Ministry for Primary Industries
Manatū Ahu Matua

Responding to climate change in the land-based sectors:

A Social Science Research Strategy for New Zealand
Full Report

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Executive Summary

This is the full report of the social science project 'RURALS': *Realistic, Useful and Reliable Research for Advancing Land based Sectors Sustainability*, conducted by ESR for MSI/MPI in 2011-12. It presents a social science research strategy on responding to climate change in the land based sectors in New Zealand, including the context for the Strategy development and the technical reviews and consultation which led to the Strategy. A summary version of the Strategy "Responding to Climate Change in the Land based Sectors: A Social Science Research Strategy for New Zealand" (the Strategy), is also published as a separate document.

The project was funded under the Sustainable Land Management and Climate Change (SLMACC) Programme in the Ministry of Primary Industries

'Social science' includes a wide range of disciplines including sociology, psychology, geography, anthropology, political science, and economics. It also includes specialised and interconnecting fields of inquiry including systems theory, policy science, science communication, 'science, technology and society' studies, evaluation and behavioural economics. Social science can provide both frameworks to analyse and understand social processes, and inform and evaluate social interventions. In relation to climate change, this means that social science can help explain human activity contributing to climate change and responding to climate change, and social science can support policy responses and sector and local decision-making about climate change.

Social research can be used to design, deliver and evaluate policy programmes and social interventions and to create more effective ways of changing individual and societal behaviours. At the same time, social science is also valuable because it can take a 'bird's eye view of the whole socio-ecological system, and ask higher order questions about the nature of the system and how it might change. A fundamental question to ask is "what are we changing *from* and what are we changing *to* and why?" Once that has been determined then there are applied questions about the transition required – how to get there, by when, what resources are needed and determining the key players.

Social science can be applied to a number of dimensions of climate change, including:

1. The social basis of beliefs, behaviours, technologies, practices and systems that lead to environmental pressures and disruptions, including climate change.
2. The social processes underlying the production of knowledge about the state of the environment, including the production of biophysical science knowledge about the climate system and climate change.
3. The transfer, interpretation, uptake, and acceptance or rejection of biophysical science knowledge on the climate.
4. The impacts of climate change on society and the economy, including the varying impacts for different regions and sections of society.
5. The mental models held by different people and groups about the social system and the influence of human society on the biosphere.
6. The different knowledge frameworks that people draw on to form mental models and make judgements about what they see in the world e.g. Western science, indigenous knowledge.
7. The way in which the 'climate change problem' is constructed by different individuals and groups in society, and how this influences their reaction.
8. The way in which solutions to the climate change are constructed and contested by different groups.

9. Understanding the drivers for social change and the most effective forms of social intervention to achieve it e.g. education and communication, policy and regulation, cultural and political change.
10. The impacts of different climate change mitigation/adaptation programmes on society and the economy.

The purpose of the RURALS project was to develop a New Zealand social science research strategy for climate change focused on the land based sectors. Drawing on New Zealand and international literature and participatory methods, it sought to define the current state of knowledge in this field; identify future research needs and priorities in theoretical and applied research, including Māori research priorities; and recommend methods for implementation and evaluation of the Strategy. The project brought together four communities of interest: funders and commissioners of research, policy end-users in government and industry, providers of social science research, and stakeholders in the land based sectors with an interest in the social dimensions of climate change.

The project team was led by the Institute of Environmental Science and Research Limited (ESR), in partnership with Landcare Research, AgResearch and NIWA, and with international contributions from the UK and the Canada.

The report puts 'social science research on climate change' in a global and New Zealand context. It summarises six literature reviews in topic areas proposed by the funder:

1. The drivers of change, including effective communication, to increase uptake and ensure investment is well targeted.
2. How farmers, growers and foresters understand the risks of climate change and how they are motivated to take action?
3. The barriers to change and opportunities for change at the ground/farm level.
4. The design, implementation and evaluation of climate change programmes and activities at a farm/ground (production system level) and a national level.
5. The design and use of systems approaches that encompass production, Māori, sectors, local and central government elements, as well as education, research, science (physical and social) and technology transfer.
6. Māori specific needs, issues and approaches for social science research in relation to mātauranga, taiao and innovation to address climate change for land based sectors.

The report identifies key research questions suggested by the literature, and through end user and stakeholder workshops with the land-based sector. It synthesises this material to propose seven research outcome areas and objectives for a New Zealand social science research strategy for responding to climate change in the land based sectors. The seven outcome areas are:

A. **Innovation, dissemination and up-take of practices** in New Zealand land based sectors that will mitigate and/or adapt to the effects of climate change.
B. **Market development** based on production practices in New Zealand land based sectors that mitigate the effects of climate change.
C. **Policy support** on New Zealand's strategic direction in relation to climate change and its implications for land based sectors.
D. **Understanding the challenge of climate change** from multiple perspectives in order to support engagement.
E. **Innovative approaches to decision-making, governance and participation** that span from national to local levels of governance and incorporate stakeholder and Māori perspectives.

F. Understand **factors that impact resilience, adaptability and transformability** in the New Zealand land based sectors.
G. Effective approaches trans**-disciplinary and participatory research methods** and policy formation that integrate the expertise of bio-physical and social scientists, Māori, policy development, and practitioner stakeholders.

These outcome areas and their associated research objectives are set in a framework for implementation and review in the Strategy. This is presented in the final section of this document, and the whole Strategy is summarised in a shorter document which accompanies this full report.

1. Background

This is the full report of the social science project 'RURALS': *Realistic, Useful and Reliable Research for Advancing Land based Sectors Sustainability*, conducted by ESR for MSI/MPI in 2011-12. It presents a social science research strategy on responding to climate change in the land based sectors in New Zealand, including the context for the Strategy development and the technical reviews and consultation which led to the Strategy. A "Responding to Climate Change in the Land based Sectors: A Social Science Research Strategy for New Zealand" (the Strategy), is also published as a separate document.
The project was and was funded by the Sustainable Land Management and Climate Change (SLMACC) Programme in the Ministry of Primary Industries

1.1 THE SLMACC PROGRAMME

The RURALS project was funded under the Sustainable Land Management and Climate Change (SLMACC) Programme. SLMACC has been administered on behalf of the Ministry for Primary Industries (MPI) by the Ministry of Science and Innovation (MSI) and formerly the Foundation for Research, Science and Technology (FRST) since 2008. These research investments are aimed at identifying the impacts of climate change, reducing agricultural greenhouse gas emissions, encouraging the establishment of forest sinks, and capitalising on new business opportunities arising from the world's response to climate change.

1.2 THE 'RURALS' PROJECT

Responding to the requirements of MPI, the purpose of this project was to develop a social science research strategy for climate change in the land based sectors that addressed five areas:

- the drivers of change including effective communication to increase uptake and ensure investment is well targeted,
- how farmers, growers and foresters understand the risks of climate change and how they are motivated to take action,
- the barriers to change or opportunities for behaviour change at the ground/farm level,
- the design, implementation and evaluation of climate change programmes and activities at a farm/ground (production system) level and a national level,
- the design and use of systems approaches that encompass production, Māori, sectors, local and central government elements, as well as education, research, science (physical and social) and technology transfer.

The project set out to deliver a New Zealand Social Science Research Strategy for Climate Change in the Land Based Sectors, in a ready state for implementation by end users in government, agricultural and forestry, industry and science organisations. Drawing on New Zealand and international literature, it sought to define the current state of knowledge in this field; identify future research needs and priorities in theoretical and applied research, including Māori research priorities; and recommend methods for implementation and evaluation of the Strategy.

The project team was led by the Social Systems Group at ESR, in partnership with social scientists at Landcare Research, Ag Research and NIWA, and with international contributions from the UK and the Canada. Team members were selected with wide experience and contacts in the land based sector, and with practical policy experience as well as academic research knowledge. Full details of the project team are in the appendix.

1.3 DEVELOPING A 'SOCIAL SCIENCE RESEARCH STRATEGY FOR CLIMATE CHANGE IN THE LAND BASED SECTORS'

The project aim was to develop a research strategy that would produce findings of practical use for the land based sector. The content of the strategy had to meet the needs of end users in government and industry who fund or implement social research - while also contributing to excellent social science knowledge in New Zealand and internationally. The project thus links across the domains of social science, policy and practical needs of the sector.

The development of the 'Strategy' was treated as an applied social science task. It was based on an approach called 'participatory action research' which brings together theory and practice so that people with a range of interests work together to create solutions; and puts emphasis on the everyday knowledge of people as well as academic knowledge. Taken together, all these inputs can be seen as our collective 'social knowledge'. In the case of complex issues like climate change, there is an increasing awareness that a combination of knowledge sources is needed to provide the best analysis of the problem and a rich source of solutions. Conventionally, research strategies are often developed solely by research funders or by the research community itself. This project brought together four communities of interest: funders and commissioners of research, policy end-users in government and industry, providers of social science research, and stakeholders in the land based sectors with an interest in the social dimensions of climate change. For more details on these groups, see the appendix.

The project team used stakeholder participation methods to develop and refine the issues and questions to go into the final research strategy. This approach has provided a sound base for the future implementation, monitoring and evaluation of the research strategy.

The six steps in the project were:

(i) Scoping and relationship building (late 2011)

- Establish links with all those with an interest in this project.
- Scope out issues and refine process with client [MPI].
- Identify and summarise from international and New Zealand literature "good practice" for the development, presentation and implementation of research strategies (with special attention to relevance to the current project: social science research, climate change, land based sectors).
- Identify and review key documents from New Zealand Government and key decision-making stakeholders onresponding to climate change, to summarise the policy context for a social science research strategy on climate change in the land based sectors.

(ii) Literature Reviews (Feb- May 2012)

- Assemble evidence from the New Zealand and international literature to show the contributions social science research can make to enhance responses to climate change in the land based sectors in New Zealand, specifically in relation to:
  - The drivers of change, including effective communication, to increase uptake and ensure investment is well targeted.
  - How farmers, growers and foresters understand the risks of climate change and how they are motivated to take action.
  - The barriers to change or opportunities for behaviour change at the ground/farm level.
  - The design, implementation and evaluation of climate change programmes and activities at a farm/ground (production system) level and a national level.

- The design and use of systems approaches that encompass production, Māori, sectors, local and central government elements, as well as education, research, science (physical and social) and technology transfer.
- Māori specific needs, issues and approaches for social science research in relation to mātauranga, taiao and innovation to address climate change for land based sectors.

(iii) Policy end user workshop (April 2012)

- A combined session of researchers in the team and policy managers in government to:
  - Share the project findings on international best practice for the preparation of research strategies.
  - Target the research to match the key issues, needs and priorities in policy, funding and purchasing agencies.
  - Build awareness of the project and ensure inputs from both central and local government agencies.

(iv) Interactive stakeholder workshop (June 2012)

- A participatory discussion with 36 government, science, industry, biophysical scientists, social scientists, and including Māori, to:
  - Generate a shared view of the social issues around climate change and the value of social research.
  - Highlight the breakthrough actions needed in New Zealand in mitigation, adaptation and new business opportunities.
  - Identify what new information and research is needed to support these actions.
  - Clarify what information we have now and know how to implement; what we areas will make a difference but we do not know how to make it happen successfully; and where there is a fundamental lack of knowledge.
  - Prioritise research ideas for future investment.

(v) On line engagement platform (June 2012 -)

- Design of an easy, accessible master list of research issues and questions around social science and climate change, focused on the land based sector, which reflects the priorities as identified in the steps above - and allows a wider audience to continuously add new ideas and indicate their preferences for future research.

1.4 STRUCTURE OF THIS REPORT

This report starts with an outline of the RURALS project, followed by an introduction to the Strategy, including its purpose, objectives and end use. It then sets out the context for developing the Strategy, summarises the findings of six literature reviews prepared by team members, and presents the outcomes of stakeholder workshops. Research questions are identified throughout and highlighted in green text boxes.

The proposed research content for the Social Research Strategy for Climate Change in the Land based Sectors is outlined in section 13. It identifies a range of key research outcomes, each with research objectives. The Strategy outcomes and objectives were derived by clustering the questions in this report and identifying relevant outcome areas and research objectives implicit in the questions.

2. Introduction: "New Zealand Social Research Strategy for Climate Change in the Land based Sectors"

2.1 PURPOSE, SCOPE AND RATIONALE

This Strategy is to support and enhance New Zealand's response to climate change in the land based sectors through social science research.

It is widely recognised that social processes are critical to the success of climate change action, but until recently there has been relatively little research in this area. The IPCC has identified social science research questions as priorities in the next phase of international climate research (Reisinger, 2010), as has the UNESCO World Social Science Report (Balstad, 2010). International scholars (e.g. Gifford, 2006, 2011) have highlighted the social and psychological factors behind decision-making in relation to the environmental behaviour; others (e.g. Shove, 2010a; Spaargaren, 2011) have emphasised the need to better understand the role of social practices in relation to climate change, and how such practices might be studied and influenced. Shove (2010a, 2010b) argues for broadening the range of what social science can offer in climate change policy. The International Social Science Council has recently identified the cornerstone social research needed for climate change (Hackmann & St. Clair, 2011). In New Zealand, social scientists have been developing their expertise in this field and recently identified theme areas for a NZ Social Science Research Agenda on Climate Change (Cronin et al., 2011).

This project focuses on the social dimensions of sustainable land management and climate change. It will enable New Zealand to deploy social science knowledge and expertise to advance understanding of the barriers and opportunities for change in the land based sectors (agriculture, horticulture and forestry). The Strategy will contribute to more effective policies and interventions by government and industry. This report identifies the issues and themes currently being addressed in the field of social science and climate change (in both the New Zealand and international literature), what is known now, and where future research is needed. It includes a proposed list of research themes and questions, and highlights those areas of research that can produce practical and useful findings in relation to the land based sectors in New Zealand.

As a preface to the following sections, it is useful to define what we mean by 'social science' and what it can offer in relation to climate change.

'Social science' includes a wide range of disciplines including sociology, psychology, geography, anthropology, political science, and economics. It also includes specialised and interconnecting fields of inquiry including systems theory, policy science, science communication, 'science, technology and society' studies, evaluation and behavioural economics. Social science can provide both frameworks to analyse and understand social processes, and inform and evaluate social interventions. In relation to climate change, this means that social science can help explain human activity contributing to climate change and responding to climate change, and social science can support policy responses and sector and local decision-making about climate change.

The ISSC report states that "social science knowledge is an indispensable part of the global scientific, policy and social mobilization effort" required to respond to climate change (Hackman & St Clair, 2012, p. 4). Social science is needed to understand the social dimensions of climate change and to design better responses to managing it. Social science

capacity needs to be developed, alongside biophysical science, to provide a fuller picture of the climate situation and options for action. In addition, new approaches to integrating social science with biophysical science are needed, to produce a robust knowledge framework to inform climate policy.

Social research is based on high-level theoretical ideas about how we understand the world, how society works, including how it works in an ecological context, and the different knowledge frameworks that people use to interpret what they see and experience. Social theory helps us understand how people give meaning to their world, what they value and how they relate to each other about what is relevant, important or right. Social science provides insights into social change, including into how individuals, groups, institutions, ideas, concepts and power relationships between different groups create change. It uses methods such as public engagement or discourse analysis, and specific techniques such as interviews, surveys, observations, workshops and models.

Social science needs to be distinguished from a policy or 'social intervention', which is a specific action or programme aimed at changing something in society i.e. intervening in how things work to produce a different outcome. A social intervention might include legislation, economic instruments or education programmes. Other social interventions might include setting up a collaborative forum such as the Land and Water Forum[1], organising a rural community group, or providing training for farmers in managing dairy effluent. Social scientists can take a 'bird's eye' view and look at why such a social intervention might happen, who is involved, how it works, what are the consequences – and according to whom?

Social science can be applied to a number of dimensions of climate change, including:

1. The social basis of beliefs, behaviours, technologies, practices and systems that lead to environmental pressures and disruptions, including climate change.
2. The social processes underlying the production of knowledge about the state of the environment, including the production of biophysical science knowledge about the climate system and climate change.
3. The transfer, interpretation, uptake, and acceptance or rejection of biophysical science knowledge on the climate.
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5. The mental models held by different people and groups about the social system and the influence of human society on the biosphere.
6. The different knowledge frameworks that people draw on to form mental models and make judgements about what they see in the world e.g. Western science, indigenous knowledge.
7. The way in which the 'climate change problem' is constructed by different individuals and groups in society, and how this influences their reaction.
8. The way in which solutions to the climate change are constructed and contested by different groups.
9. Understanding the drivers for social change and the most effective forms of social intervention to achieve it e.g. education and communication, policy and regulation, cultural and political change.
10. The impacts of different climate change mitigation/adaptation programmes on society and the economy.

[1] http://www.landandwater.org.nz/

2.2. OBJECTIVES OF THE STRATEGY

This Strategy draws on the wider literature around social science and climate change and applies it to the land based sectors in New Zealand. It seeks to:

(i) Demonstrate the contribution that social science can make to climate change research and policy in the land based sectors.
(ii) Identify the key issues and themes around climate change adaptation and mitigation in the land based sectors, and where and how social science can be applied to address these.
(iii) Highlight the social research needed to support sustainable approaches to climate change in the land based sectors in New Zealand.
(iv) Identify current knowledge and research gaps in the international and New Zealand literature on:

- The drivers of change including effective communication to increase uptake and ensure investment is well targeted.
- How farmers, growers and foresters understand the risks of climate change and how they are motivated to take action.
- The barriers to change or opportunities for behaviour change at the ground/farm level.
- The design, implementation and evaluation of climate change programmes and activities at a farm/ground (production system) level and a national level.
- The design and use of systems approaches that encompass production, Māori, sectors, local and central government elements, as well as education, research, science (physical and social) and technology transfer.
- Māori specific needs, issues and approaches for social science research in relation to mātauranga, taiao and innovation to address climate change for land based sectors.[2]

(v) Identify priority themes and questions for future social research in New Zealand and those areas of research that can provide practical and useful results in the land based sectors.
(vi) Build a consensus and commitment among stakeholders who may be research. funders, commissioners, producers or users of social science on the research priorities.
(vii) Provide effective processes of engagement to support the framing, commissioning and evaluation of social science research on climate change.

2.3 MANDATE FOR AND USERS OF THIS STRATEGY

This Strategy has been prepared under the Ministry of Primary Industries (MPI) SLMACC programme, following input from the Ministry of Science and Innovation (MSI), now Ministry of Business, Innovation and Employment (MBIE); The Ministry for the Environment (MfE); Local Government New Zealand; and the Royal Society of New Zealand (RSNZ). The Strategy preparation included consultation with a range of social and biophysical scientists, industry, farming and community representatives, including Māori. It therefore provides a sound platform for setting social science research directions and priorities related to climate change in the land based sector.

While it was initially commissioned by MPI, the Strategy is expected to provide useful information for a number of government agencies including MPI and MBIE, MfE, Te Puni Kokiri, Department of Conservation (DoC), and Ministry of Foreign Affairs and Trade. It also

[2] These points are derived from the original request for proposals, issued by MPI, for the preparation of this Strategy.

serves as a resource for the wider research sector including CRIs, universities and other research institutes, the private sector and the community.

3. Context

3.1 GLOBAL CONTEXT

There is widespread global recognition that the impacts of climate change have resulted from human activities. The overwhelming majority of scientists agree with the Intergovernmental Panel on Climate Change's (IPCC, 2007) assessment that climate change is 'unequivocal' and 'very likely' (a 90% chance) human-induced (Demeritt, 2006; Collins et al, 2007; Demeritt, 2006; Somerville, 2011; Boycoff et al, 2009). Public surveys, for example in New Zealand and Canada, indicate that most citizens are concerned about the impacts of climate change and global warming, and think that the impacts are already evident and/or will be in their life time (New Zealand Business Council for Sustainable Development, 2009; Wall et al, 2006).

Energy production and consumption from non-renewable sources is the single most important causal factor in climate change (Lohman, 2008). Recent global warming and climate change has primarily been the result of fossil fuel use (coal, oil and gas), agriculture and land use changes, for example deforestation (IPCC, 2007). The linking of climate change to multiple interdependencies that cut across geographic (local, regional and global) and temporal scales, creates a 'tragedy of the commons' par excellence. There has been a significant focus on land use activities and the primary production sector, not least because of the effects of the continuing release of greenhouse gases (GHG) from agriculture, and the displacement of biodiversity (carbon sinks), but also due to the increasing demand for energy resources in intensive agricultural production and distribution systems. At the same time, agriculture and horticulture is confronted by the impacts of a disrupted climate, in the form of variable and extreme weather patterns, and severe events such as floods and droughts. Under some scenarios, however, the land based economy may also be the beneficiary of changes in the climate as new growing and marketing opportunities open up.

Approaches to addressing climate change have been led from Europe, based on the research and activities associated with the International Climate Change Panel, and international agreements such as the Kyoto Protocol which have focused on mitigation i.e. reducing greenhouse gas emissions in order to slow down the processes of global warming and the associated negative impacts. Transitioning to more sustainable and low carbon lifestyles will require transformations to take place across every sector of society (UNEP, 2007). While such transformations need to account of uncertainties in detailed scenarios for future climate change (Adger et al., 2007), the underlying challenges to 'business as usual' resource intensive production need to be addressed. Internationally, and in New Zealand, there is increasing attention on the role that new practices and technologies in the agricultural, horticultural, and forestry sectors can play in mitigating greenhouse gas emissions (Nabuurs et al., 2007; P. Smith et al., 2007; UN, 2010). These practices and technologies are also being endorsed as part of adaptation measures in these sectors to both the projected impacts (e.g. increased risk to the security of food, energy and water supplies), and opportunities (e.g. increased productivity and yields and demand for food and forestry trade), resulting from climate change (Easterling et al., 2007; IPCC, 2007).

The challenge for policy-makers is to identify ways of encouraging the adoption of these new practices, production methods and technologies while maintain economic and social objectives. Understanding these global dynamics, as well as those issues that are unique to New Zealand, is an important task, which is heavily dependent on good research and information, including social science research.

3.2 NEW ZEALAND POLICY CONTEXT

In New Zealand, the Ministry for the Environment (MfE) is the lead central government agency for climate change policy-making, including hazard management; while the MPI - formerly the Ministry of Agriculture and Forestry - has key responsibilities for the land based sector. In response to the challenges associated with sustainable land-management and climate change, MPI and MSIhave funded a number of research projects (see Appendix 6). Many of these studies have addressed social science research themes, primarily in economic and systems research, including:

- Costs and benefits of climate change adaptation.
- Modelling and impact assessment of climate change impacts.
- Valuation of primary resources.
- New cropping opportunities.
- Carbon trading.
- Determinants of farmers' environmental behaviour.
- Learning and adaptation.
- Research, knowledge and outcomes.
- Business opportunities for Māori land.

