for action learning

"It is difficult to know how successful we have been in lifting farmer's awareness of climate change"

(Mathers, 2013, p. 2)

""We can safely assume there will be some low hanging fruit in terms of practice change, and that in time the depth of thinking and responsiveness will expand...this can't be easily verified until a farmer questionnaire is conducted in the future"

(Beef & Lamb NZ, 2014, p. 8)

Lack of monitoring and evaluation was the most significant issue identified for the SLMACC technology transfer projects, where only two projects used a pre- and post-event measure that assessed the outcomes of the project (Beef & Lamb NZ, 2012; Kloeten & Praat, 2014). The Sheep and Beef Farmers Project was a good practice example of using M&E. It paired evaluation measures with monitoring systems, including quarterly review statements to provide evidence of project quality, as well as a steering group and communications plan (Beef & Lamb NZ, 2014). When used in conjunction with a tracking system (fortnightly updates), these measures allowed the project team "to scan the project across all areas, [and] take judgement calls on 'where to next'". This was "a mechanism to provide evidence that the project was progressing according to plan, or [if] any changes were required". The critical question in this context was "And if not, why not?" (Beef & Lamb NZ, 2014, p. 10). This proactive attitude to monitoring progress allowed the project team to: a) change the content of the workshops quickly and effectively; b) change monitoring methods to ensure they were capturing desired data; and c) adjust protocol during hui to acknowledge local areas and local people (Beef & Lamb, 2013).

Table 5 overleaf shows the extent to which M&E was implemented in each of the technology transfer projects, including the outcomes or impacts being formally measured (devised from evidence in project outputs). For the Resources Development project, the project team commented "we were dependent on the participant surveys conducted by the respective contractors" (Rhodes,

Brown & Dynes, 2013, p. 5). This would have provided an excellent opportunity to consistently assess the outcome of the resources provided. However, “these surveys were limited in content and objectivity, and consequently comment and feedback tended to be subjective and often anecdotal” (Rhodes, Brown & Dynes, 2013, p. 5). In a majority of cases, the targeted end-user was clearly identified in the research proposal, but subsequent use of the research or uptake of technology transfer activities by these end-users was not monitored.

Table 5. Presence of formal* monitoring of outcomes or impacts (e.g. increased awareness, knowledge, behaviour and skills) in each of the SLMACC technology transfer projects.

Project name	Pre-implementation measure	Post-implementation measure	Was change over time measured?
Demonstration project to Arable and Vegetable Farmers	Yes: Survey questionnaire assessing sector exposure to climate change	No	No
Demonstration project to Sheep and Beef Farmers	Yes: Needs analysis and survey questionnaire assessing perceptions of climate change	Yes: Survey questionnaire assessing perceptions of climate change and facilitator commentary posts	Yes
Demonstration project to Kiwifruit Growers	No	Yes: Survey questionnaire assessing workshop quality (not included in all workshops)	No
Demonstration project on Deer Focus Farms	No	No	No
Demonstration project for the Pork Industry	No	Yes: Survey questionnaire assessing workshop quality and preferred technology transfer methods	No
Demonstration Forests project	Yes: Multiple methods to assess sector needs	No	No
Resource development project	No	No	No
Climate Cloud	No	Yes: Usage statistics	No
Extension Handbook	No	No	No
Train the Trainer	Yes: Knowledge uptake measure	Yes: Knowledge uptake measure	Yes

*Formal M&E was defined in this review as having structure and/or process, such as a survey questionnaire, needs analysis or impact assessment. Informal discussions with participants post-workshop were not included as formal M&E activities.

M&E should be incorporated in every project from the outset, or at a very minimum, an evaluation should be conducted prior to the end of the project (White, 2014). This is the best way to effectively, efficiently and accurately assess the achievement of outcomes and impacts (Social Policy

Evaluation and Research Unit, 2017). Utilising M&E from the outset of a project, through its duration (see Figure 6 for different types of evaluation), enables a project to continuously improve and increase impact (Allen et al., 2017). Barr et al. (2016) provide useful tools for costing the inclusion of M&E in projects.