Other government documents (from the Ministry of Economic Development, DoC, MSI and Treasury) address policy issues and research questions around climate change generally. The following summary has been collated from the ministry Briefings for Incoming Ministers (BIMs) (2011-2012). Significant policy issues and questions for climate change policy presented to the new government included:

- The need for balance between levels of costs for the economy versus incentives to adjust to a lower carbon economy.
- What form of international agreement will follow the expiry of the Kyoto agreement in 2012? What are the uncertainties, and how will New Zealand's emissions performance be perceived externally?
- New Zealand emissions are increasing, and our emission profile is complex and multi-sectoral (transport, industry, energy, and agriculture), with agriculture responsible for 50% of emissions. Agriculture is currently excluded from the Emissions Trading Scheme (ETS), and decisions will be needed about the timing of inclusion, availability of options, and the effectiveness and efficiency of the ETS price signal, and impacts on competitiveness.
- The need for further complementary measures to meet long-term emissions targets, such as promoting technological change, innovation, and behaviour change.
- Adaptation is seen as best achieved by integrating adaptation activities in existing processes, practices and policies at all levels of society. Processes and priorities are to be factored into local government decision-making.
- How will the risks associated with hazard management from climate change events be managed? Who carries risk and liability costs, and how can central government support regional policy instruments to build community adaption and resilience?
- Advancing the goals set out in the New Zealand Energy Efficiency and Conservation Strategy with energy efficiency measures to: (i) help reduce carbon emissions; (ii) improve productivity and competitiveness; and (iii) contribute to better health.
- Climate change poses a significant risk to New Zealand's conservation values, but there are uncertainties about how the environment will be affected by climate change scenarios. It is possible that some mitigation actions may also cause adverse impacts

on conservation values so there is a need to balance these against responsibility to maintain our share of global biodiversity.
- Treasury aims are to reduce the short-term costs imposed by ETS while positioning the economy for the longer-term risks and potential opportunities associated with climate change.
- An important aim of MSI is to improve policy development through more direct links to the science, business and research communities, and setting priorities for investments in business-led research and development and public good science.

Some key areas identified in government documents included:
- Mitigating agricultural greenhouse gases, enhancing forestry sinks, understanding the impacts of climate change (social, economic and systems aspects) and adaptation, innovation and effective technology transfer. A key question relates to the rate and magnitude of mitigation efforts, in light of continuing uncertainties.
- The Emissions Trading Scheme (ETS) is the main mitigation instrument – price signals are expected and intended to encourage responses both on-farm and off-farm, and will also 'incentivise' greater research and development efforts.
- Who carries risk and liability and how could this be shared between public and private sectors? What trade-offs need to be made by individuals and communities in managing risk decisions? What is the balance between individual and community responsibilities? What are the expectations of central government?

An overarching priority identified for the incoming government by MfE was to create:
- A long-term view.
- A cross-agency approach (engaging community and business), co-ordinating across agencies, wider dialogue with local government and private sector.
- A uniting vision and framework.

Turning to the present day, the Government's main policy tool to reduce emissions is the New Zealand Emissions Trading Scheme (ETS), which puts a price on greenhouse gas emissions. In August 2012, the Government announced changes to the ETS. The aim was to maintain the costs that the ETS places on the economy at current levels, in order to ensure that businesses and households do not face additional costs during the continued economic recovery; and to ensure that New Zealand continues to do its fair share on climate change. There were also a number of important changes to improve the operation of the ETS, providing more flexibility for forest landowners and ensuring the scheme is 'fit for purpose' after 2012. [3]

The summary above indicates government priorities for addressing climate change – which are aimed at working through international agreements to reduce greenhouse gas emissions in order to slow down the rate and frequency of adverse impacts, and working with sector stakeholders to roll out new technologies and implement adaption initiatives. We now comment on the relevance of the policy context to the development of this Social Research Strategy for the land based sector.

Scientific agreement that global warming and associated adverse impacts are occurring as a result of human activity has been and continues to be a key driver for change. However, the uncertainties raised by some groups about climate change science, and the related 'science and society' communication issues, can be a barrier to policy development and implementation. The challenge is to access the useful knowledge that can lead to substantive sector and public behaviour change. This includes biophysical, technological and social

[3] See: http://climatechange.govt.nz/emissions-trading-scheme/ets-amendments/index.html

science knowledge. To date, there has been a substantive effort internationally to map out the biophysical science research questions related to climate change. Now attention is being directed to what social science research is required.There is an important interplay between the science of climate change, how it is perceived, and understood, and the actions that might be taken in response. Given the critical role that primary industry plays in the New Zealand economy, the responses developed for the land based sector are a substantive part of the total New Zealand response. The framework or 'mental model' that key actors (including farmers, foresters, rural communities, industry and sector organisations, and policy decision-makers) hold in their minds about the climate change problem – and preferred solutions - is an important driver for policy development.

From this brief discussion of the policy context, we can start to identify a number of research questions that would open up our understanding of climate change responses in the land based sector in New Zealand. These are set out in the box below.

Research questions:

What is the underlying framework that key actors are using in the land-based sector (including farmers, foresters, rural communities, industry and sector organisations, and policy decision-makers) to understand the climate, climate change scenarios, and proposed measures for mitigation and adaption?

What governance frameworks and policy instruments are available to support mitigation and adaptation in the land-based sector; and which are preferred?

How is the tension between the economic costs and environmental benefits of climate action managed in policy discourse by key actors in the land-based sectors; and are alternative discourses available?

What is the relationship between and impact of policy mechanisms such as the ETS, and other intervention mechanisms such as technology investment, communication, behaviour change and social collaboration in the land-based sectors?

How can policy frameworks use approaches such as systems theory to address the complexity of issues in the land-based sector e.g. connecting energy use, land use planning and biodiversity?

How is resilience to climate change in the land-based sector being understood in relation to resilience to other significant changes (global financial crisis, or geo political shifts in markets)?

What is understood in the land-based sector about the benefits and opportunities arising from climate change mitigation and adaptation?

How is the New Zealand response to climate change in the land-based sector being perceived in our key external markets?

4. Review of current research in New Zealand and internationally on social science and climate change.

4.1 EXISTING SOCIAL SCIENCE RESEARCH STRATEGIES ON CLIMATE CHANGE.

Internationally, there is a drive to harness social science to understand and address the complex challenges associated with climate change. This interest appears to be driven in the first instance by the apparent hiatus between scientific knowledge of climate change and social action. Social science is also being seen as crucial to enhance economic and technical innovation, and to promote social behaviour change for mitigation, adaptation and resilience.

Social science is now being developed as the next frontier in climate change research, working alongside and integration with biophysical science. See for example the list of social research questions identified by the IPCC, summarised by Reisinger (2010), and set out in the appendix to this report.

Recently, the ISSC has prepared its Global Environmental Change Design Project, a 10 year research funding and coordination initiative for the social sciences on climate change and global environmental change (Hackman & St Clair, 2012, p.5). This is aimed at foregrounding and strengthening social science in the development of new, inter-disciplinary research at the international level, and articulating the importance of the social sciences in the knowledge base to address problems of global change (p.6). The authors state that "global environmental change is requiring new ways of producing knowledge and making sure it gets used." This initiative drew on findings from numerous international forums, an international survey of social scientists and humanities scholars, regional workshops and individual interviews to create a "substantive, concrete agenda comprising multiple priority themes and topics" (p.7). Key themes included:

- The central issues of climate change impact, adaptation, mitigations, vulnerability and resilience.
- Concerns focused on ecosystems, environmental services and biodiversity.
- Problems of primary resources needs related to water, energy, land, food etc.
- Critical domain issues (e.g. urbanisation, waste, extreme events, disaster risks, technology and innovation).
- Sector-specific priorities.
- Policies and response measures.

The ISSC authors, Hackman and St Clair, outline what they see as the 'transformative cornerstones' of social science to produce new knowledge in relation to multiple actors, sectors, governance roles and responsibilities:

- Historical and contextual complexities.
- Consequences (and unintended consequences).
- Conditions and visions for change.
- Subjective sense-making.
- Responsibilities.
- Choice and decision-making.

Their report includes a comprehensive list of research questions related to each of these topics.

The ISSC states that the social sciences "are an essential piece of the research puzzle, to be fully integrated through the research process, starting with the identification of research

agendas and the framing of research questions" (p.7). This cornerstone document was used during the RURALS project to elicit stakeholder ideas on social research priorities, and also to delineate the themes and questions for the New Zealand Social Science Research Strategy for Climate Change in the Land based Sectors.

The integration of social science into the wider climate change research agenda has been addressed by a number of countries. The Canadian Climate Change Impact and Adaptation Research (C-CIARN) symposium report, for example, noted that the lack of clarity about directions for future policy, programmes and related actions has led to stronger calls for social science input (Wall et al, 2006). Research is also needed to "integrate the outcomes from diverse relationships and interactions at different conceptual, spatial and temporal scales". The report identified the need for two complementary approaches:

- Top down – macro-scale conditions and scaling down (predominantly biophysical science).
- Bottom-up – system, community of interest (mostly social science).

The report concluded that there is "need to find solutions for problems that transcend traditional disciplinary and sectoral boundaries, where there are mutually interdependent environmental, health, economic and socio-cultural dimensions" (ibid, p.8).

A recent workshop in the U.S.A., attended by sociologists with an interest in climate change research, identified similar research areas: multi-level and global governance; decision-making and risk assessment; cultures of consumption; advocacy and action research, organisations and networks (Nagel et al, 2009).

The Australian Research Council's list of National Research Priorities [4] includes "Responding to climate change and variability: Increasing our understanding of the impact of climate change and variability at the regional level across Australia and addressing the consequences of these factors on the environment and **on communities** [emphasis added]. The Australian Department of Agriculture, Fisheries and Forestry has a research programme which has prioritised research into "alternative management practices and the development of adaptation management practices and techniques." [5] The Department funded a project on Community Networks and Capacity Building, to build the leadership and representative capacity of target groups to strengthen community resilience and the productivity of primary industries.[6] Australia has also produced a climate change research strategy for primary industries, and has commissioned research on adaptation which stresses the importance of social research questions. A key publication - "Adapting Agriculture to Climate Change: Preparing Australian Agriculture, Forestry and Fisheries for the Future" (Stokes & Howden (eds), 2010 [7]) includes chapters on socio-economic and institutional considerations for adapting to climate change; greenhouse gas emissions sources and sinks; and risks and priorities for the future. The authors stress the need to look beyond the impacts of climate change to the practical actions that can be taken by Australia's primary industries to effectively tackle the challenges of climate change and capitalise on opportunities.

The New Zealand workshop report "Degrees of Possibility: Igniting social knowledge around climate change" (Cronin et al, 2011) includes keynote papers, ideas developed in multi sector discussion groups, and social research observations. It provides a briefing for central government decision-makers and science organisations on the key areas identified for future social research on climate in New Zealand, including:

[4] See http://www.arc.gov.au/pdf/nrps_and_goals.pdf
[5] See http://www.daff.gov.au/climatechange/australias-farming-future/climate-change-and-productivity-research
[6] See http://www.daff.gov.au/climatechange/australias-farming-future/community_networks_and_capacity_building
[7] See http://www.publish.csiro.au/nid/20/pid/6170.htm

- Social understandings of climate, of climate change research and future scenarios.
- Implications of biophysical climate system changes on N.Z. social and economic systems.
- Understandings of, and approaches to mitigation, adaptation and resilience.
- Social equity and justice.
- New Zealand socio-political relations in a regional context.
- Processes of social change.
- Governance processes, including risk assessment, risk modelling and decision-making.
- Knowledge production.
- Supporting economic transformation.
- The 'birds-eye' view – socio-political framings and framings of climate change.

The research themes identified in the 'Degrees of Possibility' report were also noted in the preparation of this Strategy which is focused on the land based sector.

4.2 REVIEW OF THEMES AND QUESTIONS IN THE SOCIAL SCIENCE LITERATURE

To support the preparation of this New Zealand Social Science Research Strategy, a wide ranging series of literature reviews was conducted and peer reviewed in February - July 2012.[8] The results of these reviews are presented in the next sections of this report, with research themes and questions highlighted in green text boxes.

This review of international and New Zealand research publications and policy reports provides an overview of what is known now on the topic, the themes and issues that have been addressed, and questions outstanding. It also illustrates how social science is being prioritised in the policy sector, including an increasing understanding that social research can provide answers for navigating 'wicked problems' such as climate change; support more effective policy discussion, improve the design of programmes; and effectively target social interventions to promote desired social outcomes. While social science has a great deal to offer in this regard, social scientists also believe that their value lies in being able to maintain a wider perspective on the whole social landscape, to analyse and objectively critique the social context and conceptual framings being used by different actors, and to apply and extend social theory to fully understand what is going on. It is therefore important that critical social research is also supported and alongside more instrumental methods and interventions.

The literature reviews for this project focused on six key issues identified by MPI. To recap, these included:

1. The drivers of change including effective communication to increase uptake and ensure investment is well targeted.
2. How farmers, growers and foresters understand the risks of climate change and how they are motivated to take action?
3. The barriers to change and opportunities for change at the ground/farm level.
4. The design, implementation and evaluation of climate change programmes and activities at a farm/ground (production system level) and a national level.
5. The design and use of systems approaches that encompass production, Māori, sectors, local and central government elements, as well as education, research, science (physical and social) and technology transfer.

[8] The authors included Ann Winstanley, Brendan Doody, Garth Harmsworth, Jeff Foote and Graeme Nicholas, with inputs from Karen Cronin and Alison Greenaway. This baseline material was peer reviewed by Robert Gifford, Bob Frame, Bruce Small and Darren King.

6. Māori specific needs, issues and approaches for social science research in relation to mātauranga, taiao and innovation to address climate change for land based sectors.

These topics are addressed in turn in the following sections of this report.

5. The drivers of change including effective communication to increase uptake and ensure investment is well targeted

The following discussion summarises the literature review findings and highlights research gaps and questions arising – see green boxes. All of these questions have been pulled together to comprise the Research Strategy, summarised in the document accompanying this report.

5.1 TYPOLOGIES OF FARMER BEHAVIOUR CHANGE

There is considerable attention paid, in both the policy and research arenas, to the need for farmers' behaviour change and/or best practice farm management, to achieve climate change mitigation and adaptation (MfE, 2011; MAF, 2011). Behaviour change for climate mitigation and adaptation can be also be achieved as a co-benefit of other sustainability practices (such as decreasing water and energy demand, and employing new technology), or by mainstreaming climate action through existing policies and programmes e.g. hazard management.

A sample of the international and New Zealand literature on drivers of change includes:

- Understanding the role of climate perceptions, expectation and forecasts in farmer decision-making; USA (International Research Institute for Climate Prediction, 2004).
- Understanding why farmers adopt best management practice (Tamini, 2011; Baumgart-Getz et al, 2012).
- Understanding behaviours in a farming context; U.K. (DEFRA, 2008).
- Decisions made by farmers that relate to climate change; Australia (Hogan et al, 2011).
- Understanding rural community resilience (McManus et al, 2012).
- Psychological barriers that limit climate change and adaptation (Gifford, 2010).
- International review of behaviour change initiatives; Scotland (Southerton et al, 2011).
- Adaptation in agriculture; New Zealand (Kenny, 2010).
- Barriers to public engagement with climate change in the U.K and policy implications (Lorenzoni et al, 2007).

Understanding the psychology of individual attitudes and motivations is an essential building block to promote and/or influence desired behaviour change. Gifford's (2010) well known 'Seven Dragons of Inaction' model provides substantial insight into barriers to behaviour change, and describes the factors associated with:

- Limited cognition – people are not as rational as they would like to think they are.
- Ideologies – beliefs that clash with climate change mitigation.
- Comparisons with other people – compared to others' situation.
- Sunk costs – investments of time, money and resources necessary, but then hard to divest or change.
- Discredence – trust is required before people will take notice.
- Perceived risk – six areas of risk: functional, financial, social, psychological/self, temporal.
- Limited behaviour – tokenism, inconsistencies.

Other studies have integrated psychological with demographic (e.g. age and gender) and/or contextual variables (e.g. farm type, life-style) to develop wider typologies of farmer behaviour.

In an Australian study, for example, Hogan et al (2011) created the following typology:

> *Cash-poor long-term adaptors* (35% of respondents): This was the largest group and they actively sought to adapt their farming practices to manage risks associated with climate change and to be sustainable. This group were younger, healthy, socially connected, were information seekers, believed in climate change, were resilient, and participated in government assistance programmes.
>
> *Comfortable non-adaptors* (25% of respondents): This group was older, socially connected, benefited from good farming conditions and income, and were confident in their ability to deal with change. They did not use government support, were not information seekers, and experienced little pressure to consider adaptive practices, but to retain current practices and lifestyle.
>
> *Transitioners* (20% of sample): This group had a lot of women farmers, low adaptive capacity, experienced farm-related pressures, had the lowest incomes and fewest resources. Farmers in this last group were socially isolated, in the poorest health, had problems accessing information and resources but were still seeking to adapt farming practices to manage climate change and be sustainable.

Hogan et al. concluded that, while farmers can identify strategies to enable adaptive transitions, policy mechanisms and institutional processes are required to facilitate translation of science and technology into practices. These processes include the (re)generation of non-government and industry support groups to facilitate on-farm change in attitudes and practices. They also found that farmers were more interested in 'sustainability' than 'climate change', but were also concerned about how their community think farmers should act (moral responsibility). Their analysis suggested that, to achieve long-term sustainable practices, policy-makers might be best to focus on farmers' sense of social or moral responsibility, rather than referring to climate change directly.

The DEFRA (2008) farmer segmentation model produced a different typology of farmers, variously as: 'custodians', 'lifestyle choice', 'pragmatists', 'modern family business', or 'challenged enterprises'. The aim of this study was to identify the diversity of attitudes, motivations and behaviours in farmers in order to tailor communication programmes. This was predicted on the rational and/or emotive aspect of farmer psychology and behaviour (see also Hatzakis et al, 2005 and Swim et al, n.d.).

Some authors, however, question the individual typology approach to behaviour change.

Maru et al (2011, p.19) accept that these typologies "… can assist with reducing complexity, detecting patterns and groups, identifying gaps, tailoring communication and prioritising resource allocation and interventions." The authors are, nevertheless, critical of the lack of explicit description of the methods used in typologies, and the lack of rigour and validity of their indicators. They point to a lack of conclusive studies in the wider behavioural field, especially given the well-known gap between attitudes and action. Instead of 'top down' typologies of farmers created by experts, Maru et al call for more participatory typology-building that engages stakeholders in discussion on their approaches and options, and which, the authors suggest, could assist communication as well as social learning and action.

Both the DEFRA (2008) discussion paper and the Scottish government's international review of behaviour change initiatives (Southerton et al, 2011) drew attention to the complexity of, and interrelationships between, the multiple influences on behaviour change. Southerton et al

(2011) developed a simple analytical framework for analysing the thirty cases they reviewed. The three key components were: (i) initiatives influencing the individual; (ii) social norms, cultural conventions and shared understandings; and (iii) material objects, technologies and infrastructures that enable and constrain behaviour. DEFRA drew on theory of behaviours, the "sustainable diamond" 4 E's (enable, encourage, engage and exemplify) and behavioural economics to create an integrated framework. This incorporated a psychology-based approach to behaviours; consideration of the role of government intervention; and consideration of behavioural economics, to consider individual, shared and societal influences on farmer behaviour and their likely responses to policy interventions. The key conclusions were that influences on individual behaviours are complex, but applying a common framework can aid understanding. The report noted: attitudes, actions and behaviours all need to be measured at different stages; there is diversity in the farming industry; and that social factors (networks, norms, social capital and collective action) are important; and that understanding behaviour is an inter-disciplinary challenge. It concluded that using this framework provides the basis for future applied analysis, that need not then review existing knowledge on farmer behaviour and motivations.

In summary, there is a substantial literature outlining the psychological drivers and barriers to farmer behaviour change, and some diversity of opinion in the social research community about the approaches that might be used, including typologies. (Some of this literature is discussed further in a later section of this report, on barriers and opportunities for change). Further analysis is needed in the social science community to establish what mix of methods would be most appropriate in New Zealand, and how this research might be integrated with other knowledge on wider social and systemic factors, to achieve behaviour change, including social change methods being developed here.

One notable New Zealand study is Kenny's on-the-ground work with East Coast farmers. This form of local engagement may be more effective than top down policy-based communication strategies aimed at a changing a particular segment of the farmer population such as the "non-adaptors" in Hogan's (2011) typology.

More work is also needed on the next step, i.e. designing communication programmes to change behaviour in key groups, and following up to evaluate if and how such targeted strategies work in practice. Evaluating the effectiveness of existing programmes is an important priority. The issue of communication is discussed in detail later in this section.

Research questions:
What typologies of behaviour change in farmers and foresters from the international literature might usefully be applied to the New Zealand land-based sectors?

How are such typologies being used to design communication programmes?

What do we know about the effectiveness of such communication programmes on behavioural and sustainably outcomes internationally and in New Zealand?

Where are the best practice models and programmes already in use of New Zealand and how might they be used more widely?

5.2 MOVING BEYOND INDIVIDUAL BEHAVIOUR CHANGE TO SOCIAL CHANGE.

There is growing discussion in the international and New Zealand literature about the reliance in policy programmes on attitude and/or behaviour change as the key to climate mitigation and adaptation. Shove (2010a) critiques the focus on what she calls 'ABC' – attitude, behaviour and choice - arguing that there is a "yawning gulf" between what the social sciences could contribute and the restricted models and concepts currently embedded in U.K. environmental policy. Along with Shove, many authors, including Campbell (2009) and Barr et al (2011), react to what they see as the one-dimensional view of citizens as autonomous individuals without reference to their wider social and political relationships, and their frequent treatment merely as consumers maximising commodity choices. In their view, this precludes a deeper analysis of how people identify and relate to others in society; how they come to follow the 'practices of everyday life'; how they respond to technologies as part of their social world; how they imagine, contribute to, and are affected by broader social change; and how change actually occurs. (These ideas are referred to as theories of 'practice' and 'transition'; and are discussed in more detail in a later section of this report). Shove argues that the narrow ABC approach obscures the extent to which governments and other social institutions "sustain unsustainable economic institutions and ways of life" and structure options and possibilities for the future (ibid, p.1274).

Even if individual behaviour change were the best focus, the factors contributing to behavioural outcomes are so complex that they may be impossible to track, model and replicate in any reliable way. Shove refers to the U.K. policy focus on predominantly psychological and economic research into attitudes, behaviours and choice, which identifies drivers and barriers that are seen as interchangeable depending on other interrelated factors and contexts. She argues that this extensive list of contextual factors "suggests there is no obvious limit to the number of possible determinants and no method of establishing their history, their dynamic qualities, their interdependence or their precise role in promoting or preventing different behaviours" (ibid, p.1275).

In contrast, Gifford (Pers. Comm. August, 2012) argues that some authors may unfairly characterize the nature and goals of the "individualistic" approach when they describe it, too narrowly, as simply "ABC and linear." Some aspects of the practice approach also need to be re-considered. While there is value in an approach that is holistic, complex, and interactive, Gifford sees the practice approach as subjective (on the part of both the researcher and the interviewees) and difficult to generalize beyond the focus group; and this limits its policy value.

We conclude that there is a variety of approaches which have value and which should receive attention in future research.

Taking a wider view of change, one avenue for future research might be to apply some typologies which have proven effective in explaining individual psychological factors and applying these to social institutions. For example, Gifford's well recognised 'dragons' typology of individual barriers to change might equally be applied to institutions and policy-making. There is precedent in New Zealand for extending the use of models e.g. the Ministry of Health Health's Impact Assessment tool can be applied to policies in other Ministries to ensure policies do not impact negatively on health. Gifford's model could provide a mechanism to assess the formulation and likely implementation of climate change policies to ensure integration, consistency and salience.

Another way of addressing social complexity may be through the concept of networks. When asking how people in New Zealand are responding to climate change, Russell et al

(forthcoming) identified how multiple and diverse networks – across organisations (including local government) and individuals – provide contexts and mechanisms for action. They found that locality-based action was "catalysed by, and intertwined with, sustainability discourses aiming towards a lower carbon economy over a longer timescale." Along with other studies, their research is asking questions the underlying framework of mitigation-adaptation. They suggest this should be supplemented by "a more diverse suite of mental models for making sense of climate change" (ibid).

In contrast to what she calls 'ABC' approaches, Shove outlines the concept of 'Transition Management', a key part of the Dutch National Environmental Policy Plan. This is informed by a number of disciplinary traditions, and explores "how environmentally problematic ways of life are reproduced and how they change" (ibid). This kind of approach also considers systems of provision – food, water, energy – as more than contexts in which consumer choices are made. Individual choice is constrained by the wider systems and technologies in place in society, which create demand behaviours in individuals that unavoidable (e.g. the design and operation of transport infrastructure or housing). People are therefore carriers of practices in their daily lives that are driven by larger processes and decisions than their own.

The international literature suggests that the concept of 'social capital' is another promising avenue for understanding behaviour change and/or best practice management for the land based sector (Adger, 2003; Jones et al, 2012; Russell et al, forthcoming). This concept could be explored more in New Zealand. The literature suggests that networks, and social and community ties based on trust and reciprocity, are likely to be an effective avenue to influence behaviour change. However some authors (Tamini, 2010; Hogan, 2011) question the extent to which corporate-owned farms (with strong profit imperatives for shareholders and/or absentee owners) are likely to adopt adaptive behaviours and farm management practices that are morally responsible to local communities, in the same way that individual farmers or family farm communities might do.

If social capital does indeed hold promise, then research on how policy can support these community and/or network-based mechanisms could provide useful insights, as well as ways of evaluating policy effectiveness. This also follows Tamini's (2010) suggestion that government policies that invest in social capital may help create an enabling environment for the adoption of best management practice.

Research questions:

How might understandings of farmer psychology and existing typologies be integrated with other New Zealand-specific variables?

What variables need to be included, why and what outcomes are envisaged?

How might understanding social capital in rural communities provide insights into achieving farmer behaviour change?

How might understanding of social networks and mental models provide insights into achieving farmer behaviour change?

How might new governance approaches, like 'Transition Management', be applied in New Zealand and are there other promising approaches that should be explored?

5.3 EFFECTIVE COMMUNICATION FOR BEHAVIOUR CHANGE

The concept of 'effective' communication was noted in the discussion above on identifying types of farmers in order to change their behaviour. Many communication programmes, including those applied in the climate change arena, are based on public relations methods which seek to deliver a pre-determined message, define key audiences, ascertain what they do or do not know already, refine the message for the target audiences, and deliver it through the most effective mechanisms (publications, websites etc). Sometimes, but not always, these programmes are reviewed and refined through evaluation.

This conventional approach is valid and useful, but it is predicated on a linear model of delivering information from the expert or proponent of change - through communication channels - to the object to be changed. With complex and contested issues such as climate change, this underlying communication strategy may itself run the risk of failure. The object of change ("the target audience") or the effectiveness of the delivery mechanism (e.g. print versus new media?) is seen as problematic. Considerable effort and cost is then expended in seeking to manage the beliefs, values, understandings, attitudes, awareness and behaviour of target audiences through the provision of information. However, this significantly underestimates the influence of social, cultural and political factors on peoples' responses - and overestimates the influence of information to change them. Alternative communication strategies, based not on 'one-way communication' but on 'two-way communication' and dialogue, are discussed in detail below. For now, we look at some of the issues experienced in climate change communication.

Much of the literature on communication is focused on improving the clarity of the message, reducing friction in the communication channel, or enhancing the receptiveness of the audience. Climate change information is seen as particularly difficult to 'get across' to audiences because it is abstract, complicated and far away from everyday life. The big message about anthropogenic climate change must, out of scientific necessity, be hedged with smaller messages regarding the uncertainty of specific scenarios and probabilities.

For example, a recent MSI-funded report on scientists' communication (Winstanley & Hepi, 2012) found that scientists in New Zealand find it difficult to communicate uncertainty and probabilities to non-scientific audiences because of quite different understandings and interpretations of what uncertainty means: "... people will look at positive probabilities and negative probabilities with different weightings, so you can't convince people on an emotional level with probability, it's not going to work, that's never going to work" (Winstanley & Hepi, 2012, p.13). John and Lewens (2010, p.3) suggest that these differences can be represented as a tension between views of scientists' competence and sincerity. They state that: "sincere communication about the limits of knowledge, uncertainty and ambiguity surrounding scientific findings may be at odds with the production of decisive, reassuring policy measures. Scientists will sometimes find themselves drawn in both directions at once, with the result that maintaining trust in general will be difficult". One scientist thought that the increased public scrutiny and political sensitivity of climate change science would lead to a reduction of science communication (Winstanley & Hepi, 2012).

Science is expected to have the answers and to speak with a confident voice. From this perspective, society delegates to scientists the task of understanding the myriad workings of the biophysical world and, in effect, people ask scientists to mediate between daily life and the wider world, to predict and protect them from the hazards of nature. For example, in Italy seismologists were accused of manslaughter after failing to predict a large earthquake that killed 308 people in 2009. In the USA a civil servant, also charged with manslaughter, stated

that he felt betrayed by science while a commentator stated that the case "reflects a lack of understanding about what science can and can't do." [9]

Uncertainties around the spatial and temporal impacts of specific climate scenarios – how, when and where more local impacts will occur - makes planning for such change and communicating science and policy decisions more challenging, especially in the context of requiring, supporting and promoting behaviour changes on significant public or sector scales.

Compounding this situation is the changing relationship between science and society generally. Over the last 30-40 years there has been extensive documentation of the breakdown of public belief in the authority of science, and of social trust in some scientific applications and technologies and their regulation by public institutions. In significant instances, scientists themselves have challenged the use of some technologies and their potential effects on society and the environment. The 'science, technology and society' literature suggests that scientific concern about the environmental impacts of certain technologies is a pre-cursor to these concerns entering the public arena and merging with non-scientific factors, to generate a grand feedback loop to policy and science institutions. In this context, scientific authority claims - including the reputable statements of international climate scientists - are now heard in a more sceptical public arena. This generic scepticism has been leveraged by some groups with different views on climate change and is amplified in the news media.

Under these circumstances, scientists as a community have struggled to balance their communication strategies and the scientific persona they present to society. Should climate scientists keep their attention in the lab and on their models, or should they step into the public domain with a message or warning, and act as advocates? The message about climate change is predicated on the ideal principles of objective and neutral science, yet the social context in which that message is received has required scientists to become increasingly adept at negotiating the social and political dynamics around climate science as a public 'issue'. These different goals and orientations for science communication are very effectively outlined by Piekle, for example, in his book *The Honest Broker* (2008). More research is needed to understand how scientists are negotiating their way in this arena, and the implications for effective climate change communication.

A number of academic papers have focused on how climate change is represented in the popular media and how this impacts on public perceptions and responses to climate change research and policies. Zehr (2000, p.9) examined the representation of scientific uncertainty about global warming and climate change in the U.S. popular press. His central argument was that the focus on uncertainty has constructed a boundary between science and the public, such that scientists come to see the public as misinformed and not holding "appropriate reverence for scientific process." This stance can, in turn, become a barrier to effecting change. The MSI science communication project cited above (Winstanley & Hepi, 2012) revealed a number of concerns held by scientists about how the news media affected public responses to science through misrepresentation, 'pseudo-science', and trying to get a 'balance' by presenting opposing views. There is a substantive gap between how scientists would like to be able to communicate science through the media and what actually gets reported. This leads to continuing expectations on the part of scientists about how the news media should change its reporting, and how readers should respond. This approach to science communication by scientists (and often by policy actors too) misunderstands how the news media actually works,

[9] http://www.foxnews.com/scitech/2011/05/27/italian-scientist-charged-manslaughter-failing-predict-earthquake/#ixzz1ezx6085k

and probably always will. It also mistakenly assumes that a lack of public responsiveness to the scientific message on climate change shows that the public is lacking in understanding, uninterested or ignorant, often underpinned by an assumption that if people only have the 'right' information they will change their behaviour accordingly.

This public deficit model has been severely critiqued because it assumes a homogenous public rather than diverse publics, tends to discount the legitimacy of other forms of knowledge and experience, and sets up hierarchical structures that do not reflect the multiplicity of factors influencing policy and decision-making. Pigeon and Fischoff (2011, p.41) sum up these points in the following way:

> Many climate scientists are understandably frustrated by the limited response to what they see as the greatest threat facing our planet. One impulsive response to a seemingly recalcitrant public is a big advertising campaign. However, unless founded on sound social and decision science principles and accompanied by rigorous empirical evaluation, such efforts have little chance of sustained success. Moreover, each communication failure makes future success less likely, by eroding both the public's trust in the experts, who seem not to know their needs, and the experts' trust in the public, which seems unable to understand the issues. Given the gravity and the complexity of climate-related decisions, **we need a new model of science communication**, with new collaborations among the sciences at both the national and the international level [emphasis added].

New research in the field of science and risk communication needs to be prioritised and brought to bear on this situation to improve the focus and outcomes of communication strategies around climate change. In particular, research on dialogic (Anderson et al, 2004) rather than linear forms of communication is a priority.

One of the underlying causes of miscommunication around science, including the discourse around climate change science, is the gap between expert and public perceptions of risk. There is a well-established international literature on risk communication - referenced below - which provides insights into the specific challenges around climate risk communication.

The marked difference between the lay public's perceptions of environmental and technological risks including climate change (see Bord et al., 1998; Weber, 2010; Brechin & Bhandari, 2011; Lorenzoni & Pidgeon, 2006; Wolf & Moser, 2011) and those of experts "has long been a cause for concern and even perplexity among those responsible for management of such risks" (Bickerstaff, 2004, p.827; Ho et al., 2008; Slovic, 1987). As a result an extensive, diverse and growing social science literature has sought to explore public responses to a wide range of risk and environmental concerns (see Krimsky & Golding, 1992; Lash et al., 1996; Wilkinson, 2001; Bickerstaff, 2004; and Zinn, 2008). Providing a definitive summary of this literature is beyond the scope of this review, but the insights that can be obtained from both individualistic and socio-cultural understandings of risks are particularly useful for understanding how different narratives are seen to be valid by different actors, and how farmers, growers and foresters might be motivated to take action.

Research on public perceptions of risk originally sought to "understand (and close) the apparent gap between expert and lay perceptions of risk" (Irwin, 1995; Bickerstaff, 2004, p.828; Wilkinson, 2001). As a consequence, the field was:

> founded upon a distinction between objective or statistical risk on the one hand and subjective or perceived risk on the other. The former refers to risk as defined and measured by experts, for example through experimental studies, epidemiological surveys or probabilistic risk analyses. The latter typically refers to non-expert or 'lay'

misperceptions or misunderstandings of that (objective) risk (Bickerstaff, 2004, p.828).

The trend for public perceptions to differ from those of the experts has commonly been seen to arise from the public's ignorance about the scientific or technical facets of the issue, a "diagnosis that exemplifies what has been labelled the 'deficit' model of public (mis)understanding of science" (Bickerstaff, 2004, p.828). Such a diagnosis is underpinned by a belief that the gap between lay perceptions and the scientific reality of issues, such as climate change, can be attributed to the inadequacies or 'irrational' assumptions behind this public bias or error (Irwin, 1995; Burgess et al., 1998; Bickerstaff, 2004).

It is now widely acknowledged that the 'lay public' as an "undifferentiated risk-perceiving entity" is a fallacy (Bickerstaff, 2004, p.830). As highlighted in the literature on farmers, growers and foresters, a society is "always composed of many groups with very different attitudes towards and appraisals of what risk is and what values are relevant to making acceptability decisions" (Bickerstaff, 2004, p.830; see also: Rayner & Cantor, 1987; Pidgeon & Beattie, 1998). Various psychological studies have shown how risk perceptions and attitudes differ by gender, ethnicity, nationality and social class (Rohrmann, 1999; Slovic, 2000) and that a number of social, cultural and political factors amplify risks [10] (Kasperson et al., 1988; Pidgeon et al., 2003). Alongside this research there is a growing body of work in sociology (Irwin et al., 1999; Lash, 2000), anthropology (Douglas, 1986, 1992; Douglas & Wildavsky, 1982) and geography (Bickerstaff & Walker, 2001, 2003; Bush et al., 2002) informed by a socio-cultural perspective. Those adopting this perspective argue that perceptions of and responses to risk and hazard are developed, expressed and sustained in particular social, cultural and political contexts (Bickerstaff, 2004; Irwin et al., 1999; Wilkinson, 2001). Understanding farmers, growers and foresters perceptions of the risks of climate change and how they might be motivated to take action, therefore, requires a better appreciation of their social and cultural experiences of everyday life (Bickerstaff, 2004; Irwin, et al., 1999).

Alongside these observations, there is a growing emphasis on the role the public (including farmers, growers and foresters) can play in generating insights for both policy-makers and scientists. Rather than being viewed as 'non-experts' who present a 'barrier' to the successful implementation of new practices and technologies, a number of scholars suggest that the public should be portrayed as possessing 'lay' or 'contextual' knowledges (see Brown, 1992; Irwin, 1995). They argue that the public can "often possess rich stocks of experience and expertise based upon […] everyday observation" (Wynne, 1996; Irwin et al., 1999, p.1312) Drawing on such knowledges, the public often produce broader accounts of the risks, uncertainties and challenges presented by new technologies by highlighting a number of important contextual variables that are either overlooked or in some instances trivialised by policymakers and/or scientists. If these 'local knowledges' are employed appropriately, therefore, they can "make a positive contribution to policymaking and debate" and generate "cognitive gains for policymaking and decision-making" (Irwin et al., 1999, p.1312). This was one of the goals in the establishment of the New Zealand SMLACC programme i.e. to engage industry sector groups, local government, Māori and researchers.

[10] The social amplification of risk framework "incorporates sources, channels, and flows of information, and the role of culture and of social institutions in reinforcing or attenuating particular risk "signals," to provide accounts of why particular hazards are identified as risks and how communication about those hazards impacts or fails to do so on the larger society (Pidgeon et al, 2003; Taylor-Gooby and Zinn, 2006: 401).

Research questions:

How do climate scientists and policy makers see the 'communication problem' around climate change? What framings and strategies are being used in current communication initiatives and how effective are these?

What is the role of trust in climate change communication?

How can climate change scientists appropriately and effectively position themselves in climate change communication?

What can New Zealand learn from international best practice in climate change communication and social marketing?

What is known about the best way to construct communication targets, messages and delivery mechanisms?

What is the role of the news media in climate change communication and social awareness?

Extending beyond deficit models, how might new approaches to communication based on international risk communication and dialogue research be applied to NZ climate change communications?

Where in New Zealand do we already have effective communication and engagement programmes working - and how can these be evaluated and extended for wider use in climate mitigation and adaptation?

5.4 INCREASING UPTAKE AND EFFECTIVE TARGETING OF SCIENCE INVESTMENT

This heading relates to a vast literature on technology transfer and innovation, which has had substantial international attention and is now gaining traction in New Zealand. Many policy and communication interventions, including those for climate change, are predicated on assumptions about technology transfer which may not be borne out in the real world. In essence, there is an expectation that society can mitigate or adapt to climate change problems through the development and application of new science and technologies. However, as highlighted at a recent New Zealand conference on science policy studies, despite these aspirations the underlying social dynamics of innovation are still not well understood.[11]

In many countries, resources are being focused on the development of new scientific solutions and technologies to deal with climate change. This 'production' orientation to science may not succeed without at least as much attention being paid to the demand side of the process. It is assumed that a seamless conveyor belt will transfer new technologies from science institutions to end users, who will take up new products, equipment and methods and deploy them in their operations. The production, transfer, uptake, adoption and diffusion of new technologies model is treated as an unproblematic linear process. However, this

[11] See the keynote address by Prof Helga Nowotny, President European Research Council, at SPS 2012 www.sps2012.org.nz

underestimates and overlooks the many complex social, political and economic factors surrounding technology creation and its use in real world social contexts. Furthermore, there are few mechanisms at work to signal back into the science 'production house' which technologies will best meet end-user needs and achieve the desired economic, social and environmental outcomes. More nuanced and dynamic feedback processes are needed to create accurate investment signals in the innovation cycle.[12] There is a fertile area for social research on the real-world processes of innovation, including better processes for end-user engagement in technology assessment and design. Existing knowledge internationally in the fields of participatory and anticipatory technology assessment (e.g. Guston & Sarewitz, 2002) provides a useful reference point for future New Zealand research.

Research questions:

What assumptions are being made in the design of climate change policy and programmes about the dynamics of innovation and the role of technology transfer for climate change mitigation and adaptation in the land-based sectors?

How can more processes be designed to integrate climate change objectives and the needs of the land based sectors in the design of new technologies to ensure more effective uptake?

What new governance processes e.g. upstream engagement and participatory technology assessment, are needed to prioritise investment in the most relevant and effective science and technology solutions for climate change?

[12] See for example the work of the ESR/PFR social research project on sustainable decision making for future foods, which is seeking to connect stakeholder dialogue feedback to strategy and investment processes in a science institution www.esr.cri.nz/futurefoods

6. How farmers, growers and foresters understand the risks of climate change and how they are motivated to take action

The section is based on an extensive international literature review, including a number of New Zealand studies previously funded by MPI under the SLMACC programme. It begins with a discussion on how farmers, growers and foresters understand the risks of climate change. The perceptions of farmers and growers are considered together - as distinctions between crop, produce and livestock farmers are not always made apparent. [13] Findings from the risk literature emphasise the importance of understanding how perceptions of, and responses to, risks such as climate change are developed, expressed and sustained in particular social, cultural and political contexts. The second part of this section examines the many ways in which farmers are motivated to take action. As in the previous section, the key themes and potential research questions are highlighted in green boxes.

6.1 FARMERS' AND GROWERS' PERCEPTIONS OF CLIMATE CHANGE

There is a growing body of research on farmers' and growers' understandings and experiences of and responses to climate change both internationally (Alpizar et al., 2011; Battaglini et al., 2009; Bento et al., 2009; Bryan et al., 2009; Buys et al., 2012; Eakin, 2005; Fleming & Vanclay, 2010; Fujisawa & Kobayashi, 2011; Hansen, et al., 2004; Head et al., 2011; Hogan et al., 2011; Mertz et al., 2009; Mubaya et al., 2012; Reid et al., 2007; Rickards, 2012; Senaratne & Scarborough, 2011; Smit et al., 1996; Vedwan, 2006) and in New Zealand (Cradock-Henry, 2008; Cradock-Henry, 2011; Fairweather et al., 2009; Kenny, 2010; Kenny & Fisher, 2003; Kenny & Porteous, 2008; Rosin et al., 2008; Sinclair et al., 2010).

A mixture of quantitative (questionnaire surveys) and qualitative approaches (interviews, focus groups and workshops) has been employed to explore these issues, although quantitative approaches, and disciplines such as psychology, have tended to be dominant. The literature is increasingly focused on the impact that climate change will have on farmers and growers, and their households and communities, in both developed (the global North) (Buys, et al., 2012; Cradock-Henry, 2011; Head et al., 2011; West and V´asquez-Le´on, 2008) and developing (the global South) countries (Bryan et al., 2009; Eakin, 2005).

A number of these studies have investigated farmers' and growers' perceptions of climate change (Battaglini et al., 2009; Fairweather et al., 2009; Hansen et al., 2004; Rosin, 2008; Kenny & Fisher, 2003; Weber, 1997), particularly in Australia (Buys et al., 2012; Donnelly et al., 2009; Fleming & Vanclay, 2010; Head et al., 2011; McDonald et al., 2006; Milne et al., 2008; Thwaites, et al., 2008). Overall, this research highlights that farmers and growers are divided on the causes of climate change, and in some instances, whether climate change is happening at all.

In Australia, many studies have found a divergence between farmers who interpret local climate changes as either the result of natural 'climate variability' (extreme natural weather events) or 'climate change' (anthropogenic change) (Buys et al., 2012; Fleming & Vanclay, 2010; Head et al., 2011; McDonald et al., 2006; Milne et al., 2008; Thwaites et al., 2008). For example, Donnelly et al. (2009) surveyed 2000 urban dwellers (n=1009) and primary producers (n=991) in Australia. They found that only 28% of primary producers believed human activity is the cause of climate change, compared with 58% of urban dwellers

[13] Where relevant we have attempted to highlight the findings from research on farmers and other types of growers (e.g., orchardists and winegrowers).

(Donnelly et al., 2009). Thwaites et al. (2008) also found that just over half of their 36 interview respondents in Victoria, Australia, believed climate change was a reality. There is some evidence from the international literature to suggest that growers might be less skeptical about climate change. Donnelly et al. (2009) found viticulture producers were found slightly more likely to believe in human-induced climate change compared to other primary producers. Furthermore, a questionnaire survey of 255 winegrowers in France, Germany, and Italy found that a significant number of respondents had noticed on-going climatic changes over the past few decades (Battaglini et al., 2009).