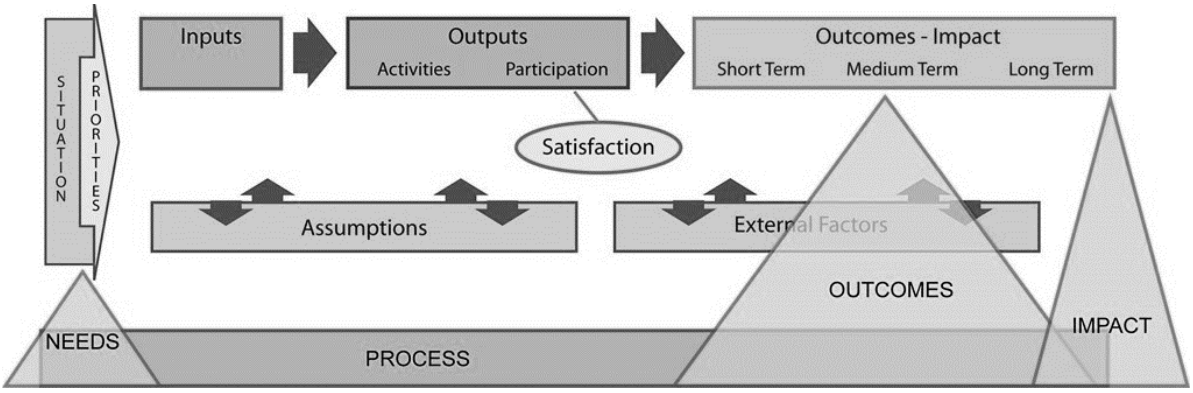


Figure 6. Different types of evaluation: from needs assessment, to process, outcomes and impact evaluations.

Where M&E has been implemented in a project, meausres tend to focus at the output level, such as measuring the number of attendees at events (Bozeman et al., 2015). These measures are referred to as 'out-the-door' measures, which ask 'was the technology transferred?' (Bozeman et al., 2015), and fail to assess the wider, more valuable questions about outcomes and impact. This is true for the SLMACC technology transfer projects, where the majority of M&E focused on counting event attendees, or the number of resources produced (Barugh, 2013; Wall et al., 2011, Dunningham, 2016). These metrics do not permit an accurate estimation about the amount of knowledge and behaviour increases that occurred as the result of an event, or how many farmers intended to implement a change on their farm. Bennett's Hierarchy (Radhakrishna & Bowen 2010) is an evaluation model for extension projects that provides a useful starting point for thinking about stronger, more relevant and robut measures of project impact (Figure 7).