Thwaites et al. (2008), and others, argue that the divide between farmers and growers over the causes of climate change has resulted in differences in climate change discourse and terminology (Buys et al., 2012; Fleming & Vanclay, 2010; Head et al., 2011; McDonald et al., 2006). As Buys et al. observe, while "rural residents agreed that the environment and local weather events were common talking points within the community […] there was a clear divide in how these changes were conceptualised and labelled—as 'climate change' by those who believed in anthropogenic or human-induced factors and as 'weather variability' by those who were more sceptical" (2012, pp. 245-246). These studies (Buys et al., 2012; Fleming & Vanclay, 2010; Head et al., 2011; McDonald et al., 2006), and earlier research (Weber, 1997), highlight that those who do not believe in the human-induced argument frequently make reference to past weather events in order to dispute the science. It has been argued, therefore, that these rural residents "need to be convinced that climate change is real, and the impacts will be more serious than the climatic variability they have experienced in the past" (Buys et al., 2012; Donnelly et al., 2009; Fleming & Vanclay, 2010).

In New Zealand, Rosin et al. (2008) examined farmers' awareness of and anticipated response to the proposed emissions trading scheme (ETS) and associated afforestation policies, by undertaking interviews with 29 pastoral farmers. They found that farmers justified their opposition to such policy and a delay in developing strategic responses to climate change on the basis of the "uncertainties surrounding both climate change policy and science" (Rosin et al., 2008, p.iii). Furthermore, farmers perceived greenhouse gas regulation "as the product of urban interests, that rests on a failure to adequately distinguish between industrial and "natural" (agricultural) sources" (Rosin et al., 2008, p. iii).

Fairweather et al. (2009) surveyed 106 farmers on a range of issues including their views on their responsibility for reducing greenhouse gas emissions. Most farmers felt they do not contribute to climate change and should not take responsibility for reducing emissions. The core of farmers who did accept climate change and farmers' role in it, however, tended to be younger and had a university education (Fairweather et al., 2009). In contrast, Kenny and Porteous (2008) found in their interviews with 18 kiwifruit growers that there is an increasing awareness in this group of climate change, and concern in relation to the potential for increased frequency of extreme weather events, the effects of warmer winters and autumns, effects on rainfall patterns, and changes to pests and diseases.

Farmers and growers are aware that climate change will present a number of risks to the sustainability of their farms and orchards. The most common risks identified are: 1) increases in extreme weather events (e.g., heavy rains, floods and windstorms); 2) more pest and disease problems; 3) increased fire danger; 4) effects on water resources (e.g. supply, storage and reticulation); 5) effects on pastures, crops, and cultivars; 6) increased erosion problems; 7) effects on animal health; 8) increased social and economic pressures (Battaglini et al., 2009; Buys et al., 2012; Head et al., 2011; Kenny, 2010; Kenny & Fisher, 2003; Kenny & Porteous, 2008; Mertz, et al., 2009; van den Dungen et al., 2011b). Furthermore, as the weather and climatic variability are an integral part of both farming and growing, many rural

communities are particularly attuned to the risks and challenges such variability creates for their industry and locality (Buys et al., 2012; Cradock-Henry, 2011; Head et al., 2011; Kenny, 2010; Kenny & Fisher, 2003; van den Dungen et al., 2011b). Focus groups, interviews and workshops, with farmers in Eastern New Zealand and kiwifruit growers in the Bay of Plenty, illustrate they are already experiencing and anticipating the future impacts of a changing climate in their local areas (Kenny, 2010; Kenny & Fisher, 2003; Kenny & Porteous, 2008). In addition to the many risks identified above, farmers in this region are aware that due to local conditions there will be less summer pasture growth and as a result a need for more summer supplementary feed (Kenny & Fisher, 2003). Kiwifruit growers, on the other hand, are concerned that less of a winter chill will be a challenge particularly for 'Hayward' kiwifruit and there will be more salt water intrusion in coastal areas (Kenny, 2010; Kenny & Porteous, 2008).[14]

Several of these studies reveal that many farmers and growers are aware of the potential benefits and opportunities that climate change may present (Buys et al., 2012; Head et al., 2011; Kenny & Fisher, 2003; Kenny & Porteous, 2008). Research carried out with rural communities in New South Wales, Victoria and Tasmania found that many people believed that climate change would present opportunities for the agricultural industry (i.e., crop diversification) and the broader community (i.e., tourism) (Buys et al., 2012). In fact, when asked to describe how agriculture would be affected by climate change, most participants identified positive adaptation possibilities (Buys et al., 2012). It was perceived that longer periods of high temperatures would "correlate with longer cropping seasons, along with fewer frosts, enabling a wider variety of crops to be grown—however, rainfall patterns were considered detrimental" (Buys et al., 2012, p.244).

The results of six workshops run with farmers throughout New Zealand also reveal that participants felt climate change would result in a number of positive impacts (Kenny & Fisher, 2003). Benefits of climate change identified included "opportunities for diversification and land use change" and "a longer growing season with less winter feed needed" (Kenny & Fisher, 2003, p.37). It is not clear how widely farmers, foresters and growers are looking out for wider strategic benefits which might be achieved if New Zealand meets the sustainability demands from consumers in key export markets. This might be a topic for further research. There has been some attention on how farmers and growers are currently addressing, or might respond in future to, climate change (Artur & Hilhorst, 2012; Battaglini et al., 2009; Bradshaw et al., 2004; Buys et al., 2012; Cradock-Henry, 2011; Fujisawa & Kobayashi, 2011; Head et al., 2011; Kenny, 2010; Kenny & Fisher, 2003; Mertz et al., 2009; Senaratne & Scarborough, 2011; Smit et al., 1996; van den Dungen et al., 2011a, 2011b; Vedwan, 2006). In terms of climate change, farmers and growers can choose to respond either in a reactive (the wait-and-see approach) or proactive (adapt now to future risks and opportunities) manner (Buys et al., 2012; Head et al., 2011; Smit et al., 1996). Those who choose to be proactive can then adapt either tactically (e.g., with changes in input use and timing of planting and harvesting) and/or strategically (e.g. changing the selection of crop varieties, increased diversification of crops and/or crop insurance) (Bradshaw et al., 2004; Cradock-Henry, 2011).

A number of studies highlight that there is optimism, to some extent, in both the farming and growing communities that the sectors can adapt to future climatic risks (Battaglini et al., 2009; Buys et al., 2012; Head et al., 2011; Kenny & Porteous, 2008; van den Dungen et al., 2011a, 2011b). Research from Australia has highlighted there is a general belief and optimism in the 'resilience' of farmers and their ability to successful adapt and adjust to climatic changes (Buys et al., 2012; Fleming & Vanclay, 2009; Steffen et al., 2011). Similarly, Kenny has reported that farmers in the eastern regions of New Zealand have a "strong belief that

[14] It will be important to keep track of the multiplied impacts of the PSA virus in the kiwifruit industry and climate change impacts.

there is sufficient knowledge and experience to adapt to on-going climate change" (2010, p.62). In contrast, research with kiwifruit (Kenny & Porteous, 2008) and wine growers (Battaglini et al., 2009) have shown mixed results. Kenny & Porteous (2008) found there is confidence in the ability and capacity of growers and the industry as a whole to adapt to a changing climate. This confidence, however, is "balanced with a recognition that a planned, proactive, approach to adaptation is required to minimise risks and maximise opportunities" (Kenny & Porteous, 2008, p. 8). A survey of winegrowers found that most respondents reported negative expectations in light of on-going global changes such as climate change (Battaglini et al., 2009).

6.2 FORESTERS' PERCEPTIONS OF CLIMATE CHANGE

To date, foresters' understandings, experiences and responses to the risks of climate change have received only limited attention internationally (Beddoe & Danks, 2009; Blennow & Persson, 2009; Charnley et al., 2010; Colombo, 2006; Davidson et al., 2003; Fischer & Charnley, 2010; Guariguata et al., 2012; Labriole & Luzadis, 2011; McKinnon & Kaczanowski, 2003; Ogden & Innes, 2007; Williamson et al., 2005; Williamson et al., 2008) and even less in New Zealand [15] (Payn et al., 2010). Most of this research has been involved quantitative, often psychological, research (questionnaire surveys) with public forest managers (Colombo, 2006; Guariguata, et al., 2012; Labriole & Luzadis, 2011; Ogden & Innes, 2007; Payn et al., 2010; Williamson et al., 2005) or private forest owners (Beddoe & Danks, 2009; Blennow & Persson, 2009; Charnley et al., 2010; Fischer & Charnley, 2010) and has been carried out in the United States or Canada. Very few studies have employed qualitative research methods to understand foresters' perceptions of risk (McKinnon & Kaczanowski, 2003; Payn et al., 2010; Williamson et al., 2008).

Overall, this research highlights that the majority of foresters believe that climate change is occurring and are concerned about the risks of climate change (Blennow & Persson, 2009; Colombo, 2006; Guariguata et al., 2012; Labriole & Luzadis, 2011; Payn et al., 2010; Williamson et al., 2005; Williamson et al., 2008). For example, an electronic survey of 150 natural and planted tropical production forest managers and decision makers in Africa, the Americas, Asia and the Pacific found 89% of respondents expected forest changes attributable to climate change (Guariguata et al., 2012). Similarly, a questionnaire survey of 1950 Swedish private forest owners found that 75% of respondents believed that the climate was changing to an extent that would affect the forest (Blennow & Persson, 2009). A few studies, including one undertaken in New Zealand (Payn et al., 2010), have found that some foresters dispute whether climate change is human-caused and in some instances whether it is occurring at all (Beddoe & Danks, 2009; Labriole & Luzadis, 2011).

Foresters are aware that climate change will present a number of risks for the sustainability of forestry. The most common risks identified are changes in: 1) the intensity, severity or magnitude of forest insect outbreaks, pathogens and diseases; 2) extreme weather events (e.g., heavy rains, floods and windstorms); 3) intensity, severity or magnitude of forest fires; 4) growth, productivity, or regeneration of trees and non-timber forest products; 5) biomass and carbon; 6) forest dieback; and 7) biodiversity (e.g., change in presence and abundance of plant and animal species, loss of habitat diversity, disruption of species interactions) (Guariguata et al., 2012; McKinnon & Kaczanowski, 2003; Ogden & Innes, 2007; Payn et al., 2010; Williamson et al., 2008).

[15] A number of studies have investigated farmers' perceptions of the Emissions Trading Scheme (ETS) and associated afforestation policies (e.g. Fairweather et al., 2009; Rosin et al., 2008; Sinclair et al., 2010). Some research has also been undertaken on sustainable forest management (e.g. Fairweather et al, 2003), the social and economic impacts of forestry on communities (MAF, 1993) and policy to encourage carbon sequestration in plantation forests (Kerr et al, 2004).

Foresters' views on the potential benefits or opportunities that climate change may present are less well understood. In New Zealand, Payn et al. (2010) used an electronic survey (n=170) and a series of workshops to examine forestry sector members' understandings of climate change, and their views on the potential risks and opportunities it might create for forestry and mitigation and adaptation activities. They found the most common opportunities identified were in relation to carbon markets and credits, increased forest growth and productivity, the creation of new products, the possibility of product diversification, and new or increased use of wood materials and products in different sectors (e.g., building materials, energy and fuel) (Payn et al., 2010).

There has been some attention given to how foresters are currently addressing or might respond in future to climate change (Colombo, 2006; Eastaugh et al., 2009; McKinnon & Kaczanowski, 2003; Ogden & Innes, 2007; Payn et al., 2010; Williamson et al., 2008). In general, these studies highlight a mixture of a 'business-as-usual' and 'optimistic' view in the industry in relation to climate change adaptation. [16] Studies in both Canada (Ogden & Innes, 2007) and New Zealand (Payn et al., 2010) found that the majority of respondents felt that the goals of adaptation were either synonymous with sustainable forest management and/or good forestry practice. For example, Payn et al. (2010) reported that members of the New Zealand forestry sector considered adaptation to be what is normally referred to as 'good forestry practice', but just applied differently. Such practices include the identification of species for new climates, drought tolerant genotypes, pest and disease resistant genotypes, and silviculture practices that take into consideration wind, fire and water issues (Guariguata et al., 2012; Payn et al., 2010).

Another study which involved qualitative interviews with key local stakeholders including individuals from government, agriculture, forestry and the general public in Vanderhoof, Canada, demonstrates an overriding optimism about the likelihood of successful adaptation (Williamson et al., 2008). Participants felt that as the region had faced several obstacles and challenges over the years and has always developed solutions they, therefore, had the required skills and experience to adapt and respond to the realities of climate change (Williamson et al., 2008).

6.3 UNDERSTANDING THE CULTURES, EVERYDAY REALITIES AND PRACTICES OF FARMING, GROWING AND FORESTRY

A number of trends can be identified from the literature on farmers', growers' and foresters' perceptions of climate change, as discussed above:

- There is a divide between farmers and growers over the causes (natural vs. anthropogenic), and in some instances, the existence, of climate change.
- Farmers and growers are concerned about the risks and impacts of either climatic/weather variability and/or climate change. [17]
- Most foresters believe that climate change is occurring and are concerned about the risks and impacts of climate change.
- Most farmers, growers and foresters are optimistic about climate change and believe that their community and industry will be able to adapt and adjust to a changing climate.

In contrast to views among many in the sector, the vast majority of scientific and policy experts in the fields of agriculture (Smith et al., 2007), horticulture (Easterling et al., 2007;

[16] A survey of 81 staff at the Ontario Ministry of Natural Resources was less optimistic (Colombo, 2006). Only 14% of respondents believed that forest managers could control the impacts of climate change on forests. This research in part demonstrates the differences between foresters' perceptions of the risks of climate change and those of scientists and policy-makers.

[17] As discussed earlier, those who believe interpret local climate changes to be the result of anthropogenic or human-induced factors most commonly refer to 'climate change' , whereas those who believe that changes are part of a natural climatic cycle refer to 'climatic/weather variability'.

Smith et al., 2007) and forestry (Easterling et al., 2007; Nabuurs et al., 2007) would argue that anthropogenic climate change is happening and, that while the adaptive capacity of rural communities might be generally high, there may only be a limited window of time and opportunity to successful climate change resilience strategies (Adger et al., 2007; IPCC, 2007; Smith et al., 2009; Steffen et al., 2011).

6.4 HOW FARMERS, GROWERS AND FORESTERS ARE MOTIVATED TO TAKE ACTION

Extensive quantitative and qualitative research has been undertaken on the diverse factors (social, cultural, economic and political) that motivate farmers and growers to make particular decisions and undertake certain practices. Several overlapping subject areas have received particular attention, including: biodiversity/nature conservation (Greiner et al., 2009; Knierim, 2004; Pannell et al., 2006); the adoption of best management practices (BMPs) (Baumgart-Getz et al., 2012; Gillespie et al., 2007; Prokopy et al., 2008); extension (Botha et al., 2008; Cohen, 2010; Fleming & Vanclay, 2009; Small & Roth, 2007); sustainable systems of production (Blackstock et al., 2010; Campbell et al., 2012; Mortlock & Hunt, 2008; Schoon & te Grotenhuis, 2000; Theocharopoulos et al., 2012); conversion from conventional to organic production (Cranfield, et al., 2010; Darnhofer et al., 2005; Fairweather, 1999; Koesling et al., 2008); and more recently, climate change mitigation and adaptation (Buys et al., 2012; Head et al., 2011; Tambo & Abdoulaye, 2012).

The literature on the motivations of foresters is not as well developed, but again covers a number of topics which often overlap and align with research on farmers and growers, such as: biodiversity/nature conservation; (Boon & Meilby, 2007; Primmer & Karppinen, 2010; Raymond & Olive, 2008; Serbruyns & Luyssaert, 2006; Uliczka et al., 2004; Wolf & Primmer, 2006); the adoption of BMPs (Aust & Blinn, 2004; Schuler & Briggs, 2000); agro-forestry (McDonagh et al., 2010; Pannell, 1999; Rosin et al., 2008); sustainable forestry (Fairweather et al., 2003; Sharma & Henriques, 2005); public, commercial and private forestry (Bliss & Martin, 1989; Chavasse, 1971; Kaetzel et al., 2011; Shiferaw et al., 2009); and climate change mitigation and adaptation (Guariguata et al., 2012; Ogden and Innes, 2007; Payn et al., 2010). Given the overlaps between the literatures on farmers, growers and foresters, this section will consider the factors which motivate individuals across these three sectors.

The theoretical idea that someone can be 'motivated to act' carries a particular economic and psychological legacy. From this perspective, the focus is on trying to understand and characterise the various economic (i.e., risk-benefit trade-offs, choice) or psychological (i.e., attitudes, beliefs, values and motives) factors that influence, shape or sustain the behaviours of farmers, growers and foresters. [18] This information is then used to identify the most suitable targets and delivery mechanisms for interventions to facilitate sustainable practices (for a review see Jackson, 2005). This approach has come to dominate understandings of behaviour change, and has had a profound influence on environmental and climate change policy in many areas including agriculture, horticulture and forestry.

These approaches, and the policy-making thinking from which they originate, are representative of the 'ABC' framework of behaviour change (Shove, 2010a), noted in an earlier section of this report. Behaviour or social change, from this perspective, is "thought to depend upon values and attitudes (the A), which are believed to drive kinds of behaviour (the B) that individuals choose (the C) to adopt" (Shove, 2010a, p.1274). It is assumed, in other words, that behaviour is the outcome of an essentially linear process in which individuals

[18] For a more dynamic account of agriculture practices see Campbell et al. (2012)

consciously make more or less rational decisions (Harrison & Davies, 1998) or 'choices'. Providing a fuller account and critique of this approach, however, is beyond the scope of this review (see Hargreaves, 2011, 2012; Shove, 2010a, 2010b).

Looking to what research might be needed in New Zealand in future, this literature review highlights the importance of understanding the dynamic, tangled and contextual nature of 'everyday life', which may not be fully captured by focusing solely on motivations alone. The remainder of this section addresses individual and social change from the perspective of adopting new practices and technologies, notably:

1. Management approaches and styles
2. Financial and economic considerations
3. Social capital
4. Learning, education and training
5. Institutional policy contexts: voluntary and mandatory rules and regulations.

Each of these topics is explored in the sections that follow.

6.4.1 Management approaches/styles

Motivations, goals and priorities of the farm, orchard or forest

The management approaches and styles of owners and operators of farms, orchards and forests are driven by a number of motivations, goals and priorities (Chavasse, 1971; Fairweather, 1999; Fischer & Bliss, 2006; Fischer & Charnley, 2010; Hunt et al., 2005, 2006; Kline et al., 2000; Pannell et al., 2006; Serbruyns & Luyssaert, 2006; Small et al., 2005; van den Dungen et al., 2011b). Production, financial, economic and profit-making are the most commonly identified motivations (Fischer & Bliss, 2006; Hunt et al., 2005, 2006; Serbruyns & Luyssaert, 2006; Small et al., 2005). For example, focus group research on the key drivers of intensification in the sheep, dairy and deer industries in New Zealand found that profit was the main driver (Small et al., 2005). Such goals and priorities, however, cannot be considered in isolation. There is a diversity of other motivating factors, including: lifestyle and wellbeing; survival of livelihood; environmental concerns; succession planning; recreational; contributing to community and social sustainability; work satisfaction; and attachments to the land and the place (Campbell et al., 2012; Fischer & Charnley, 2010; Hunt et al., 2005, 2006; Kline et al., 2000; Serbruyns & Luyssaert, 2006). Surveys in Australia found, for instance, that graziers were less motivated by financial/economic and social considerations than by conservation and lifestyle motivations (Greiner & Gregg, 2011).

These diverse motivations, goals and priorities play an important role in determining the acceptability and uptake of new practices, technologies and policies (Fischer & Bliss, 2006; Kline et al., 2000; Rosin et al., 2008; Schneider & Ingram, 1990; Serbruyns & Luyssaert, 2006). In New Zealand, for example, Campbell et al. (2012) discuss how farmers and growers position their farms and orchards in relation to the environment - both on their properties and in a wider context. They found that organic producers "more consistently privileged nature in their management decisions and emphasised their environmental responsibilities and impacts" (Campbell et al., 2012, p.135). In contrast, non-organic producers placed more emphasis on the need to balance environmental concerns with economic viability and practicality (Campbell et al., 2012). Similarly, a study of family foresters in the USA found that owners' beliefs about the appropriate role for humans in nature determined how actively they managed (from 'no management', to 'intensive') their forest (Fischer & Bliss, 2006).

Risk and innovation

The orientation of farmers, growers and foresters towards risk and innovation has been found to be important in their willingness to adopt particular practices and technologies (Campbell et al., 2012; Feder et al., 1985; Gillespie et al., 2007; Greiner et al., 2009; Hunt et al., 2005, 2006; van den Dungen et al., 2011a, 2011b). Studies of the adoption of Best Management Practices (BMPs) have found that risk adverse producers were more likely to adopt BMPs or innovations that would reduce the likelihood of risks (e.g., sudden soil loss or erosion from heavy rainfall) or to not adopt an innovation that is perceived to increase risk (Abadi Ghadim et al., 2005; Gillespie et al., 2007; Rahelizatovo & Gillespie, 2004). Research in New Zealand has highlighted that integrated green kiwifruit orchardists did not like change, whereas gold kiwifruit orchardists were more likely to take risks and innovate (Rosin et al., 2007). Sheep and beef farmers in New Zealand have also been found to have distinctive responses to risk and innovation (Rosin et al., 2007). Conventional farmers appear to be more conservative in response to the demands of an "increasingly retail and consumer-orientated market" (Rosin et al., 2007, p. 28). Integrated and organic farmers, in comparison, have been prepared to take on additional risk in order to "actively approach the challenge of this market" (Rosin et al., 2007, p. 28).

It has been suggested that increasing age may also inhibit both the adoption of new practices and technologies (Gillespie et al., 2007; Hogan et al., 2011), and physical and innovative performance (Fairweather et al., 2009). Research on kiwifruit growers, however, has shown that many enter the New Zealand industry later in life when they are on a path to an active and graduated retirement, and more financially secure, and consequently they are in a stronger position to innovate (Hunt, 2009). Similarly, Fairweather et al. (2009, p.44) suggest that as sheep/beef and dairy farmers become "more financially secure they may be less taken up with an emphasis on production and more inclined to pay attention to environmental concerns" (see also Campbell et al., 2012). In contrast, Hogan et al. (2011) highlight that, in Australia, younger, cash-poor farmers were more concerned about sustainability and the risks of climate change than older well-resourced farmers.