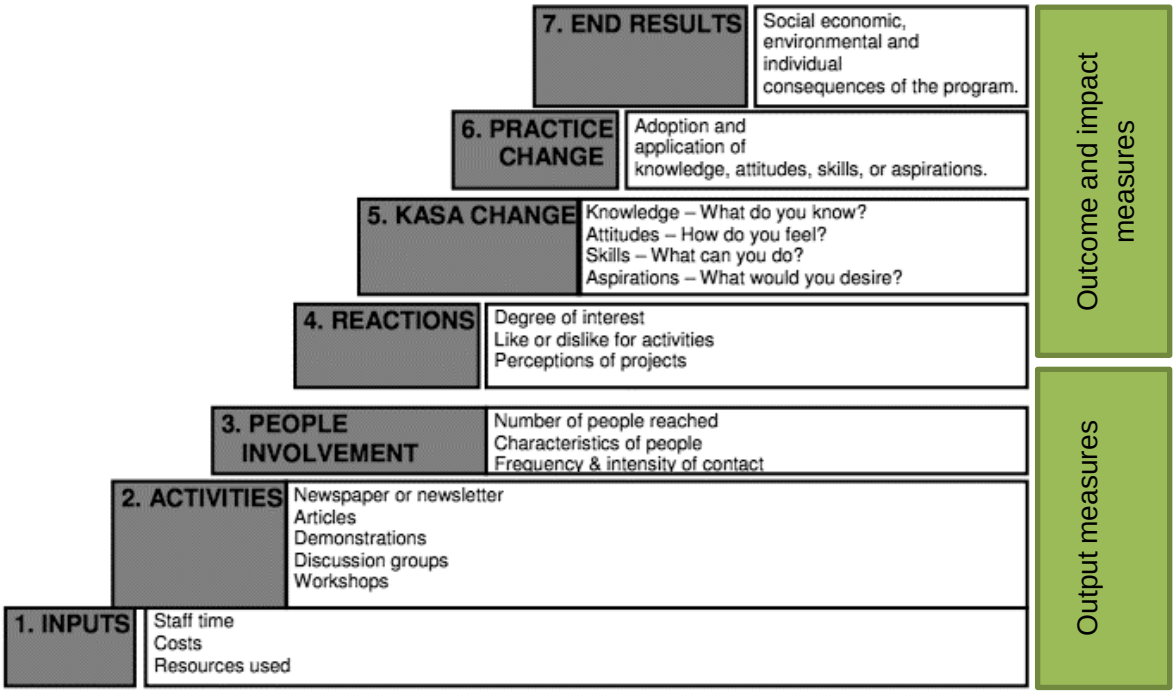


Figure 7. Bennett's hierarchy of evidence for evaluation of program impacts, highlighting output versus outcome and impact measures.

The lack of M&E in the SLMACC technology transfer projects (in particular measure of outcomes and impact) has also meant a lack of information about:

- If or how research is being used to inform policy (e.g. by Regional Councils). This is inherently connected to the measurement of impact.
- If or how resources developed through the projects have been taken up and used within the science community (including unintended use and benefits).

It is acknowledged that assessing outcomes and impacts ex-post is time-intensive, costly, and difficult to attribute back to the project (Social Policy Evaluation and Research Unit, 2017; Radhakrishna & Bowen 2010). However, mandatory reporting on key criteria such as those used in the rubric for this review may be necessary to include in future contracts and scope, to ensure adequate M&E occurs. These key criteria ideally need to be developed by the project team at the start of the project. This would enable MPI as the investor in these projects to better evaluate the outcomes and impacts of projects[7].

8.2 Participatory extension methods

Consistent with the findings from Casey et al. (2015) and Dunningham et al. (2015), where possible, technology transfer activities need to be participatory, with participants such as farmers interacting, and not to simply attending and absorbing information from scientists or other nonfarmer 'experts'. This was re-iterated by event participants, who expressed a desire to have more interactive discussion, and involvement of local farmers, whom they found credible and relatable (i.e. with the potential to positively influence others' behaviour):

"Maybe have a guest speaker farmer"
"Would have been interesting to have more questions and answers"
"Get some farmers along...farmers views on these issues"
"Invite top farmers to explain management systems and pros and cons of these"
(Kloeten & Praat, 2014, p. 13)

"[Having] group discussion with other likeminded local farmers and industry people. This gave a sense that we farmers are all in the same boat and that we need to do something about it"
(Beef & Lamb, 2013, p. 11)

Although most projects had some degree of participatory engagement, such as having a question and answer session at the end of an event (e.g. Kloeten & Praat, 2014), having discussion among participants, and with like-minded presenters and facilitators, presents a unique learning opportunity. This will be increasingly important as the technology transfer activities encourage a shift toward implementation and behaviour change, and the logistics of implementation in different farming systems become critical. To address these topics it is important to have farmers share their experiences and expertise with implementing practices alongside other technical knowledge from rural professionals and scientists, to help translate how a practice can be implemented in their own farm systems (Sewell et al., 2014). Having an experienced facilitator to design and guide the process is important to the success of participatory engagement.

[7] See Ministry for Business, Innovation & Employment (2017) for more information on measuring impact.

8.3 Co-design of resources and events

Co-designing the content and structure of events and resources with end-users increases the likelihood that the resources and events provided will be fit-for-purpose and meet next- and end-user needs (Casey et al., 2015). The degree of stakeholder involvement should be matched with the complexity of the issue being addressed, as described in the Extension Handbook (Casey et al., 2015, p. 41).

Payne et al. (2016) provide a series of diagnostic questions regarding the technology and problem being addressed by extension to assess the degree of stakeholder engagement that is needed. Examples where involvement of stakeholders and/or end users resulted in improved events and resources in the technology transfer projects included:

- The Kiwifruit Growers project engaged in "in-depth consultations…with both principal partners to this project, Zespri and Bay of Plenty Regional Council." This enabled the project leader to ensure the aim of the project was clear; "their needs therefore are not for communication to growers and other land managers…rather they are seeking development of a deeper understanding of climate change…as a means of support behaviour change and value creation." (Kenny & Roberts, 2011, p. 1). Likely due to "Zespri [taking] the lead in terms of timing and promotion of the workshop", "the process worked very well with the majority of the participants actively engaged…[as] participating growers saw the relevance of these sessions in the context on the current Psa-V challenge" (Kenny, 2012b, p. 4).
- In the Deer Farmers project, co-design of the presentation events with a key Deer Industry Body appeared to help contribute to the fact that "All of the field days were very well attended". The material was "designed to integrate into the general theme of the day, while still exposing deer farmers to…the best on-farm mitigation options currently available" (Wall et al., 2011, p. 4).
- In contrast, in the Arable and Vegetable Farmers project, where "there were ongoing challenges with maintaining engagement with farmers and industry partners", "the resources that were developed…were largely derived from outputs from previous projects, so farmers were mostly aware of their existence". This resulted in the project being "business as usual" (Mathers & Bloomer, 2013, p. 14).

These examples, in congruence with the literature, suggest that co-design of the content and structure of resources and events improves outcomes and impacts (Casey et al., 2015). Nevertheless, it is acknowledged that co-design is not always possible, necessary or beneficial (Payne et al., 2016).

9. Additional opportunities

9.1 Improving attendance at events

"[The event] lacked farmer support. Almost a common complaint was that not more farmers were present and [this] reflects the early adopter's scenario"

New Zealand Sheep and Beef farmer (Beef and Lamb, 2014, p. 12)

"Throughout the project there were ongoing challenges with maintaining engagement with farmers and industry partners"

(Mathers & Bloomer, 2013, p. 13)

Despite widespread advertising and detailed communications plans for many of the technology transfer events, attendance rates for farmers and growers were as low as one participant (for example see Kenny, 2012b). Admittedly for some events, more diverse advertising strategies could have been utilised; for example, the pork farmer events were advertised using a single outlet (Barugh, 2013). However for others, advertising across platforms (newsletters, publications, mailed notices), combining with industry events, and inviting industry specialists was not sufficient to attract a reasonable audience (Kenny, 2012b; Mathers & Bloomer, 2013). This suggests larger issues, which are likely beyond the control of the technology transfer Project Teams themselves. In light of the consistency of this issue across projects, more work is needed to identify how these larger issues can be addressed to increase attendance. For example, through higher-level and consistent messaging from Government, industry bodies, leading farmers and research organisations regarding the opportunities from adapting and mitigating climate change.

9.2 Information provided must be consistent

"There was a lot of comment on the need for RP's to promote awareness of climate change. It is critical a common set of messages is produced, as a handout, for rural professionals (RPs) to both distribute and guide discussion"

"Summarise key messages for discussion, prioritise. Inconsistent messages to farmers will set awareness back big time".

(Kloeten & Praat, 2014, p. 13)

Finally, for the Train the Trainer project, rural professional attendees stressed the importance of delivering a consistent message to farmers. Although not specifically raised by other projects, consistency remains an important consideration, particularly in regard to the broader messages delivered by the SLMACC Technology Transfer Programme as a whole. Any conflict between the information presented about climate change can result in a shift of focus from action, to doubt about the legitimacy and personal role in mitigating climate change (Fleming & Vanclay, 2010; Gifford, 2011). That is, the associated consequences of uncertainty, discordance, denial or reactance become activated, as psychological barriers to taking action against climate change (both adaptation and mitigation; Gifford, 2011). Communications should also focus on the action needed as opposed to the issue itself; this will assist in making the communication less information intensive. A system for ensuring the message remains consistent across the Technology Transfer Programme would be valuable moving forward; this is a role that MPI could play.