Current responses to 'climatic variability' and 'climate change'

Climatic variability has been an important motivating force for farmers, growers and foresters, both recently and in the past. For many in these sectors, responding to such variations are part of normal practice and efforts to improve productivity and viability and loss reduction (Buys et al., 2012; Cradock-Henry, 2011; Eastaugh et al., 2009; Guariguata et al., 2012; Head et al., 2011; Payn et al., 2010; Salinger et al., 2005; van den Dungen et al., 2011b). These responses continue to take place despite "questions over the validity of 'climate change' and subsequently the need to adapt" (Buys et al., 2012; Guariguata et al., 2012; Head et al., 2011). As illustrated earlier, it appears that differences in beliefs about climate change are reflected in how people in rural communities talk about changes in local weather patterns, either as natural 'climatic variability' or anthropogenic 'climatic change' (Buys et al., 2012; Head et al., 2011). Research from forestry suggests that a number of managers have adopted practices which, in part, address climatic variability and climate change (Guariguata et al., 2012). Guariguata et al. (2012) also found that a number of forest managers (36 of 59 respondents (61%)) had adopted at least one climate change adaptation practice (Guariguata, et al., 2012). Reinforcing the earlier observations about adaptation being akin to good forestry practice, they observe, however, that most respondents recognized that very often these 'adaptation practices' were already being implemented as part of routine management (Guariguata et al., 2012).

In Australia, many farmers and growers are already employing strategies to manage erratic weather patterns and to safeguard the viability of their livelihoods by either altering their

practices or leaving the industry (Buys et al., 2012; Head et al., 2011). For example, many farmers have "consciously selected new crop choices based on tolerance and appropriateness for the changing local climate" (Buys et al., 2012, p.244). Cradock-Henry (2011) reports how farmers in Eastern Bay of Plenty, New Zealand, are implementing both short-term tactical and longer-term strategic adaptive responses to climatic variability, such as: supplementary feeding; currency hedging; installation of irrigation systems and feed pads; early dry-off or the sale of part of the herd; and the lease or purchase of additional land as runoff. Van den Dungen et al. (2011b, p.23) also describe both the proactive responses ("on-farm feed investments such as bale age were made to cope with reduced pasture growth") and reactive responses ("buying extra feed from off-farm sources at the occurrence of a drought") of New Zealand sheep and beef farmers to climatic extremes such as droughts and heavy snowfall.

The perceived impact of climatic variability on management differs geographically, and by farm size, farm management practice, and farm structure - even in the same regions (van den Dungen, et al., 2011b). Kiwifruit growers have made a number of adaptations in post-harvest management to respond to warmer autumns in recent years (Kenny, 2008), although previous research in New Zealand has shown that very few orchardists consider droughts, frost and hail to be drivers of change (Benge, 2006; van den Dungen et al., 2011a). At present it appears that orchardists have "the capacity to control and manage climatic extremes to a high degree with strategic investments in frost protection systems, irrigation and nitrogen spraying" (Benge, 2006; van den Dungen et al., 2011a, p.28).

Experience of and responses to multiple risks and threats

Climatic variability and change are just two of the threats farmers, growers and foresters respond to in the land based sectors. A number of studies emphasise that farmers, growers and foresters juggle multiple risks (Adger et al., 2007; Bradshaw et al., 2004; Bryan et al., 2009; Cradock-Henry, 2011; Eakin et al., 2006; Guariguata et al., 2012; Head et al., 2011; Howden et al., 2007; Meinke & Stone, 2005; Ogden & Innes, 2007; Smit & Skinner, 2002; Smit & Wandel, 2006; van den Dungen et al., 2011a, 2011b; Williamson et al., 2008); and multiple temporalities (from intra-seasonal to generational succession planning) (Cradock-Henry, 2011; Head et al., 2011; Kerr et al., 2004; Reid et al., 2007; Smit et al., 1996; Smit & Skinner, 2002; Stokes & Howden, 2010) in their everyday farming, growing and forestry practices. Responding to these diverse non-climatic risks and threats often plays an important role in motivating those working in these sectors to undertake action.

For farmers and growers these risks include, but are not limited to: market price fluctuations; rising input prices; trade liberalization; fluctuations in domestic and international currencies; government policy changes and personal risks (stress, health and break-up of relationships) (Berry et al., 2011; Cradock-Henry, 2011; McMichael et al., 2006; van den Dungen et al., 2011a, 2011b). Cradock-Henry (2011) highlights the diverse short-term and longer-term responses of farmers to multiple climatic and non-climatic stressors in Eastern Bay of Plenty. He contends that, in order to cope with this ever-changing environment, farmers are forced to trade-off adaptive responses and mitigation to climatic risks and variability against shorter-term, strategic and economic goals and risks (Cradock-Henry, 2011). Similarly, van den Dungen et al. (2011b) report that New Zealand sheep and beef farmers have adopted a number of responses to address the economic restructuring of the 1980s, droughts, rising input prices and market price fluctuations. These include: reducing costs (plant and machinery, repair and maintenance and fertilizer); cutting back on fertilizer; and turning to strategically innovative cultivation methods, such as direct drilling, to reduce fuel costs and enhance soil properties (van den Dungen et al., 2011b, p.24).

Foresters are typically concerned with "more immediate and more tangible" issues than those that are perceived to be far-off and less tangible (Guariguata et al., 2012; Ogden and Innes, 2007; Williamson et al., 2008, p. 18). In other words, while foresters perceive that climate change will pose significant risks to forestry, they envisage these threats taking place in the distant future and, therefore presenting a less immediate challenge for management (Guariguata et al., 2012; Lawrence & Carter, 2009; Ogden & Innes, 2007). One New Zealand study found that most respondents (20.0%) believed New Zealand's forests would be affected by climate change within 20 years. Smaller sections of the respondents had a longer time horizon: within 50 years (15.7%); within 100 years (10.0%); within over 100 years (37.5%)) (Payn, et al., 2010). This is also reinforced in the literature on what foresters' perceive as the biggest threats or challenges for forestry. Climate change has, to-date, been ranked behind a number of other issues including commodity prices, trade policies, environmental regulations, pollution and finances and capital (Guariguata et al., 2012; Ogden & Innes, 2007; Payn et al., 2010). Guariguata et al. (2012), for instance, found that survey respondents ranked the most important threats to the productive capacity of their forests as: commercial agriculture (1); unsustainable logging (2); subsistence agriculture (3); and then climate change (4). Meanwhile, a study of family foresters in the USA found owners regularly struggled with balancing their forest management ideals against the reality of having to make money (Fischer & Bliss, 2006).

6.4.2 Financial and economic considerations

Financial and/or economic capacity, benefits, and costs, play central roles in the adoption of new practices and technologies (Baumgart-Getz et al., 2012; Gillespie et al., 2007; Hunt, 2009; Kerr et al., 2004; Serbruyns & Luyssaert, 2006). A number of studies highlight that the availability of financial capital is a key factor in adoption (Baumgart-Getz et al., 2012; Gillespie et al., 2007; Serbruyns & Luyssaert, 2006). The availability capital is often correlated with the size of the enterprise (Baumgart-Getz et al., 2012; Gillespie et al., 2007). For example, larger farms more commonly adopt new practices and technologies (Baumgart-Getz et al., 2012; Gillespie et al., 2007). The suitability of a new practice or technology is determined, in part it, by its perceived relative advantage over the idea or practice it supersedes (Rogers, 2003). A number of financial/economic factors have been highlighted as being important in this context (Gillespie et al., 2007; Pannell et al., 2006, p.1414), including:

1. The short-term input costs, yields and output prices of the practice or technology, or of other activities that it affects.
2. The impact of the practice or technology on profits in the medium-to long term.
3. Adjustment costs involved in adoption of the practice or technology.
4. The impact of the practice or technology on the riskiness of production.
5. The compatibility of the practice or technology with existing sets of technologies, practices and resources.
6. The cost or profitability of the traditional practice which the new practice or technology would replace.

The literature on the role of financial incentives in encouraging adoption, is somewhat mixed (Baumgart-Getz et al., 2012; Gillespie et al., 2007; Kerr et al., 2004; Serbruyns & Luyssaert, 2006; Siebert et al., 2006). This reflects that, in some circumstances, incentives are either: hard to access and overly complicated (Charnley et al., 2010); not accompanied with sufficient educational materials (Gillespie et al., 2007); and/or not tailored to the motivations, goals and priorities of the target audiences (Kline et al., 2000). For example, Siebert et al.'s (2006) study of European farmers' participation in biodiversity policies found that, in terms of motivating factors, 'land' and 'maintaining productivity' ranked ahead of financial incentives. In a forestry context, studies have revealed that some programmes have been successful

(Langholz et al., 2000; Zhang & Flick, 2001), while others have had limited success (Kilgore & Blinn, 2004; Klosowski et al., 2001; Pinso & Vun, 2000).

6.4.3 Social capital

The concept of social capital was touched on in a previous section.

In this section focused on behaviour change, we note that theories of social capital provide a way of integrating the role of social networks (i.e., relations with other operators, organisations, sources of information or other benefits) with social change (Campbell et al., 2012). It is argued by a number of authors that higher levels of social capital contribute "to the sustainability and viability" of production (Baumgart-Getz et al., 2012; Campbell et al., 2012, p.133; Pannell et al., 2006; Pretty, 2002; Pretty & Ward, 2001).

A number of linkages have been identified between producers and others, which may influence the adoption of new practices or technologies (Pannell et al., 2006, p.1412). Key observations in the literature are:

1. The existence and strength of landholders' social networks and local organisations, and membership of organisations, such as catchment groups, have been shown to be positively related to adoption.
2. The physical proximity of other adopters is positively related to adoption.
3. The physical distance of the property from sources of information about the innovation is important: more distant landholders are less likely to adopt, perhaps because the information appears less relevant to them than to those who are close to the information source - or perhaps because they receive less exposure to the information.
4. A history of respectful relationships between landholders and advocates for the innovation - including scientists, extension agents, other landholders, and private companies - is positively related to adoption, through enhanced trust in the advice of the advocates.

6.4.4 Learning, education and training

A lack of knowledge about and/or familiarity with new practices or technologies is often found to be influential in determining uptake (Fischer & Bliss, 2006; Gillespie et al., 2007; Pannell et al., 2006; Roth & Botha, 2009; Serbruyns & Luyssaert, 2006; Smallshire et al., 2004). For example, Pannell et al. (2006) note that innovations are more likely to be adopted when they are easy to test and learn about prior to the adoption, and less likely when they are difficult to trial. As they observe, most "innovations require a certain level of knowledge and skill for them to be applied in practice, and there can be a wealth of choices in the method of implementation (e.g. timing, sequencing, intensity, scale). Through 'learning by-doing', as well as by reading, listening and watching, the necessary skills can be established and enhanced" (Pannell et al., 2006, p.1408).

Roth and Botha (2009) found that New Zealand hill-country farmers' awareness and concern about issues of soil erosion and water quality and/or siltation of rivers and streams in the region and/or their farm, were important factors in determining whether they decided to develop a whole farm plan introduced by the Horizon Regional Council in Manawatu/Wanganui region. Meanwhile, a study in Belgium examined the acceptance of various forest management policy instruments by private forest owners (Serbruyns & Luyssaert, 2006). Those owners who were better informed and more highly educated were the most accepting of a number of instruments (Serbruyns & Luyssaert, 2006).

Research on the adoption of BMPs also emphasises the role of education and training. A study of cattle farmers' adoption rates of 16 BMPs reported that a lack of knowledge or unfamiliarity were the two main reasons for non-adoption (Gillespie et al., 2007). It was found that non-adopters were less formally educated, had limited contact with farm training institutes, and were less reliant on beef farming as a source of income (Gillespie et al., 2007). The authors argue, therefore, that education efforts contribute to increased adoption (Gillespie et al., 2007). A meta-analysis in the USA of why farmers adopt best management practices also highlights the importance of training programmes (Baumgart-Getz et al., 2012). It found that overall education and formal education were not significant determinants of adoption; however, extension training was found to have a positive influence on adoption (Baumgart-Getz et al., 2012).

6.4.5 The influence of institutional contexts on behaviour change

The institutional contexts in which farmers, growers and foresters work and operate invariably influence their practices and operations (Kerr et al., 2004; Pannell et al., 2006; Serbruyns & Luyssaert, 2006; Rosin et al., 2008; Countryside and Community Research Institute and Food and Environment Research Agency, 2010; van den Dungen et al., 2011a, 2011b; Campbell et al., 2012). Through policies, rules, regulations, and other initiatives, governments can influence industry in both positive and negative ways (Pannell et al., 2006; van den Dungen et al., 2011a, 2011b; Campbell et al., 2012). As Pannell et al. (2006, p.1414) observe in the United States, for example, support programs "based on yield tended to increase the relative advantage of the intensification of farming and thus increase adoption and use of herbicides" (see also Helms et al., 1987).

In New Zealand, economic restructuring by the 1984 Labour Government has been identified as a key driver of change for sheep and beef farmers at the family farm level (van den Dungen et al., 2011b). The diversity of responses to this restructuring spanned from "[simply] 'hanging on', which included self-exploitation and perseverant strategies - to more flexible [strategies] such as diversification and off-farm income" (van den Dungen et al., 2011b, p.26). Furthermore, the introduction of consents under the Resource Management Act 1991, and associated new rules and legislation, has also been found to have some impact on both sheep and beef farmers (van den Dungen et al., 2011b) and kiwifruit orchardists (van den Dungen et al. 2011a).

Industry organisations can also play an important role in shaping practices and norms. For example, a variety of key industry groups (ZESPRI in kiwifruit, Fonterra in diary, large meat companies in sheep/beef) are seen to "dictate the available suite of market audits" in New Zealand and producer subjectivity (Campbell et al., 2012, p. 138). As Campbell et al. observe for kiwifruit producers: "alongside organic, there is no 'conventional' option […] only different styles of integrated management." However, the dairy industry "lacked a non-organic 'green' option, as Fonterra has chosen to promote organic as its main environmental alternative" (Campbell et al., 2012, p.138).

The institutional context also includes policy settings. Is the best policy approach to change in the climate arena to use voluntary agreements and soft regulation, or hard regulations? The theoretical literature is vast, but the following New Zealand examples illustrate responses to 'soft' or 'hard' regulatory approaches to achieving change.

In New Zealand, the major policy instrument for greenhouse gas mitigation is the Emissions Trading Scheme, developed with major stakeholder and technical advisory groups. For the agricultural sector, the key issue is when and how the scheme will apply to farmers.

Arguments against the compulsory inclusion of agriculture in the ETS are that it will put an undue financial burden on primary producers, which will affect production and negatively impact the New Zealand economy. Some of the potential policy options relating to including agriculture in the ETS include:

- Reduce nitrous oxide emissions through best management practices and the use of nitrate inhibitors.
- Incentives to drive uptake, such as price on carbon, which may provide wider co-benefits e.g. improved water quality.
- Farming type is a key variable that needs to be taken into account.
- Development and uptake of cost-effective technologies to mitigate methane emissions from animal waste on large scale.
- Understanding emissions intensity, and where efficiency gains enable farmers to manage down their liability and generate surplus of units over time.
- The potential for tailoring the ETS scheme, starting with lower level of obligation, and treating different gases differently.

This represents a mix of approaches, most of which fall into the 'soft' regulatory or incentive-based or default option approaches.

Policy decisions on climate by any government are, of necessity, tailored to the wider social and political context. A survey on New Zealanders' attitudes to climate change (New Zealand Business Council for Sustainable Development, 2009) indicated that more respondents support than oppose the ETS, although a carbon tax is preferred over the ETS. Furthermore, transitional assistance was supported, as was 'recycling' ETS revenues to help businesses and households improve energy efficiency and reduce emissions. These attitudes appear to reflect agreement with a hard regulatory approach through a carbon tax, albeit somewhat 'softened' by incentives to improve energy efficiency and reduce emissions, and supporting beneficiaries and low income households. Baehler (2007) describes how New Zealand economic policies have been consistently tempered by egalitarian democracy, which suggests that a blend of hard and soft regulation to mitigate emissions could be seen as publicly acceptable and therefore act as a driver for change. Lorenzoni et al (2007, p.446) suggest that limiting attention to behavioural change "focuses on voluntary reduction of energy use by individuals, encouraged through provision of information and economic incentives and subsidies" - an approach they argue has had no impact. They suggest that while there may be widespread public awareness and concern, this does not constitute 'engagement'; they conclude that "attempts to engage publics will be more effective if they are part of – and seen to be part of – a coherent, consistent response to climate change" (ibid, p.454).

New approaches are now being developed and used in New Zealand, based on stakeholder engagement and collaboration rather than regulation, to achieve sustainability outcomes. Evaluations of these processes suggest, however, that a combination of hard and soft approaches may still be needed to achieve results.

An early example of a voluntary agreement was the Clean Streams Accord. Deans and Hackwell (2008, p.5) claim, however, that the Accord has not delivered the expected water quality improvements: "While supporters of the Accord have argued that it has been instrumental in changing attitudes and actions among the majority of dairy farmers, it is clear that as a voluntary measure, the Accord has failed to deal with serious non-compliance and poor operating practice on dairy farms." While some farmers improved their practices others did not. The authors argue that the measure of the Accord's success has been 'best practice management' not water quality improvements. Their suggested solution is to follow initial voluntary approaches with regulatory approaches.

The recent report [19] from the Land and Water Forum, a multi-stakeholder group operating under a collaborative governance approach to water resource management, outlines an approach for determining environmental limits to water quantity and quality. This report recommends combining stakeholder collaboration with formal policy instruments. It outlines how to create more effective National Policy Statements, Natural Regional Resource Plans and Resource Management Act (1991) processes through collaborative decision-making by including community, stakeholder and iwi participation.

Another policy mechanism for achieving change is based on the concept of 'co-benefits' i.e. to take advantage of a policy direction, plan, or regulation in one area (such as water or energy management), to realise benefits that also address climate change. Closely associated with co-benefits is the concept of 'mainstreaming' to "address climate change adaptation alongside other existing programmes of work within key institutions, to provide a way of overcoming some of the barriers to change" (Baker et al, 2010). The MfE BIM (2011) states that "adaptation is seen as best achieved by integrating adaptation activities in existing processes; practices; policies at all levels of society" (MfE BIM, 2011). Smit and Wandel (2006, p.285) suggest that it is "extremely unlikely for any adaptive work to be undertaken in light of climate change alone", and that "work tends to occur as incremental modifications to existing initiatives" (ibid, p.289). Russell et al (forthcoming) also note that institutions, sectors, NGOs, and community-based groups already engage in multiple networks and activities that contribute to understanding vulnerability, resilience, mitigation and adaptation for climate change. However, many of these activities are not necessarily framed in terms of 'climate change' per se; 'sustainability' appeared to be a more common and salient framing.

Research questions:

Is the best approach to change in land-based sector to use voluntary agreements and soft regulation, or hard regulations?

How can existing experiences with collaborative governance [e.g. Land and Water Forum] be evaluated and effectively extended to support wider climate change mitigation and adaptation objectives in the land-based sector?

How might regulatory approaches work alongside other interventions to achieve behaviour change?

Are policy approaches based on 'co benefits' or 'mainstreaming' likely to lead to effective climate change mitigation and adaptation in the land-based sectors?

How might a fuller understanding of the concepts, language, mental models and discourses around 'climate change' 'sustainability' and 'resilience' be developed, and used to support more effective policy interventions?

What is known generally in the literature about social change, including rapid social change, and how might that conceptual understanding be applied to develop effective behavioural and social change programmes in the land based sectors?

[19] The Second Report of the Land and Water Forum (2012). Accessed from www.landandwater.org.nz

This issue of environmental change discourse, and the language around key words such 'climate change' or 'sustainability' and 'resilience', requires closer attention in future research.

6.5 SUMMARY OF THE LITERATURE ON RISK PERCEPTION AND MOTIVATION

There are a number of opportunities and gaps in the existing social science literature on the risk perceptions of farmers, growers and foresters - and the ways in which they are motivated to take action. Different framings, issues and tensions are apparent throughout this diverse literature. A number of these coincide with the results of both New Zealand (Cronin, et al., 2011) and international initiatives, (*Europe*: Hackmann & St. Clair, 2011; *Australia*: LWA, 2008; Barnett, et al., 2011; *USA*: Nagel, et al., 2010; *Canada*: Wall, et al., 2006), which have sought to understand the role social science can play understanding and addressing the diverse and multifaceted challenges of climate change (see also Campbell et al., 2012; Shove, 2010a, 2010b).

Research questions:

How do both individualistic (attitudes, beliefs and knowledge) and contextual (social, cultural and political) factors inform understandings of risks and motivation for change; and what is the interplay between these factors in the land-based sector?

What are the differences between lay (subjective) and expert ('scientific'/'objective') understandings of climate change risk in the land-based sectors, and how might those differences be overcome?

How are changes in local climate understood, expressed and experienced in the land-based sectors e.g. as 'natural' *weather/climatic variability* or 'human-induced' *climatic change*?

What lies behind the contrasting assessments of the adaptive capacity of the primary production sectors (local perceptions of resilience vs. expert and policy concerns about vulnerability)?

How does knowledge about risks and climate change get produced locally (experience and expertise based upon everyday observation in the primary sector) and in science – and what opportunities are there for reconciling those knowledges?

What role do communities, businesses and industries play in understanding the risks, opportunities and responses to climate change in the land-based sector? And how can they be involved in the framing of research and funding priorities?

Is climate variability/climate change being understood and addressed as a separate risk or just one of a number of risks (e.g., rising input costs, trade liberalization, policy changes, personal risks) facing the land based sector?

What sorts of interventions can help facilitate changes in existing practices and technologies e.g. Are best management practices appropriate in every context?

What is the role of information in motivating action in the landbased sector?

To what extent do farmers, growers and farmers need to 'understand' and 'believe' in climate change for action to take place?

To what extent are farmers, growers and farmers motivated by internal (personal and family goals, social and moral responsibility) or external forces (community, social norms, industry, markets and government)?

What is the role of soft (voluntary) and hard (proscribed) approaches to regulation, respectively, in facilitating changes in practice in the land-based sector?

To what extent are actor's responses or 'choices' made in relation to risks, threats and opportunities determined by their ability to act - or structured by the contexts of operation (social, cultural and political factors)?

What is the role of the wider public as 'citizen-consumers' in motivating changes in how food, fibre and wood products are produced in the land- based sector?

What types of social scientific methods, knowledge and theories are needed to inform future change in the land based sector?

How is social change being constructed: as a predictable relatively linear process vs. always dynamic and uncertain?

How can collaborative, participatory and inter/trans-disciplinary approaches be forged between social scientists, biophysical scientists and key stakeholder groups in the landbased sector?

7. The barriers to change or opportunities for behaviour change at the ground/farm level

Since the 1970s, a number of disciplines, including psychology, economics, sociology, and geography, have sought to understand and characterise the various factors that influence, shape and sustain individual behaviours - and to identify the most suitable targets and delivery mechanisms for interventions seeking to facilitate sustainable behaviour change. In this context, the individualist and the systemic or structural paradigms have dominated not only the ways in which environmental and climate change issues have been researched, but also the manner in which governments and policy-makers have sought to address them (Shove, 2010a; Spaargaren, 2011). Recently, a third paradigm which takes 'practices' as the central unit of analysis and change, has become increasingly popular with scholars interested in debates around sustainability and climate change (see Table 1 on the next page). As Spaargaren (2011) observes, each of these paradigms adopts distinct theoretical assumptions about behaviour change, and can be linked to preferred policy strategies for implementing change.