9.3 Reaching a wider audience with information

With the exception of the Climate Cloud and Resources project, the technology transfer projects targeted a particular end-user audience (e.g. kiwifruit growers), which is an entirely appropriate approach for targeted dissemination. However, evidence suggests only a small proportion of the end-user audience was reached in some cases; and it still begs the question: how does the wider community of farmers and general public engage with the knowledge developed through the SLMACC fund? There is an opportunity to consider this question through the use of more current approaches such as citizen science and social media engagement and learning, perhaps in conjunction with the National Science Challenges. It is also something that could be part of the design of future SLMACC proposals, particularly those with a focus on technology transfer i.e. building in the wider dissemination of relevant information beyond the target audience. MPI may need to play a role in the wider dissemination, given that individual project managers do not always have the networks beyond their sector, nor the expertise to engage with wider communication methods.

10. Applying learnings: What actions are recommended, to maximise the future value and usefulness of SLMACC research?

10.1 Summary of findings

The strengths, lessons learned and areas for improvement identified through this review are well-documented in the literature as key factors that influence the success of technology transfer programmes (e.g. reviews by Bozeman et al. (2015) Casey et al. (2015), and Payne et al. (2016)).

Table 6 below relates each of these factors identified above, to the five "categories of technology transfer effectiveness determinants" identified by Bozeman et al. (2015, p. 35). These categories examine the findings at a higher level than the rubric, namely looking at the 'who, what, to whom, when and how' of technology transfer. Strengths of the SLMACC technology transfer projects in relation to these determinants are displayed in dark green (positives), lessons learned in mid green (where there is room for improvement), and areas for improvement in light green (which require addressing).

Table 6. The relationship between effectiveness determinants of technology transfer (as identified by Bozeman et al., 2015) and the strengths, lessons learned and areas for improvement of the SLMACC technology transfer projects.

Technology transfer effectiveness determinants	Strengths	Lessons learned	Areas for improvement
1) Who (characteristics of the transfer agent)	Sophisticated science and professional expertise		↑
2) How (characteristics of the media transfer)	Attentive event organisation	Timing of events is critical Publicising of events is critical Consider different fit-for-purpose knowledge exchange methods	Embedded monitoring and evaluation Participatory methods
3) What (characteristics of the transfer object)	Fit-for-purpose resources		Co-design of resources and events
4) To whom (characteristics of the transfer recipient)		Farmers want practical, realistic and immediate take-home options for their farms	↓
5) When (demand environment)	Strategic marketing and presentation	Stakeholder buy-in is critical Use of multiple outlets for raising awareness of an event	

Figure 6 depicts that SLMACC technology transfer projects:

- Tend to be effective at the 'who' of technology transfer (utilising expert knowledge creators and extensionists (farm advisors, rural professionals));
- Tend to be effective at the 'what' of technology transfer (developing content resources and events);
- Tend to be relatively effective at gauging the 'when' of technology transfer (timing, including the economic, political, social and cultural environment);
- Need to improve the operational aspects of the 'how' of technology transfer (publicising events, recruiting attendees);
- Need to ensure focus of technology transfer events shifts from awareness raising to providing options for behaviour change (practical, realistic and immediate take-home options). Nevertheless, the extent to which awareness raising activities are needed within specific populations still needs to be evaluated, from a review of studies and survey of the wider New Zealand farmer and grower population;
- Need to ensure that when appropriate and where possible, co-design of resources and events, and participatory methods, are utilised; and
- Urgently need to embed systematic monitoring and evaluation, to:
    - Inform adaptation of project activities to changing internal project and external circumstances;
    - Evidence progress toward impact;
    - Assess the 'where to from here' of technology transfer (using the action learning cycle).
- Support the adaption of project activities to changing internal project and external circumstances, for example through providing flexibility with milestones and deliverables.
- Need to consider the wider dissemination of information beyond the target group or audience – how does this best occur, how is it resources, and who has a role to ensure this happens?