Having introduced these approaches earlier in this report, this section provides a more detailed discussion, and highlights how these three paradigms conceptualise different barriers and opportunities to behaviour change.

Traditionally, policy-makers charged with determining the environmental performance of various sectors (including energy, water and waste utilities, producers of food, materials, other goods), at both the national and international scale, have assumed "that the achievement of more sustainable patterns of [production and] consumption rests upon the decisions and actions of individual[s]" (van Vilet et al., 2005, p. 3). This approach has legitimised substantial programmes of social and environmental research, which have sought to establish the economic and psychological determinants of human behaviour (for a review see Jackson, 2005). These attempts, and the policy-making thinking from which they originate, are representative of the 'ABC' framework of behaviour change, as noted earlier in this report (Shove, 2010a). Under this framework, it is assumed that behaviour is the outcome of an essentially linear process in which individuals consciously make more or less rational decisions (Harrison and Davies, 1998) or 'choices'.

As we have said, there is continuing discussion in the research community regarding the attributes of these different approaches. Regarding the individualistic paradigm – as described by Spaargaren and Strengers (see Table 1) – we suggest it may be useful distinguish between economic and psychological approaches. Gifford stresses that there is much that can be learned about motivation and values from the psychology literature (Pers.Comm. August, 2012).

The remainder of this section identifies the various individual and social barriers to change which have been identified by economists, psychologists and policy-makers.

Table 1. Three paradigms for researching and governing environmental and climate change. Adapted from Spaargaren (2011) and Strengers (2012).

Individualist paradigm (psychology/economics)	**Systemic paradigm (sociology/science studies)**	**Practice paradigm (anthropology/sociology)**
Individuals and their attitudes are key units of analysis and policy	Producers/states and their strategies are key units of analysis and policy	Practices (and their elements) are the central unit of analysis and change
Behavioural change of individuals is decisive for environmental change	Technological innovation within the production sphere is decisive for change	Changing the elements [20] of practices are decisive for change
Individual choices are the key intervention targets (micro level)	Socio-technical systems are the key intervention targets (macro-level)	The elements that 'hold' practices together are the key intervention targets (meso-scale)
End-users/consumers determine the fate of green products and ideas	Technologies and markets determine the fate of green products and ideas	Changing or mixing elements, and innovation in practices, determines the fate of green products and ideas
Key policy instruments and approaches: social (soft) instruments (persuasion through information provision)	Key policy instruments and approaches: direct regulation targeting providers (laws, market-based instruments)	Key policy instruments and approaches: identifying and supporting the creation of technological, social and cultural innovations.

7.1 INDIVIDUAL BARRIERS TO CHANGE

7.1.1 Cognitive/conceptual barriers

Lack of knowledge/ignorance

Ignorance or a lack of basic knowledge about issues such as climate change can act as a barrier in two ways. First, if individuals are not aware of a problem they are unlikely to address it (Gifford, 2011). Second, if people are aware, they still might lack basic knowledge about the causes, impacts and solutions to such problems (DEFRA, 2008a; Gifford, 2011).

Research on climate change suggests that, along with the general public (Lorenzoni and Hulme, 2009; Weber, 2010), farmers and growers (Hansen et al., 2004; Weber, 1997) and foresters (Guariguata et al., 2012; Labriole & Luzadis, 2011) are aware of and concerned about climate change but often do not fully understand the causes, impacts and potential solutions. Despite information being available (to those who are willing to find it), this information is not automatically used or translated into knowledge or action (Carolan, 2005; Fleming and Vanclay, 2010; Lorenzoni et al., 2007, p. 451) - for a number of reasons:

[20]Most scholars drawing on practice theory identify four interacting elements that 'hold' practices together. In her work Strengers (2012, p. 228) describes these as: 1) practice knowledge about "how to carry out and perform a practice"; 2) common understandings about "what the practice means and how it is valued"; 3) rules about "what procedures and protocols must be followed and adhered to"; and 4) material infrastructure or "the 'stuff' that makes the practice possible, sensible and desirable.

- Lack of knowledge about where to find information.
- Lack of desire to seek information.
- Perceived information overload.
- Confusion about conflicting information or partial evidence.
- Perceived lack of locally-relevant information; e.g., about impacts or solutions.
- Format of information is not accessible to non-experts.
- Source of information is not seen as credible or trustworthy, particularly the mass media.
- Confusion about links between environmental issues and their respective solutions.
- Information conflicts with values or experience and is therefore ignored.

Comprehension, uncertainty and experience

Climate is the result of "multiple interactions between the oceans, land masses and the atmosphere" and can have "complex effects […] on the environment, including, but not limited to, the weather" (Fleming & Vanclay, 2010, p. 16). Such effects take place over "long time scales of years, decades and centuries, so cause and effect connections are difficult to establish and cycles are not often experienced by individuals and/or not accurately remembered" (Fleming & Vanclay, 2010, p. 16; Weber, 1997; Weber, 2010). The scale at which climate systems and cycles operate can make them appear to be "too distant and abstract, or too vast and unalterable" (Fleming & Vanclay, 2010, p. 16; Lorenzoni et al., 2007; Moser & Dilling, 2004). A sense of uncertainty can arise, therefore, from the difficulties associated with understanding and interpreting the complex and scientific nature of climate change, and the failure to experience these changes (Snowden, 2009; Weber, 1997; Wolf & Moser, 2011). These characteristics can render people ambivalent to the reality and severity of climate change, as they may feel the "evidence [is] unreliable, incomplete, conflicting; and because they [are] aware of political and societal controversy and inaction over climate change" (Fleming & Vanclay, 2010; Lorenzoni et al., 2007, p. 451; Rosin et al., 2008).

The emphasis placed by the news media on the scientific and political disagreements surrounding climate change can also reinforce such sentiments (Boykoff, 2007; Carvalho and Burgess, 2005). It has also been observed that the "lack of constant attention paid to climate change by the media [can be a] reason for uncertainty about the presence and seriousness of the issue, and in some cases as an explicit reason for unwillingness to engage" (Hargreaves et al., 2003; Lorenzoni et al., 2007: 451).

Scepticism and experience

One reaction to the uncertainties and difficulties of comprehending and experiencing climate change is scepticism about the reality and causes of climate change, and about the need for, and effects of, mitigation and adaptation actions (Fairweather et al., 2009; Lorenzoni & Hulme, 2009; Payn et al., 2010; Rosin et al., 2008; Weber, 1997). As noted in the previous section, in Australia a growing number of studies have found a divergence between farmers who interpret local climate changes to be the result of natural 'climate variability' (extreme natural weather events) or 'climate change' (anthropogenic change) (Buys et al., 2012; Fleming and Vanclay, 2010; Head et al., 2011; McDonald et al., 2006; Milne et al., 2008; Thwaites et al., 2008). Particular worldviews (e.g., fatalism) or lack of clear political engagement with the issue can also give rise to scepticism (Hinchliffe, 1996; Lorenzoni et al., 2007; Stoll-Kleemann et al., 2001).

Such perceptions can shape how information, policy and initiatives are perceived, interpreted and responded to in future (Lorenzoni & Hulme, 2009; Lorenzoni et al., 2007). Rosin et al. (2008) examined farmers' awareness of and anticipated response to the proposed emissions trading scheme (ETS) and associated afforestation policies, by undertaking interviews with 29 pastoral farmers in New Zealand. They found that farmers justified their opposition to such policy and delay in developing strategic responses to climate change on the basis of the "uncertainties surrounding both climate change policy and science" (Rosin et al., 2008, p. iii).

Disempowerment, helplessness and fatalism

The portrayal of climate change as a global problem has resulted in a disconnection between the scale of the problem and the contribution that individuals believe they can make in the everyday lives (DEFRA, 2008a; Fleming & Vanclay, 2010; Lorenzoni, et al., 2007; Moser & Dilling, 2004). Drawing on various research studies, Lorenzoni et al. (2007: 452-453) found that people in the United Kingdom and Italy accepted that individuals contribute to climate change and should participate in addressing the problem. Despite these sentiments, however, people generally felt that "individual action would have little effect in comparison to other, large scale emitters" (Lorenzoni et al., 2007: 452-453). Similarly, a survey in the United Kingdom found that about a third of the public (30%) felt there was no point in acting domestically on climate change, because actions in other countries would cancel out their actions (DEFRA, 2008a). Citizens often suggest that it is not worthwhile taking individual action as it will do little to address a global problem such as climate change (Eden, 1993; Lorenzoni et al., 2007; Stern & Kirkpatrick, 1977).

Fatalism has also been observed as a barrier to engagement about climate change. In such instances individuals feel that "the problem [has] gone too far already and [is] irreversible by human action", so it does not warrant any engagement (Lorenzoni et al., 2007, p. 452).

7.1.2 Attitudes, beliefs and values

A number of psychological theories or models suggest that people's behaviour is influenced by their attitudes, beliefs and values. Such theories are typically formulated around the notion of expectancy-value. In its simplest form, this suggests that an individual's "attitude towards (preference for) an object (e.g., product, technology, service, place, person or idea)" is determined by their beliefs about the characteristics of the object (expectancy) and their evaluation of those characteristics (values) (Jackson, 2005, p. 43).

Subsequent models, most notably the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975) and the Theory of Planned Behaviour (TPB) (Ajzen, 1991), use this basic model as the starting point, but expand on it in various ways. For example, farmers', growers', and foresters' beliefs (e.g., whether it is natural or anthropogenic) and values (e.g., how important it is to address the problem) about climate change lead to an attitude (e.g., negative, indifferent or positive) towards mitigation or adaptation behaviours, practices or technologies. The TRA would suggest that the attitudes of farmers, growers, or foresters, and their subjective norms, [21] would then determine their intention to behave in a particular way (e.g., whether they adopt a particular mitigation or adaptation behaviours, practices or technologies). Attitudes, beliefs and values also remain central to more recent and integrative psychological theories of behaviour (e.g., Stern's (2000) ABC model and Triandis' (1977) Theory of Interpersonal Behaviour). Negative or indifferent attitudes, beliefs and values about issues such as biological conservation and climate change, or associated practices or technologies, present a significant barrier to behaviour change on the ground or farm level

[21] Subjective norms are individuals' perceptions of whether the people closest to them think they should or should not perform the behaviour in question (Fishbein &Ajzen, 1975).

(Barnes & Toma, 2012; Boon & Meilby, 2007; Greiner et al., 2009; Klosowski et al., 2001; Primmer and Karppinen, 2010; Prokopy et al., 2008).

Choice

The notion of choice is central in the economic literature, and some of the psychological literature, on behaviour change. The model of rational choice is a starting point for most discussions about behaviour and is influential in much existing policy (Collier et al., 2010; Institute for Government, 2010; Jackson, 2005: vii; Shove, 2010a). This model assumes that individuals make decisions "by calculating the individual costs and benefits of different courses of action and choose the option that maximises their expected net benefits" (Jackson, 2005, p. vii). Here, an individual's ability to adopt new technology on their farm, orchard or forest is "is constrained by their budget (i.e. finances) and the different prices and availability of all the products and services they could buy" (Collier et al., 2010:,p. 4). Aside from these constraints, an individual's ability to make the best choice is limited only by the availability of appropriate information, and suitable competition between firms to ensure that companies are not in a position to exploit individuals by charging higher prices (Collier et al., 2010). In instances where these conditions are not met, "there are said to be 'market failures' and there is a role for government to intervene" (Collier et al., 2010; Jackson, 2005). The assumptions of this model are: 1) "individual self-interest is the appropriate framework for understanding behaviour"; 2) "'rational' behaviour is the result of processes of cognitive deliberation"; and 3) "consumer preferences are […] taken as a given without any elaboration of their origins" (Jackson, 2005, p.vii).

Subsequent advances in economics, and social and cognitive psychology, have heavily criticized and sought to address the limitations of this model. For example, the field of behavioural economics has supplemented existing economic approaches and analysis by refining the basic assumptions about individual behaviour (Sunstein & Thaler, 2003; Thaler & Sunstein, 2008). Similarly, cognitive and social psychologists have sought to identify various internal and external factors which influence behaviour (Ajzen, 1991; Fishbein and Ajzen, 1975; Stern, 2000; Triandis, 1977). Behavioural economists and psychologists argue that the behavioural choices people make are influenced by a number of cognitive, individual and social factors (Collier, et al., 2010; Gifford, 2011; Stern, 2000; Sunstein & Thaler, 2003; Thaler & Sunstein, 2008; Triandis, 1977; Weber, 2010). These factors include:

1) bounded rationality: people routinely make irrational decisions, which they would not have made, "if they had paid full attention and possessed complete information, unlimited cognitive abilities, and complete self-control" (Thaler &Sunstein, 2008, p. 5);
2) discounting: people's preferences are not consistent over time as they tend to heavily discount the short term and "make decisions inconsistent with long term preferences" (Collier, et al., 2010, p. 4);
3) affect: people's actions are powerfully shaped by emotional associations;
4) social norms: people are strongly influenced by what others do;
5) defaults: people 'go with the flow' of pre-set options;
6) priming: actions are often influenced by sub-conscious cues; and
7) salience: attention is drawn to what is novel and seems relevant to us.

Overall, this literature suggests that choice can operate as a barrier either in relation to the availability of suitable choices (e.g., climate change mitigation or adaptation technologies), or in relation to an individual's ability to make choices that are in their best interest (e.g., decisions that address both the risks and opportunities of climate change) (Collier et al., 2010; Gifford, 2011; Jackson, 2005; Stern, 2000; Sunstein & Thaler, 2003; Thaler &Sunstein, 2008;

Triandis, 1977; Weber, 2010). Both of these types of barriers are identifiable in the literature on the adoption of new practices and technologies in farming and forestry (Barnes & Toma, 2012; Bryan et al., 2009; Fleming & Vanclay, 2010; Gillespie et al., 2007; Greiner, et al., 2009; McDonagh et al., 2010; McKenzie-Mohr & Smith, 1999; Pannell et al., 2006; Vanclay, 1992).

7.1.4 Habits and routines

Many scholars believe that most ordinary, everyday behaviours are undertaken with very little conscious deliberation (Collier, et al., 2010; DEFRA, 2008a; Gifford, 2011; Jackson, 2005). Cognitive and social psychologists argue that habits, routines, and 'automaticity' perform an essential role in the cognitive effort necessary to act competently (Baumeister et al., 1998; Posner & Snyder, 1975; Schneider & Shiffrin, 1977). The capacity for "efficient cognitive processing becomes increasingly important in a message-dense environment, such as the modern society in which we live" (Jackson, 2005, p. ix). The 'routinization' of everyday behaviours, however, makes them "less visible to rational deliberation, less obvious to understand, and less accessible to policy intervention" (Jackson, 2005, p. ix). As a consequence, individual intentions to change are regularly undermined by habitual behaviours which, over time, become an "important structural feature of behavioural 'lock- in'" (ibid).

Given that the behaviours needed for sustainability and climate change - whether it be on the farm, orchard and forest - are routine in nature, habit is a key barrier for behaviour change (Collier, et al., 2010; DEFRA, 2008a; Gifford, 2011; Jackson, 2005).

7.1.5 The value-action or attitude-behaviour gap

There is a marked disparity between the awareness and concern of various groups (including the public, farmers and foresters) of environmental issues, such as biological conservation and climate change, and their actual behavioural response. This phenomenon is widely-reported as the 'value-action' or 'attitude-behaviour' gap (e.g., Blake, 1999; Kollmuss& Agyeman, 2002; Ungar, 1994), and is considered to be a significant barrier to behaviour change (Jackson, 2005; Lorenzoni et al., 2007). This gap has been attributed to the complex nature of everyday behaviours (e.g., Blake, 1999; Kollmuss & Agyeman, 2002; Ungar, 1994).

Critiques of economic and psychological approaches to change would argue that this gap between potential and actual behaviour results from a failure to understand the dynamic and complex nature of everyday life - including the role that material infrastructures [22] play in shaping, constraining and enabling certain behaviours (Geels, 2010; Hargreaves, 2011, 2012; Shove, 2010a, 2010b; Spaargaren, 2011).

7.1.6 Practicalities and constraints

Another barrier to change in farming, growing and forestry arises from the practicalities and constraints associated with adopting proposed practices or technologies. This has been identified both in the literature on diffusions of innovations (Gillespie, et al., 2007; Greiner et al., 2009; McKenzie-Mohr and Smith, 1999; Pannell et al., 2006; Vanclay, 1992) and in relation to climate change (Barnes & Toma, 2012; Bryan et al., 2009; DEFRA, 2008a; Fleming & Vanclay, 2010; Lorenzoni et al., 2007; McDonagh et al., 2010; Moser & Dilling, 2007). Practicalities include: "available time, money and social infrastructure, as well as considerations of convenience, ease, flexibility, divisibility, referring to the breakdown of a change in behaviour into the required steps" (Fleming & Vanclay, 2010, p. 16). Individual

[22] Material infrastructures might include transport systems or on farm technologies.

"states of motivation, risk, resources, support, individual character traits and skills also play a part" (Campbell et al., 2012; Fleming & Vanclay, 2010, p.16).

In the farming context, economic, social, and environmental factors are highlighted as important in determining whether a new idea or practice is adopted (Gillespie et al., 2007; Pannell et al., 2006, p. 1414). These include:

- The short-term input costs, yields and output prices of the practice or technology or of other activities that it affects.
- The practice or technology's impact on profits in the medium-to-long term.
- The practice or technology's impacts on other parts of the system within which it will be embedded.
- Adjustment costs involved in adoption of the practice or technology.
- The practice or technology's impacts on the riskiness of production.
- The practice or technology's compatibility with existing sets of technologies, practices and resources.
- The practice or technology's complexity.
- The cost or profitability of the traditional practice which the practice or technology would replace.
- The compatibility of the practice or technology with existing beliefs and values.
- The impact of the innovation upon the family lifestyle.

7.2 SOCIAL BARRIERS TO CHANGE

One of the critiques of much the earlier economic and psychological literature was that it failed to properly consider the importance of the social context in which individuals carry out their everyday behaviours (Collier, et al., 2010; DEFRA, 2008a; Jackson, 2005). Subsequently, a number of social psychologists (Ajzen, 1991; Fishbein & Ajzen, 1975; Stern, 2000; Triandis, 1977), and more recently behavioural economists, have sought to understand the role that 'context' plays in shaping an individual's behaviour (Institute for Government, 2010; Sunstein & Thaler, 2003; Thaler &Sunstein, 2008). A number of these issues have been briefly touched upon in the above, but are now elaborated further.

7.2.1 Social norms and expectation

Social norms and expectations are another form of constraint identified in the literature on behaviour change, sustainability and climate change (Campbell et al., 2012; Carolan, 2005; DEFRA, 2008b; Gifford, 2011; Jackson, 2005; Lorenzoni et al., 2007; Shove, 2003). Socially-acceptable ways of behaving on the farm, orchard, or forest can "become habitual behaviours, making them unquestioned and thus more intractable (Campbell et al., 2012; Jackson, 2005; Lorenzoni et al., 2007, p. 453). For example, research from New Zealand on organic farming highlights how social norms can be influential in determining what is acceptable. Egoz et al. (2001, p.177) observed that although "organic practices are environmentally friendly, they do not have landscapes which are tidy and cultivated, and reflect New Zealand's legacy of a hardworking settler mentality." As a consequence the landscapes on organic farms are "interpreted by some as being indicative of laziness and neglect and by others as responsible and environmentally healthy" (ibid). Similarly, Campbell et al. (2012: 135) report the social stress experienced by members of the dairy sector who converted to organic practices, and in doing so "stepped outside the acceptable norms of the wider industry culture."

Furthermore, ownership and consumption of certain goods such as cars and electronic goods are typically important status symbols in our society, and people, including farmers, growers,

and foresters, "feel they are expected to achieve this" (Csikszentmihalyi &Rochberg-Halton, 1981; McCracken, 1990; Urry, 1999). Others argue that once individuals become "accustomed to a particular standard of living, their perceptions of needs and expectations change" (Lorenzoni et al., 2007, p. 453; Shove, 2003). This creates new expectations which are then "perpetuated in discourses about quality of life and, once absorbed into daily routine, become interpreted as 'needs' rather than 'wants'" (O'Riordan, 1976; Shove, 2003; Steg &Sievers, 2000).

7.2.2 Perceived lack of action by governments, business and industry

Research on public and farmer perceptions of climate change has suggested that their percieved lack of political action by local, national, international governments can be a significant barrier to engagement (Lorenzoni &Hulme, 2009; Lorenzoni et al., 2007; Rosin et al., 2008). Lorenzoni et al (2007), reporting on three different studies with members of the public, found that many participants justified their own failure to act on climate change "by referring to the lack of commitment to mitigate greenhouse gas emissions by the USA and lack of evidence of substantial action by the British government" (Lorenzoni et al.:453). It has been argued that such observations echo a "deeper, more widespread distrust in government and politicians" (Irwin et al. 1999; Lorenzoni et al., 2007, p. 453; Rosin et al., 2008; Worcester, 2001).

The perceived failure of business and industry to sufficiently address the issue of climate change has also been identified as a reason for not undertaking action on climate change (Lorenzoni &Hulme, 2009; Lorenzoni et al., 2007). Such sentiments reinforce a belief that, when compared to large-scale emitters (countries, business and industry), individual action will make little difference. It has been argued that this is a form of denial. Here individuals attribute the "responsibility for causing and mitigating climate change [to] others (individuals, governments, business, industry and other countries)" or contend that "technological solutions [will] 'save us'" (Lorenzoni et al., 2007. p. 452). Denial of personal accountability and the externalising responsibility and blame is seen as as presenting a major challenge for behaviour change initiatives (Blake, 1999; Gifford, 2011; Lorenzoni et al., 2007; Stoll-Kleemann et al., 2001).

7.2.3 Lack of enabling initiatives

As touched upon earlier, even in instances where individual farmers, growers, or foresters are willing to take action, their ability to do so can be limited by the lack of enabling infrastructures and mechanisms (McKenzie-Mohr & Smith, 1999; Pannell et al., 2006; Serbruyns & Luyssaert, 2006; Vanclay, 1992; Zhang & Flick, 2001). For instance, a new practice or technology may not be in accord with current configurations of technologies, practices and resources (Pannell et al., 2006). As Parnell et al. (2006) observe, "a new higher yielding wheat variety is readily adoptable by an existing wheat farmer because it is compatible with the farmer's current machinery, rotations, agronomic practices [and] herbicide usage" (p. 1414). For the same farmer, however, "a new type of tree crop is unlikely to be as compatible with existing practices, so the cost of making the transition to a new farming system that includes the tree crop would tend to reduce its relative advantage and moderate its adoption" (p. 1414). Other farming, growing and forestry practices require particular environmental conditions such as moisture, nutrients or particular types of soil (Gillespie et al., 2007; Pannell, et al. 2006).

7.3 SYSTEMIC/STRUCTURAL UNDERSTANDINGS OF BEHAVIOUR CHANGE

The structuralist approach to behaviour change emerged as a result of the "disappointing experiences with the individualist model to environmental change" (Spaargaren, 2011, p. 814; van Vilet et al., 2005). Spaargaren suggests that this paradigm can be seen "as a reaction to the failures of the individualist strategies" (p. 814). In the systemic paradigm, the focus of policy shifts from primarily individuals, to institutional actors such as local and regional governments, companies, organisations, labour unions and a variety of environmental Non-Government Organisations (NGOs) (Spaargaren, 2011; van Vilet et al., 2005). This approach seeks to facilitate environmental change via top-down mechanisms such as industry regulations and standards and the development of new and more efficient technologies and infrastructures (Spaargaren, 2011; van Vilet, et al., 2005). Such an approach has largely been aimed at citizen-consumers, but it has also been applied in other sectors of society, including farming, horticulture, and forestry (e.g., Campbell et al., 2012; Kerr et al. 2004; Pannell et al., 2006; Rosin et al., 2008; Serbruyns & Luyssaert, 2006; van den Dungen et al., 2011a, 2011b).

The systemic paradigm identifies a number of structural barriers to behaviour change (see Geels, 2005; Geels, 2010; Shove, 2003; Southerton et al., 2004; Urry, 2005; van Vilet et al., 2005). From this perspective, behaviour cannot be understood as resulting only from "the free, independent, isolated choices and preferences of individuals" (Spaargaren, 2011, p 817). For example, on the farm, orchard, or forest, land management behaviours are pre-configured by socio-material tools, equipment, technologies and infrastructures and "their (sometimes rather implicit) cultural and policy regimes" (Spaargaren, 2011, p. 817). These 'things' or objects both enable and constrain the ways in which individuals can use them e.g., the design of objects can both create opportunities for new uses and limit others (see Latour, 1987; Latour, 1991). This literature draws on concepts from science and technology studies - such as technological innovation, systems of provision, co-evolution, lock-in effects, sunk costs and technological regimes - to highlight the significant challenges of transitioning to more sustainable and low carbon futures, including energy, transport and agri-food systems (Elzen et al., 2004; Van den Bergh &Bruinsma, 2008; Wiskerke & Van der Ploeg, 2004). In the interest of space we now focus on two concepts: 1) socio-technical systems; and 2) path dependency and lock-in.

7.3.1 Socio-technical systems and co-evolution

Economists and psychologist distinguish between individuals/ 'the internal' (e.g., farmers, growers and foresters attitudes, beliefs and values), and the context/ 'the external' (social, cultural and political), as separate entities which shape and influence behaviours. In contrast, science and technology scholars have emphasised the need to understand how the social, cultural and material dynamically 'co-evolve' together. Consequently, there is more effort being made to understand these socio-technical systems which are "made up [of] a cluster of elements, involving technology, science, regulation, user practices [or behaviours], markets, cultural meaning, infrastructure, production and supply networks" (Geels and Kemp, 2007, p.442). The agricultural, horticultural and forestry sectors can all be understood from this perspective (see for example Peltola, 2005; Smith, 2007). Drawing on the notion of socio-technical systems it is then possible to explore how both sustainable and unsustainable conventions in farming, horticultural and forestry co-evolve as a result of the interactions between various system elements (Peltola, 2005; Smith, 2007). As outlined below, the ways in which socio-technical systems co-evolve can limits particular opportunities for change while creating others.

Path dependency and system lock-in

The idea of 'path dependency' highlights how existing technologies, behaviours and practices will determine and "structure avenues of future development" (Dennis and Urry, 2009; Geels, 2005; Shove, 2003, p. 12). Rip and Kemp (1998, p. 354). define this concept in the following way: "path dependencies refer to the interrelatedness of artifacts with other artifacts, infrastructure and routine." The classic example in the field of innovation is the durability of the QWERTY keyboard (David, 1985): "a deliberately inefficient format but one that has become established in a manner now difficult to dislodge" (Shove, 2003, p. 12). In other words, the "[a]lignment between actors, along with sunk costs of various forms led, in this case, to a hardening of the 'path' such that it has become increasingly difficult to break away from the QWERTY arrangement" (ibid).

The notion of path dependency has significant implications for understanding the ability of farmers, growers and foresters to change their behaviours and adopt new practices and technologies (Campbell et al., 2012; McKenzie-Mohr & Smith, 1999; Pannell et al., 2006; Serbruyns and Luyssaert, 2006; Vanclay, 1992; Zhang & Flick, 2001). As Shove (200, p. 12) observes, patterns of "path dependency have consequences for change and stability at various levels: between firms, within technological [and sectorial] communities, amongst [producers] and across the plane of social meaning, convention and expectation." Existing technologies, practices and resources on farms, orchards and forests (Pannell et al., 2006; Serbruyns and Luyssaert, 2006; Vanclay, 1992; Zhang & Flick, 2001) can make "reversals and dramatic changes of directions difficult" and, therefore, "have the dual effect of cutting off otherwise plausible trajectories of sociotechnical development while paving the way for others" (Shove, 2003, p.12). As consequence, farmers, growers and foresters can become 'locked-in' to certain paths of development (see Geels, 2005; Jackson, 2005) which can limit the opportunities for radical change and reinforce environmentally unsustainable behaviours (Hobson, 2003; Shove, 2003).

7.4 PRACTICE THEORY UNDERSTANDINGS OF BEHAVIOUR CHANGE

Practice theory [23] is by no means a unified theory but rather a collection of accounts that promote the idea of 'practices' as a fundamental social phenomenon. Practices are typically considered as actions, activities or 'doings' and 'sayings' that are "repeatable, regular, and recognizable in a given cultural context" (Levi, 2005, p. 1880). The origins of practice theory can be traced to two important social science scholars: Bourdieu (1977, 1984) and Giddens (1979, 1984). Working in the 1970s and 1980s, their scholarship can be seen as an attempt to overcome the limitations of the two paradigms described above (see Table 1).
They argued that by focusing too much on one master concept (e.g., the 'individual' or the 'system') the social sciences had failed to sufficiently investigate or appreciate the role played by the other and interactions between the two (Giddens, 1979; Schatzki, 1996). Instead these authors promoted the idea of focusing on practices as not only the pivotal objects of analysis, but also as the principle constitutive element in social life "by reference to which other social entities such as actions, institutions, and structures are to be understood" (Schatzki, 1996, p. 11).

For researchers and policy-makers interested in understanding and facilitating behaviour change, the benefit of practice accounts are that they neither privilege the micro- (the individual) or the macro-scale (the structural). Unsustainable practices, behaviours and

[23] For ease of use we refer to 'practice theory' in the singular rather than plural, and as practice theory rather than 'social practice theory' as it is also known.

patterns of production and consumption are the outcome of meso-scale processes (the practice). Practice accounts, therefore, emphasise the importance of understanding the dynamic and complex nature of everyday life by focusing on habitual, routine, and often mundane practices. For farmers, growers and foresters, such practices might relate to: irrigation; fertilising; spraying; planting; disease control; ploughing; harvesting; energy; waste; and work. These practices take place at particular times (e.g., daily: morning, afternoon, evening; and seasonally: spring, summer, autumn, winter) and in particular spaces (home, the office, the farm, orchard or forest), and are guided, shaped and co-evolve with practical skills and knowledge, individual values and beliefs, shared norms, rules and conventions, and the material world. From this perspective, the focus is no longer on understanding behaviour as the outcome of an individual's attitudes, beliefs and values and the choices they make. In other words, the 'value-action' or the 'attitude-behaviour' gap no longer exists, because values and attitudes are seen as embedded in, and part of, actions and behaviours.

Importantly, practices are 'carried out' by practitioners and must therefore be continually performed for a practice to continue to persist. For example, in farming, the practice of digging the ground with a hoe eventually gave away to the ploughing the fields with horse or oxen (Fussell, 1966). Horses and oxen were then replaced by steam-powered ploughing engine or steam tractors which were a far quicker way of working (Fussell, 1966). Gradually these steam-powered devices were superseded by internal-combustion powered tractors (Ankli, 1980). In the last couple of decades shallower ploughing and other less invasive tillage techniques have been taken up in some areas suffering from soil damage and erosion (Mäder and Berner, 2012). This short history of the practices of digging highlights how certain once they are no longer 'carried out' disappear. There is always a possibility, however, that they can re-emerge (e.g., organic farming has returned to a number of more 'traditional' and sustainable farming practices).

From the perspective of facilitating behaviour change the practice approach, therefore, allows one to ask:

1. How are resources used and consumed as part of habitual, routine, and often mundane, everyday practices (e.g., digging the field)?
2. How do more or less sustainable practices emerge, persist, fade and change (e.g., technological innovation or a return to traditional farming practices)?
3. How might practices be (re)configured in more sustainable ways (e.g., Are there opportunities to draw on a traditional ways of doing? Is there scope to adopt more efficient practices or technologies)?

7.4.1 The elements that 'hold' practices together

Practice theorists argue that the problem with existing approaches to behaviour change is that they fail to account for "the ways in which, variously, social relations, material infrastructures and context are intrinsic to the performance of social practices" (Hargreaves, 2011, p.82; Hobson, 2003). From the practice perspective, individuals (attitudes, beliefs and values) or systems (infrastructures and technologies) are not 'barriers' to behaviour change but rather are one of the elements that 'hold' unsustainable or sustainable practices together. Each element interconnects and intersects with other elements and, therefore, is not reducible or distinguishable (Pantzar & Shove, 2010).

The argument is that a change in one or more of these elements will be reflected in the way the practice is 'carried out', or whether it continues to be performed at all. Despite a number of variations, most scholars interested in sustainability and climate change have identified somewhat similar elements that 'hold' practices together. In particular, these researchers pay

attention to the dynamic and co-evolving relationships between the individual, social and material. [24] Strengers (2012) for example identifies four elements:

1) Practical knowledge about "how to carry out and perform a practice."
2) Common understandings about "what the practice means and how it is valued."
3) Rules about "what procedures and protocols must be followed and adhered to."
4) Material infrastructure or "the 'stuff' that makes the practice possible, sensible and desirable."

7.5 OPPORTUNITIES FOR CHANGING BEHAVIOUR AT THE GROUND/FARM LEVEL

The three different paradigms discussed above are characterised by contrasting theoretical assumptions about behaviour change and preferred policy strategies for implementing change. There are some overlaps in these approaches between the different opportunities that they identify for changing behaviour or practice. In particular, there is general agreement that changing behaviours or practices is a difficult and complex process (Collier et al., 2010; DEFRA, 2008a, 2008b; DEMOS, 2003; Hargreaves, 2011, 2012; Institute for Government, 2010; Jackson, 2005; MfE, 2007a; Shove, 2010a).

Encouraging and facilitating change therefore requires a range of approaches and multiple policies. In this context, policy-makers are recognised as being more than just "innocent bystanders" (Jackson, 2005, p. iii; Shove, 2010a, 2010b). Instead they play an active role in shaping individual behaviours and practices "both directly (through regulation and taxes) and more importantly through [their] extensive influence over the social context within which people act" (DEFRA, 2008a, 2008b; Institute for Government, 2010; Jackson, 2005, p.iii; Shove, 2010a, 2010b).

As highlighted earlier , the three paradigms vary in what they see as the key intervention targets - from a focus on the individual (the micro-scale), to the socio-technical (the macro-scale) or the practice (the meso-scale). Furthermore, the individualistic (ABC) and the practice paradigms differ in how they conceive opportunities for lasting change (see Table 2 below). Despite these differences there is a growing recognition within both paradigms of the importance of understanding the individual, social and material contexts of behaviour or practice (Hargreaves, 2011, 2012; Institute for Government, 2010; Shove, 2010a).

Table 2. The contrasting assumptions and approaches of ABC [25] and practice theories in relation to energy consumption and demand. Modified from Strengers (2012).

ABC Theories (Individualistic paradigm)	**Practice theory (Practice paradigm)**
The world is populated by people	The world is populated by practices
People and their barriers, drivers, attitudes, values, opinions, choices and/or norms are the central unit of analysis and change	Practices (and their elements) are the central unit of analysis and change
Emphasis on changing people and their consumption/demand	Emphasis on the changing elements of practices
Technology, supply systems and people are separate from each other	Technologies and supply systems are elements of practices

[24] Practice theorists draw on a number of concepts from the other two paradigms such the role of social norms, the notion of socio-technical systems, co-evolution and path dependency

[25] Strengers (2012) refers to ABCD theories, where 'D' is for demand, for consistency we have chosen to follow Shove's (2010) original formulation.

People have agency	Practices, people and things have agency
People change through targeted information, education, price signals, social norms, community interaction etc	Practices circulate and change through changing or mixing elements, and through innovation in practice
Change is orderly, predictable and controllable	Change is emergent, dynamic and often uncontrollable
Efficiency improvements and demand reductions are long-lasting	Practices are constantly changing along trajectories that may negate efficiency and conservation improvements

The importance of considering these contexts together was recently highlighted in an international review of 30 initiatives to create pro-environmental behaviour change, undertaken for the Scottish Government. This report emphasises that initiatives targeting multiple contexts are likely to be more successful (Southerton, et al., 2011).

A number of acronyms and metaphors have become popular in identifying opportunities for encouraging behaviour change. Of these the most common are perhaps 'carrots' (financial incentives), 'sticks' (rules and regulations) and 'sermons' (information provision) (DEMOS, 2003; Serbruyns & Luyssaert, 2006; Zhang and Flick, 2001) and the 'four E's' (Enable, Encourage, Exemplify, Engage) (DEFRA, 2008a, 2008b; Jackson, 2005) or the 'six E's' adding: 'Explore' and 'Engage'. (Collier, et al., 2010; Institute for Government, 2010).

In the next part of this report, we use some of these 'E' headings to consider mechanisms for change. In this discussion, we highlight how such initiatives might relate to the individualistic or the practice paradigms, and what role social science might play in facilitating change.

7.5.1 Explore and evaluate

All of three paradigms emphasise the importance of understanding the individual, social and material contexts in which the behaviours and practices are being undertaken. More recent individualistic approaches suggest that this requires an understanding of nine influences (as listed below in the acronym 'MINDSPACE') on behaviour and change (Institute for Government, 2010, p.18):

1. Messenger: we are heavily influenced by who communicates information.
2. Incentives: our responses to incentives are shaped by predictable mental [models].
3. Norms: we are strongly influenced by what others do.
4. Defaults: we "go with the flow" of pre-set options.
5. Salience: our attention is drawn to what is novel and seems relevant to us.
6. Priming: our acts are often influenced by sub-conscious cues.
7. Affect: our emotional associations can powerfully shape our actions.
8. Commitments: we seek to be consistent with our public promises.
9. Ego: we act in ways that make us feel better about ourselves

These influences on particular behaviours in the land- based sectors(e.g., irrigation, fertilising, spraying) could be understood through observation, quantitative (questionnaire survey) and qualitative (interviews, focus groups) methods and then used "for informing the parameters for modelling, policy, appraisal, selecting the interventions and the evaluation of effects" (Collier, et al., 2010, p. 4; Gifford, 2011; Institute for Government, 2010). Here the social science approach would involve examining existing behaviours, and evaluating the effects of interventions.

In contrast, a practice approach would seek to understand the elements of: (1) practical knowledge; 2) common understandings; 3) rules; and 4) material infrastructure) holding the practice together. The social research methods for gaining such insights would be a mix of qualitative methods (interviews, focus groups, workshops, future visioning, back-casting), ethnographic (participant observation, visual methods (video and text)) and historical methods (analysis of archives and print media). These various insights would then be used to help formulate and explore interventions that would target the elements holding the practices together in innovative ways (see Section 7.4 Davies et al., 2012; Doyle & Davies, 2012; Spaargaren, 2011; Strengers, 2012).

Southerton et al. (2011: 31) argue there is a "real need for systematic monitoring and reporting of behaviour change initiatives so that robust measures of costs and outcomes can be reliably identified." In particular, they suggest measures need to take full account of:

- Direct causality between an intervention and its associated outcomes. This raises issues about controlling for other contextual factors that may have been equally important in the outcome associated with the initiative.
- Which components of an intervention were most important.
- Which of those components were sector or region specific and which are transferable to other sectors and regions.
- Evaluating the unanticipated consequences ('rebound effects') of an initiative.
- Timescales and thresholds of success.

7.5.2 Engage

Learning, education and training

A lack of knowledge and familiarity are often found to be influential in determining the uptake of new practices or technologies (Fischer &Bliss, 2006; Gillespie et al., 2007; Pannell et al., 2006; Roth &Botha, 2009; Serbruyns & Luyssaert, 2006; Smallshire et al., 2004). Research on the adoption of best management practices emphasises the role that learning, education and training can play, rather than the simple provision of information (Baumgart-Getz et al., 2012; Gillespie et al., 2007). As noted earlier, a meta-analysis in the USA found that overall education and formal education were not a significant determinant of adoption (Baumgart-Getz, et al., 2012). A positive relationship, however, was found between extension training and adoption (Baumgart-Getz et al., 2012).

Dialogue, deliberation and partnership

Dialogue, deliberation and the establishment of partnerships between government, research (social science and science), industry and local communities can help foster opportunities for change (Frame, 2008; Kenny, 2010; Leys &Vanclay, 2011; Moser &Dilling, 2007; Owens, 2000). First, it can help facilitate trust and understanding between farmers, growers, foresters, policy-makers and scientists (Bickerstaff, 2004; Irwin, 1995; Irwin et al., 1999). Second, it can help to identify opportunities to support mitigation or adaptation changes which may already be happening for other social, environmental and economic reasons (Shackley & Deanwood, 2002, 2003; van den Dungen et al., 2011a, 2011b). This view is echoed by Southerton et al. (2011, p. 31) in their review of international behaviour change initiatives, which found there was "considerable scope for utilizing 'less visible' mechanisms" to encourage change.

Third, such an approach shows how climate change and sustainability can be reframed and re-imagined as locally understood and relevant issues, rather than as a global problem that is distant in both space and time (Brace and Geoghegan, 2011; Head et al., 2011; Macnaghten, 2003; Owens, 2000; Slocum, 2004). Baethgen (2010, p. S70) argues for example that 'climate

change' might more usefully be viewed as part of long-term variations on a "continuum of total climate variability (seasons to decades to centuries)." Such a conception might help to move beyond on-going and unhelpful debates about the causes of climate change (Head, et al., 2011). Fourth, the public (including farmers, growers and foresters) can play a role in helping to generate insights for both policy-makers and scientists. Many scholars argue that the public should be considered to possess 'lay' or 'contextual' knowledges experts' - rather than being viewed as 'non-experts' who present a 'barrier' to the successful implementation of new practices and technologies (notably, Brown, 1992; Irwin, 1995). They contend that the public can "often possess rich stocks of experience and expertise based upon […] everyday observation" (Irwin et al., 1999, p. 1312; Wynne, 1996).

The public can generate broader accounts of the risks, uncertainties and challenges in environmental issues and new technologies, as they often raise a number of important contextual variables that are either overlooked or in some instances trivialised by policymakers and/or scientists. When these 'local knowledges' are employed appropriately, they can make "a positive contribution to policymaking and debate" and generate "cognitive gains for policymaking and decision-making" (Irwin et al., 1999: 1312).

Social scientists have now developed extensive theories and methods to understand and facilitate such dialogue and deliberation; including in New Zealand (Winstanley et al, 2005; Cronin, 2008)

7.5.3 Encourage

Rules, regulation and legislation

As noted earlier, the institutional contexts in which individuals, farmers, growers and foresters work invariably influence many of their behaviours, practices and operations (Campbell et al., 2012; Kerr et al., 2004; Pannell et al., 2006; Rosin et al., 2008; Serbruyns and Luyssaert, 2006; van den Dungen et al., 2011a, 2011b). Through policies, rules, regulations and other initiatives governments can directly and indirectly influence change in both positive and negative ways (Campbell, et al., 2012; Pannell, et al., 2006; van den Dungen, et al., 2011a, 2011b). Jackson (2005, p. 129) identifies a number of ways governments can encourage sustainable production and consumption, as follows:

- product standards can make vital differences between durability and obsolescence, between efficiency and waste, between recyclability and landfill.
- building standards can further improve or simply hinder the efficiency of the UK building stock.
- trading standards can either foster or prevent excessive or addictive consumption and play a key role in the success or failure of sustainable consumption patterns.
- media standards play a vital role in influencing the wider social and cultural context of consumer attitudes, motivations and desires.
- marketing standards can either encourage or inhibit unscrupulous or inappropriate selling, advertising and marketing practices.

Communication and information provision

There is a growing recognition in both research and policy of the need to move past the information 'deficit model' that informs many communication strategies. As noted earlier in this report, this model assumes that the reason public perceptions of issues like climate change differ from those of experts, is the public's 'ignorance' about the scientific or technical facts (Bickerstaff, 2004; Burgess et al., 1998; Irwin, 1995). The assumption is that lay perceptions are attributable to the inadequacies or 'irrational' assumptions in public

understanding, along with bias or error (Bickerstaff, 2004; Burgess, et al., 1998; Irwin, 1995). Many psychologists and economists would support this basic assumption, but now recognise that the 'lay public' (including farmers, growers and foresters) is composed of many groups and segments of society "with very different attitudes towards and appraisals of what risk is and what values are relevant to making acceptability decisions" (Bickerstaff, 2004: 830; Pidgeon & Beattie, 1998; Rayner & Cantor, 1987).

Influenced by this view of 'segments' in society, there has been an increasing trend to use social marketing to encourage behaviour change (Collier et al., 2010: 4; Frame & Newton, 2007; Gifford, 2011; Institute for Government, 2010; Jackson, 2005). Social marketing has been adopted after the failure of previous information campaigns to sufficiently 'engage' the public (Frame & Newton, 2007; Hinchliffe, 1996). Social marketing involves identifying different segments of the population on the basis of their demographics, perceptions and beliefs. These segments are then targeted with tailored communication and information (e.g., providing information about how to address barriers to a particular behaviour). Some limitations of these typologies were addressed in an earlier chapter.