Based on the findings from this review, several gaps or weaknesses within the SLMACC Technology Transfer Programme can be identified. Ultimately, the findings suggest that there is some fragmentation across the technology transfer system, and therefore variable performance. This is consistent with the findings of the technology transfer survey of farmers, which highlighted a disconnect between knowledge creators and knowledge disseminators (Ministry for Primary Industries, 2012). A diagnosis of the performance of the wider agricultural innovation system (Turner et al., 2016) also highlighted:

- A lack of coordination of (and sometimes competing) research, development and extension agendas and activities; and
- An emphasis on knowledge development, relative to other innovation support activities (e.g. extension, entrepreneurship) needed to deliver impact.

This fragmentation is also characteristic of the broader science system in New Zealand, which has struggled to adequately measure and display impact (Ministry of Business, Innovation and Employment, 2017).

The ten projects in the SLMACC Technology Transfer Programme have focused on disseminating existing knowledge and to a lesser extent developing skills (i.e. Train the Trainer) about climate change adaptation and mitigation, to audiences of farmers, growers, foresters, and their advisers. From the evidence presented in this report we can say that they have largely done what they were required to do and in most cases, employed best practice approaches to do so.

10.2 Recommendations for MPI

1. **Build in M&E at the project level**. Ongoing monitoring is needed to conduct an effective and efficient evaluation (Social Policy Evaluation and Research Unit, 2017). This may require a change in the project team's mind-sets, to understand why M&E is critical and what best practice M&E looks like (Ministry of Business, Innovation and Employment, 2017).
2. **Shift the focus of SLMACC Technology Transfer Programme to extension** (rather than technology transfer), and encourage use of fit-for-purpose extension approaches based on the MPI extension framework.
3. The current focus of SLMACC technology transfer projects has been on knowledge. There needs to be a **shift now toward designing programmes of activities to address the other three drivers of behaviour change** (attitudes, skills and aspirations), particularly as enablers and drivers of farmer and grower use of knowledge already developed and provided by SLMACC projects.
4. **Ensure technology transfer activities, approach and method are fit-for-purpose**. The gaps are not only whether we need more workshops or resources, but also *whether* more workshops and resources are going to provide the right outcomes. Start with the results you want, the audience it is targeted at, and work backwards to design the delivery activity (Casey et al., 2015).
5. **Principles of success** that have been demonstrated to lead to impact (Boyce et al., 2017; Turner et al., 2017) **should be built into all large SLMACC projects** focused on impact (not only the technology transfer projects).
6. **Ensure there is a legacy organisation involved in the project** that will have an on-going role in keeping information up to date and accessible once the project funding stops, in order to ensure and measure on-going impact (e.g. have any key resources been created from the project?)

10.3 Research-oriented recommendations

1. Review current baseline information (or gaps) and survey farmers, growers and rural professionals to **measure the current extent of**:
    - **Awareness** of region-specific climate change impacts at the farm-level;
    - **Attitudes** toward climate change adaptation;
    - Awareness of mitigation and adaptation options available and being considered;
    - **Farmer knowledge, skill and infrastructure needs** to support uptake of mitigation and adaptation options
    - **Farmer sources of knowledge** in relation to mitigation and adaptation options.

    This information will be useful for the SLMACC programme, industry bodies and rural professionals to identify strategic priorities for the types of and information provided in extension activities, as well as science knowledge gaps that need to be addressed to support farmer uptake of mitigation and adaptation options. It will also work to ensure that public investment is well targeted and worthwhile.
2. **Analyse the climate change innovation system**. This analysis will **support implementation of findings beyond individual projects, to assist in providing a more effective programme wide strategy**. An analysis of this system in New Zealand could ask who the key stakeholders are (e.g. farmers, growers, processors, policy makers, advisors, and scientists), how they interact, and how the knowledge is exchanged among stakeholders within the system. Answering these questions would help to determine where the right knowledge is not reaching key knowledge users. This analysis could be undertaken using social network analysis. In this context, an innovation system is "a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into economic use, together with the

institutions and policies that affect the way different agents interact, share, access, exchange and use knowledge" (Hall et al. 2006, p. vi–vii).

3. As the understanding of what makes good technology transfer or extension has shifted from linear and bilateral approaches to systems based, participatory and networked approaches (Klerkx et al., 2012; Ministry for Primary Industries, 2015); **the language around technology transfer also needs to shift**. For example the term "knowledge exchange" may be more appropriate in some situations, as it implies a two–way exchange that involves inclusion of farmer and grower knowledge. This is important as farmers and growers seek to implement mitigation and adaptation practices into their farm systems.
4. It may be necessary to investigate **new approaches** to extension of climate change knowledge to involve the wider public, including schools, in the generation and exchange of knowledge around climate change – for example through citizen science activities; the use of electronic communication (social media, virtual experiences, gaming etc.) This could potentially be in conjunction with the National Science Challenges who are taking similar approaches.

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12. Appendices

See below for a copy of the programme logic model and evaluative criteria rubric used for this review.

12.1 SLMACC Evaluative Criteria Rubric	Rating
1. SCIENCE CAPACITY AND CAPABILITY ENHANCEMENT	
Builds capacity for NZ to research climate change and sustainable land use, at all levels	
Improves capability and skills amongst emerging or early career researchers	
2. INFLUENCE ON SCIENCE	
Promotes collaboration among research providers, and/or between different disciplines	
Generates high quality research related to climate change or sustainable land use, which is credible and legitimate (e.g. citations, impact factor) with relevant stakeholders (e.g. International Panel on Climate Change)	
Utilises robust, best practice research methods (poor may use random or unexplainable method and excellent may use novel methods or techniques, sound results)	
Result in uptake and use of research within science community (excellent would result in strong uptake and use of research within science community)	
3. ENGAGEMENT AND NETWORKS (if applicable)	
Builds collaborative networks of key stakeholders and/or end-users (poor may include homogenous networks which disperse following project and excellent networks are heterogeneous (e.g. different epistemologies, type of expertise, values) and enduring)	
Uses participatory research process appropriate to level of engagement needed to achieve outcomes (based on MPI Extension Framework). e.g. where end users have opportunity to shape research approach, sources of knowledge and outcomes	
Uses structure or processes to guide stakeholder engagement (poor may have no clear processes for stakeholder engagement and excellent may use processes like a community of practice)	
Practices action learning (if applicable)	
4. LEARNING, AWARENESS AND KNOWLEDGE GAIN AMONG END USERS	
Generates new knowledge about climate change or sustainable land use	
Promotes knowledge exchange (particularly dissemination of research findings)	
Builds increased awareness and knowledge about climate change or sustainable land use practices	
Promotes practice or behaviour change among intended end or next user groups	
5. USABILITY OF RESEARCH FOR END USERS	
Generates specific, usable, fit-for-purpose knowledge and research for policy and trade/negotiation, research, science and stakeholder communities	
Aligns research with the needs of next or end users of the research, and is responsive to next or end user needs and knowledge gaps (poor may lack alignment and excellent may involve iterative research to meet user needs)	
Acknowledges context and effects of the research knowledge or recommendations on the broader climate system or topic area	
Creates accessible, available outputs	
6. INFLUENCE ON STAKEHOLDERS AND IMPACT FOR NZ	

[How the research is designed and delivered] maximises how wide-reaching the research influence is (inter/national, across relevant sectors and functions, e.g., policy, industry and community attitudes and behaviours)	
Results in uptake and use of research by stakeholder groups (policy, government, industry or community)	
Influences stakeholders positively in their awareness/ consideration of decision-making, and/or action around climate change or sustainable land use (e.g. policy, government, industry or community)	
Achieves significant direct impacts or benefits for NZ (poor would be no impact, good incremental, excellent would be wide ranging or more immediate impact)	
Achieves significant direct spill-over impacts or benefits for NZ (poor would be no impact, good incremental, excellent would be wide ranging or immediate impact)	

Rating scale for evaluative criteria rubric					
1 **Low degree** (Never or seldom with clear weakness)	**2 Moderate degree** (Mostly, or sometimes with few exceptions)	**3 High degree** (Always to almost always)	**IE** Insufficient evidence	**E** Emergent	**N/A** Not applicable (e.g. not asked for by SLMACC)

12.2 Programme logic model (overleaf)

Updated: March 2017

Programme logic model: The issues and desired outcomes of the SLMACC fund

Vision: [Insert vision or overall impact statement]

Critical issues

What are the current issues (or opportunities) that this project will address?

- Meet international greenhouse gas reduction goals
- Maintain profitable agricultural and forestry sectors while reducing emissions
- Maintain profitable agricultural and forestry sectors under a changing climate
- Uncertainty if we have land use practices that are sustainable for the future
- Lack of understanding of the impacts, implications and adaptations of climate change for the primary industries
- Lack of urgency for responding to climate change in the primary industries
- Lack of mechanism to respond to new climate change issues quickly and inform government policy and the public

Outcomes/Impacts

Retrospective (In last 10 years)	Short-term (1-5 years)	Mid-term (6-10 years)	Long-term (10+ years)
Established networks of researchers and policy makers to address mitigation and adaptation challenges. Increased collaboration among these networks.	Effective knowledge exchange between researchers, policy and decision makers – emerging linkages and networks	Increased capacity in areas of technology, innovation, commercialisation and best practice in the primary industries	Improved national and international reputation for primary sector and New Zealand more broadly, in climate change area
Increased capability and capacity in New Zealand in climate change science and research. New Zealand world leader in agricultural climate change mitigation research area.	Increased understanding and clarity of the critical knowledge gaps	Increased body of legitimate, credible and accepted knowledge about climate change (vs. sceptics 'alternative facts')	Consumers of New Zealand's products can choose products with accurate greenhouse gas footprint labelling, potentially leading to farmers receiving a premium
Baseline data and models for available for key stakeholders, and knowledge gaps identified to inform future research and policy	Set of mitigation options accepted by international science community	Increased number of mitigation and adaptation options available to farmers, including farmers who cannot mitigate climate change and remain profitable (e.g. land use change). Mitigations included in national inventory	On-farm standard practices include a range of mitigation options ('toolbox') to reduce emissions while remaining profitable
Increased awareness amongst researchers, primary sector and some farmers about climate change, mitigation options and sustainable land use practices	Intersection and interaction between water land used, mitigation and adaptation planning (including trade-offs) has been identified	Increased accountability and acceptance of contributing to climate change from the primary industries	New Zealand primary sectors are implementing changes to land use, value chains, policy and consumption to sustainably respond to climate change
Increased use of climate change and sustainable land management knowledge incorporated in some policy and industry best practice	SLMACC contributes to presence of stronger drivers* to influence and inform strategic planning/resource priorities/what sectors need to do. *e.g. Emission Trading Scheme price, Advise Groups, Paris Agreement	Increased use of models and knowledge developed in SLMACC projects used by more primary sectors and more individuals within those sectors	More resilient, low-emitting, sustainable, profitable, low carbon primary sector
Increased visibility and primary industry debates about climate change impacts		Implementation of some mitigation and adaptation options by some farmers (farmers build resilience)	A more sustainable GDP in New Zealand (low emission industries)
Increased policy and policy direction supported and informed by climate change research e.g. Emissions Trading Scheme		Government agencies, policy makers and sector using SLMACC research with confidence as evidence basis for advocating policies, policy directions, and business leadership e.g. Actions, Emissions Trading Scheme price, risk planning	

Assumptions:

- New Zealand context fits within global picture (and vice versa)
- External drivers outside of SLMACC e.g. global commodity prices, political, climate change

Contributes to:

Reduced annual greenhouse gas emissions in New Zealand and exceeding greenhouse gas emissions target