Incentives

Incentives, such as taxes, subsidies and penalties, can be used to encourage the adoption of new behaviours, practices and technologies (Baumgart-Getz et al., 2012; DEFRA, 2008a, 2008b; Gillespie et al., 2007; Hunt, 2009; Institute for Government, 2010; Jackson, 2005; Kerr et al., 2004; Serbruyns & Luyssaert, 2006). Drawing on insights from behavioural economics, the Institute of Government (2010, p. 21) suggests that the use of financial incentives can be both counterproductive and productive:

> … monetary compensation can lead to feelings that an activity is worthy in itself ('intrinsic' motivations) being 'crowded out' or partially destroyed. Once an activity is associated with external reward ('extrinsic' motivations), individuals are less inclined to participate with the activity in the future without further incentives […]. Conversely, incentives could „crowd in" desirable behavio
> for example, may have acted as a signal not to use cars in the centre of London, and built up a cumulative behavioural response that extended beyond the financial incentive *per se*.

The literature on behaviour change among farmers, growers and foresters is divided over the effectiveness of incentives. It suggests that the success or impact of an incentive is determined by factors such as: the type, magnitude and timing of incentives (Collier et al., 2010; Crow and Danks, 2010; DEFRA, 2008a; Greiner et al., 2009; Institute for Government, 2010; McDonagh, et al., 2010); and how easy it is for individuals to find out about, understand and get access to incentives (Charnley et al., 2010; Serbruyns & Luyssaert, 2006).

Social norms and institutions

People's behaviour and practices are founded upon many cultural conventions and social norms (Campbell et al., 2012; Jackson, 2005; Southerton et al., 2011). Influencing or changing conventions or norms can help facilitate behaviour change. This is extremely difficult to do, however, as conventions are "entrenched in ways of life and also vary across social groups" (Southerton et al., 2011, p. 9).

Furthermore, cultural conventions and social norms are the foundation of various behaviours and practices (Hand et al., 2005; Shove, 2003; Southerton et al., 2011). This reality is "both difficult and problematic because it requires shifting the foci of initiatives away from

individual consumer decisions and toward shaping and intervening in the shared behaviours of social groups" (Southerton et al., 2011, p. 9).

7.5.4 Enable

Almost all production and consumption relies on "technologies, infrastructures and the material design of goods" (DEFRA, 2008a, 2008b; Geels, 2005; Geels & Kemp, 2007; Jackson, 2005; Southerton et al., 2011, p. 11). As highlighted above, these material contexts both enable and constrain certain behaviours and practices on the farm, orchard or forest plot (McKenzie-Mohr and Smith, 1999; Pannell et al., 2006; Serbruyns & Luyssaert, 2006; Vanclay, 1992; Zhang & Flick, 2001).

Considered interventions in "material infrastructures not only create the conditions for new habits to emerge" but also can potentially lock people into sustainable behaviours and practices (Geels, 2005; Southerton et al., 2011, p. 11; Spaargaren, 2011). Additionally, the "way in that objects are designed and combined can shape the way" that they are used (Southerton, et al., 2011, p. 11). Paying attention to the design of good and services can nudge behaviours or practices in certain directions (Institute for Government, 2010; Thaler & Sunstein, 2008).

Some approaches to facilitating the development of sustainable technologies, infrastructures and goods are consumer-inclusive engagement, future visioning and backcasting (Davies et al., 2012; Doyle &Davies, 2012; Hegger et al., 2011). For example, in the Netherlands focus groups were used as a medium to present and discuss innovations in water-based consumption practices with both consumers (the public) and providers (the water company) (Hegger, et al., 2011). The study also considered the impact that such innovations would have on consumer–provider relations (Hegger et al., 2011). This process explored how future water consumption could be reduced in a manner that was open and 'consumer inclusive' (Hegger et al., 2011).

A similar approach has been taken in Ireland. Here the focus was on exploring how significant reductions in energy and water use can be made through the use of participatory future visioning and backcasting (Davies et al., 2012; Doyle & Davies, 2012).

The role of social science is very different under these approaches, compared to those presented earlier. Here the researchers are playing an active role in exploring what life might be in the future, and taking into consideration the social, ethical and structural implications of such innovations.

8. The design, implementation and evaluation of climate change programmes and activities at a farm/ground (production system) level and a national level

In New Zealand there are a considerable number of climate change programmes at both national and local levels, which are documented on government and other institutional websites (Crown Research Institutes, Universities, and other research providers). However, navigating through this information to create a clear picture of the range of programmes and activities is challenging. It is even more difficult to conduct and analysis of the design, implementation and evaluation of these programmes, especially as many of these are work-in-progress. [26] It is unlikely that the following list of work programmes is complete, but it does provide an indication of the range of programmes and activities. Given the resource and time constraints in this project, it has not been possible to review their design, implementation or evaluation. However, we do identify a series of research questions at the end of this section on programme design.

8.1 CENTRAL GOVERNMENT PROGRAMMES

The government continues to promote and collaborate in international research on climate change, as required by the 5th National Communication under the United Nations Framework. The government works closely with the IPPC, and a number of other research, observation and reporting programmes (www.mfe.govt.nz/publications/climate/nz-fifth-national-communication).

As well as contributing to international programmes, the Ministry for the Environment (MfE) and the Ministry of Primary Industries (MPI) work in conjunction with science providers to disseminate research findings on climate change, mitigation options and adaptation processes and methodologies, to ensure that New Zealanders:

- Are well informed on human modification of the climate.
- Better understand existing knowledge and uncertainties regarding the effects of climate variability and future climate change.
- Identify and implement technologies that underpin New Zealand's Kyoto Protocol commitments and long-term needs to substantially reduce greenhouse gas emissions.
- Participate effectively in managing and adapting to the impacts of climate change, including making use of any opportunities that may arise.

An overview of current MPI SLMACC research is included in the Appendix. Completed research papers and reports can be accessed at www.mpi.govt.nz/environment-natural-resources/climate-change/research-and-funded-projects. The broad programme areas of research are:

- Impacts of, and adaptation to, climate change.
- Forestry and carbon markets.
- Addressing greenhouse gases from agriculture.
- Soil carbon and biochar.
- Living with climate change (economic and social issues).

[26] Several stakeholders interviewed in a recent New Zealand study on public health and climate adaptation - the ESR 'HAIFA' project (under the GLO portfolio) - identified the need for a 'clearing house' to provide clearer information on the various programmes in New Zealand.

Further analysis of these SLMACC papers would provide insights into the design, implementation and evaluation of the wider programme of work under which the research is carried out, but this is beyond the scope of this project.

Key programmes of work being carried out by MPI reflect their aim to reduce greenhouse gas emissions and include:

- The Emissions Trading Scheme.
- Forestry in New Zealand Emissions Trading Scheme.
- Agriculture in New Zealand Emissions Trading Scheme.
- Other forestry initiatives (the permanent forest sink initiative and afforestation schemes). [27]
- Greenhouse gas reporting.
- Research.
- Greenhouse gas footprinting.

In addition to funding and disseminating research, MPI works closely with the primary sectors and local government to understand the extent of potential climate change impacts and develop mitigation and adaptation options. MPI, for example, leads a number of advisory, working groups and stakeholder groups under the Climate Change banner:

- The Peak Group (Stakeholders) including a Research, Innovation and Technology Transfer Working Group and an Adaptation Technology Working Group
- Forestry Stakeholders Reference Group
- Agricultural ETS Advisory Group
- Primary Growth Partnership (pastoral and arable production, horticulture, seafood, forestry and wood products, food processing)

The sectors that MfE works with in relation to climate change include: Transport, Energy, Industry, and Waste. The key biophysical sciences, and the institutions in which they are located, are also represented in the technical and advisory groups outlined above. To date, the limited level of social science representation in these forums has reduced opportunities for asking different kinds of questions, and widening research agendas to promote more integrated social and biophysical science. A systemic review would provide additional framings and approaches for SLMACC to consider in future, including engaging policy, sector and public actors in addressing the multiple changes required – and consequent transitions – to address the challenges of climate change.

MfE is the lead central government agency for coordinating climate change policy across government. The MfE BIM (2011) highlighted key issues relating to community resilience including: access to information, sound infrastructural planning and engineering, and strong institutional arrangements for insuring against residual risks. The Ministry for Civil Defence and Emergency Management has also worked very closely with local government, and other stakeholders, in developing their four R's framework (Reducing risk, Readiness, Response, Recovery).

The degree of integration between MCDEM, MfE and MPI is unclear from the documents accessed for this review, but both MfE and MPI are strengthening their interaction with local government under the climate change banner e.g, through the MfE (2010) Tool for Estimating the Effects of Climate Change on Flood Flow; and the MPI web-based adaptation toolbox which enables local government to:

[27] See Review of MAF Afforestation Schemes (2011) MAF Information Paper No. 2011/07.

- learn about climate change and adaptation,
- access information, tools and resources,
- assess resilience to climate change, and
- find ways to adapt to climate change.

Included in this toolbox are case studies and fact sheets by sector and by topic.

8.2 GOVERNMENT PROGRAMMES REACHING STAKEHOLDERS ON THE GROUND

How are central government programmes actually reaching those 'on-the-ground'? Two examples are provided below.

The Primary Growth Partnership is a joint investment between the Crown and industry partners: pastoral, horticulture, seafood, forestry and wood products, food processing. One programme of climate change-related work under this banner is the 'industry' good strategy undertaken by DairyNZ http://www.dairynz.co.nz/page/pageid/2145855896/Industry_Good. As well as providing information for dairy farmers and lobbying on their behalf, they provide interactive tools for farmers' home computers to learn more about reducing greenhouse gases on-farm, help fund work undertaken by the Pastoral Greenhouse Gas Research Consortium, and have carried out work to test the utility of nitrification inhibitors.

MPI has developed a Climate Change Technology Transfer Plan for Action – see http://www.mpi.govt.nz/news-resources/faqs/faqs-climate-change-plan-of-action. The aim of is to provide land managers with sufficient information, technologies and systems to enable and encourage the adoption of land management practices which help to reduce total greenhouse gas emissions; improve the efficiency of resource use and minimise the liabilities; adapt to a changing climate; and take advantage of new business opportunities relating to climate change. The action plan seeks to promote more resilient land based businesses by supporting and co-ordinating sector and government initiatives and providing up to date, relevant information on climate change to land managers and their advisers. A number of contracts have been let to service providers to deliver this plan to rural professional and sector groups. Workshops and field days have been held by sector participants for framers on climate change around the country.

8.3 ON-FARM PROGRAMMES

Kenny's (2010) work - in which he outlines a number of projects undertaken with farmers since 2004 on climate change adaptation - can be seen as a *direct intervention* in farmers' behaviours, based on participatory and structured methods of farmer engagement, and building capacity through enabling farmers to learn from each other.

Extension science programmes are also intervention-based, in the sense that science knowledge is disseminated, transferred, and translated to on-farm applications. Much of this work has focused on best practice farm management and sustainability, not climate change per se.

There have also been a number of programmes, based on developing tools for regional council and on-farm use, which are aimed at improving farm management and enabling improved water resource management and improving water quality. For example, the Integrated Research for Aquifer Protection (IRAP) programme has involved a partnership

between research institutes, central and local government, Ngāi Tahu and land sector stakeholders to answer the questions:

- What impact will land use changes have on the quality of groundwater available in the future?
- How do nutrients move through the soil to the aquifer and then through the aquifer system?
- Will using best practice farm management techniques be enough to maintain acceptable groundwater quality?

MPI SLMACC has been the driver behind the development of many programmes, interventions and tools. For example, 'FarmSim' and 'AquaSim' aim to improve nitrate management on-farm and to protect groundwater quality. Their use can promote dialogue between territorial authorities responsible for water resource management and land-users to improve farm management and protect water quality. 'OVERSEER' is an agricultural management and decision support tool which assists farmers and their advisers to examine nutrient use and movements within a farm to optimize production and environmental outcomes. The computer model calculates and estimates the nutrient flows in a productive farming system and identifies risk for environmental impacts through nutrient loss, including run off and leaching, and greenhouse gas emissions.

There are also the collaborative programmes involving research institutes and industry organisations such as DairyNZ (e.g. the utility of nitrate inhibitors), and Fonterra (the Clean Streams Accord), which support a roll-out of information, tools and knowledge via industry links with farmers. Irrigation N.Z. is another organisation that supports best practice farm management, providing advice about the uses of irrigation technology and models of collaborative water management, such as audited self-management.

There are also programmes based around farm advisory services. One provided by Lincoln University has two roles: (i) the supervision of the University's commercial demonstration farms, and (ii) the provision of farm management consulting services to fee-paying clients. Field days either on-farm (University/research farms) and/or wider national field days (e.g. Mystery Creek) can also be seen as programmes for on-farm uptake of information, technology and practice (see www.fieldays.co.nz).

It is also likely that the MPI Afforestation Grant Scheme (within the reduction of greenhouse gases work programme) has involved on-farm advice and grants. It appears to be linked to the MPI hill country erosion control programme, which also funds regional councils' erosion programmes.

Government funding streams such as the Irrigation Acceleration Fund and the Sustainable Farming Fund also support farming communities. For example, the Sustainable Farming Fund focuses on programmes of work led by community-based groups which provide a degree of co-funding. Examples of programmes funded in 2012, which reflect farmers engagement with climate change, include: Reducing the Environmental Footprint of Arable Crops, Integrating More Cropping into Sustainable Dairy Farming Systems, Waipa Dairy Collective – Managing Risk and Building Resilient Businesses, and Mitigating the economic costs to farmers following severe rain storm events.
(www.mpi.govt.nz/environment-natural-resources/funding-programmes/sustainable-farming-fund/sff-funded-programmes-2012)

Under the climate change banner, the AgResearch website indicates a number of 'Land and Environment' research programmes that are specifically farm oriented and are clearly aimed at implementing change. These include soils and land use, nutrient management, greenhouse gas emissions and mitigation, and climate change and adaptation. From the list of research projects funded by government noted above (see Appendix), it could be assumed that some of this work is based on-farm. However carrying out the 'detective work' necessary to provide a robust commentary on these programmes is well beyond the scope of this review.

8.4 OVERVIEW OF PROGRAMMES AND ACTIVITIES

The brief overview of programmes and activities in this section gives an indication of the range of work being conducted in New Zealand, but also illustrates the complexity of the 'system' of policy and programme responses to climate change. We conclude with a list of future research questions and topics of inquiry that could create a great understanding of this system, and provide a basis for evaluating its overall effectiveness.

Research questions:

How is central government progressing towards creating a uniting vision and framework that enables coherent and dynamic policy formulation and implementation?
What assumptions about behaviour change and social processes are being drawn on in the design, implementation of climate change programmes - and how does this affect outcomes?
Is the focus on individual behaviours 'on the ground' likely to produce the most effective interventions? What factors, including actors affect land based sector's response to climate change and what relative influence do they have on outcomes?
Is the reliance on tools overriding the potential benefits of other approaches e.g. participatory engagement, mental models, social practices?
What processes of comparison and evaluation have been initiated to review the effectiveness of existing research and policy programmes?
To what extent are programmes being informed by research and evaluation? To what extent are research and evaluation being informed by programmes?
How can central government create a uniting vision and framework that enables coherent and dynamic policy formulation and implementation that is (i) coherent across government ministries and (ii) sustainable across successive governments, in relation to land based sectors?
Could a 'clearing house' of climate change policies, programmes and research provide a 'one-stop shop' for New Zealand? Or could existing 'clearing houses' be used as mechanisms for sharing climate related initiatives, and knowledge?

9. The design and use of systems approaches that encompass **production, Māori, sectors, local and central government** elements, as well as education, research, science (physical and social) and technology transfer.

9.1 OVERVIEW OF SYSTEMS APPROACHES

Systems Thinking (ST) assists with understanding complexity and change (Maani & Cavana, 2000, p. 7). The basic concept behind systems approaches is the idea "that to make sense of the complexity of the world, we need to look at it in terms of wholes and relationships rather than splitting it down into its parts and looking at each in isolation" (Ramage & Shipp, 2009, p. 1). Systems thinking is applied in a variety of methods and approaches, which range from descriptive, through interpretive, to 'critical' perspectives on the world.

Daellenbach (2001) analyses approaches to operations research and management science using three categories: functionalist, interpretive, and emancipatory systems approaches, which, in turn, are related to increasing degrees of technical complexity, human complexity, and diversity of views/interests. Functionalist approaches "assume that systems are 'objective' aspects of reality, largely independent of the observer," and suit problem situations of high technical complexity, but are less useful in situations of high human complexity or high degrees of diversity of interests. Interpretive approaches assume that "the system defined for a given problem situation reflects the observer's world view." Such approaches suit relatively high degrees of human complexity and diversity of interests and values, but are less successful dealing with technical complexity. Emancipatory approaches recognise the importance of various inequalities (e.g. of wealth, status, power, authority, gender, race, or sexual orientation). Emancipatory approaches also recognise that different stakeholders may see or choose very different systems as relevant and make different judgements about the appropriate 'boundaries' around what is relevant and what is not. Boundary questions "try to make sense of a situation by making explicit the boundaries that circumscribe our understanding" (Ulrich & Reynolds, 2010).

Another core concept in systems thinking is emergence. Emergent properties can be defined as those that "'arise' out of more fundamental entities and yet are 'novel' or 'irreducible' with respect to them" (O'Connor &Wong, 2012). Checkland (1999, p. A3) has reviewed the development of systems thinking and notes the significance of the work of Maturana and Varela (1980) on the concept of a system "whose elements generate the system itself." Although poor application of systems approaches can be found (Mingers, 2006, p. 256), systems thinking and the systems movement have been "enormously productive and innovative since they emerged through developments in biology and information technology in the 1930s" (Mingers, 2006: 1). Mingers goes on to name the major contributors to the field[28], spanning from general systems theory, through cybernetics, living systems approaches, dialectical systems thinking, theory of purposeful systems, hard systems engineering, soft systems methodology, theories of autopoiesis and cognition, social systems theory, critical systems thinking, to developments in chaos and complexity theory (Mingers, 2006, p. 1).

Systems approaches offer distinctive utility to the study of complex situations and the design and implementation of interventions. Key contributions include:

[28] Von Bertalanffy, Weiner, Ashby, Bateson, Stafford Beer, Miller, West Churchman, Ulrich, Ackoff and Emery, Hall, Checkland, Maturana and Varela, Buckley, Luhmann, Habermas, Giddens, Jackson, Flood, Midgley, Mingers, and Kaufmann.

- problem structuring (Mingers and Rosenhead, 2004)
- alertness to unintended consequences
- awareness of the importance of the observer
- the concept of nested systems, and the significance of boundary judgements and worldviews when conceptualising systems
- a 'critical' stance: attending to "constraints, assumptions and conditions that are in force and then test and challenge their strength and validity" (Mingers, 2006, p. 258).

Systems approaches have been applied to account for the impact of different influences on climate (e.g. vegetation, greenhouse gases, natural events, etc.). However attempts to apply systems approaches to include human activity, and to connect social systems with ecological systems, are more recent and less well developed. In the review of literature undertaken for this report, there is now considerable support for viewing climate change in relation to social systems. Many authors promote the use of complex adaptive system ideas, the concept of social ecological system resilience, and the importance of approaches and methods that take account of context dynamics and stakeholders. Other important themes are the need to consider cross-scale dynamics (both temporal and spatial), the significance of social institutions and practices, and the relationship of systems thinking to the understanding and accounting for levels of vulnerability.

9.2 REVIEW OF SELECTED LITERATURE

Fiksel (2006) and Ison (2010) advocate for a systems approach to policy development and programme design. While the rationale for a systems approach is well established in the literature, it does not offer a definitive account of how systemic approaches might account for the biophysical and social complexity associated with climate change. We note the relevance of the 'greening' of the disciplines of operational research and systems thinking to the management of complex environmental issues (Midgley & Reynolds, 2004). This body of literature indicates research gaps that might be addressed in the research Strategy.

Critiques of reductionist approaches to modelling and intervening in complex economic, ecological and social systems are well established. By assuming cause and effect relationships, reductionist approaches tend to narrowly focus on the contribution of individual factors and develop explanation and recommendations for action based on simplistic assumptions (Checkland, 1999; Jackson, 2000). Janssen & Ostrom (2006) critique the assumption of an economically rational Homo Economicus, noting that human behaviour is heavily influenced by social and learning contexts.

Complexity means that uncertainty and surprise is common (Kurtz &Snowden, 2003). A number of authors draw attention to the unintended consequences that can arise when intervening in complex systems. Fiksel (2006) refers to the 'rebound effect' associated with private sector awareness about sustainability, where an increase in industrial resource efficiency can result in a larger ecological footprint. Presenting a case study of the conflict between pastoralism and wildlife conservation in Tanzania, Lynn (2010) notes that attempts to improve resilience in one socio-ecological system may inadvertently decrease the resilience in another interconnected socio-ecological system. Berman et al. (2012, p. 87) caution that actions to manage today's challenges may contribute to "unsustainable development in the long term."

Disillusionment with narrowly focused environmental management practices, including large-scale, capital-intensive and centrally planned conservation projects, led to the

acknowledgement and incorporation of land user, community and indigenous knowledge in the management of natural resources (Kellert et al., 2000; McCallum et al., 2007). Fairweather (2010) has developed maps of socio-ecological systems based on farmers' understandings of the influence of biophysical, social and economic factors on farm ecosystems. Lynn (2010) advocates that policy makers involve local stakeholders in the assessment of social-ecological impacts, in order to enhance overall system resilience. Kalaugher et al. (2012) demonstrate how dialogue between farmers and researchers can increase understanding about the range of adaptation options, barriers and trade-offs for climate change.

Underpinning reductionist ('command and control') approaches to ecosystem management is the belief of "humanity as superior to and independent of nature" (Folke et al., 2003, p. 353). Theories about coupled social-ecological systems and related concepts of adaptation and resilience have been developed to understand the close inter-relationships between economic, ecological and social systems (Folke, et al., 2003; Walker et al., 2004). Recently this theory has been extended to examine how climate change challenges overlap with existing vulnerabilities, by looking at the importance of tipping points in 'hot systems'. Positive feedback loops, initial conditions, cross-scale interactionsm and irreversibility lead to climate change related humanitarian crises (Lynn et al., 2010). Folke et al. (2003) consider an understanding of the dynamics of coupled socio-ecological systems as necessary to a new level of ecological literacy, and set out four key insights for managing social-ecological systems: learning to live with change and uncertainty; nurturing diversity for reorganisation and renewal; combining different types of knowledge for learning; and creating self-organisation towards social-ecological sustainability.

Walker et al. (2004) examine the importance of resilience, adaptability and transformability in linked human and natural systems. Nelson et al. (2007) review the adaptation and resilience approaches, noting that adaptation is typically actor centric and resilience is systems oriented. A number of authors build on Holling's (1986) adaptive renewal cycle model and the associated concept of panarchy. This model charts the dynamics of ecosystems as they develop from growth, to conservation, to collapse, to reorganisation. Garschagen (2010) applies Holling's adaptive renewal cycle to the Mekong Delta, Vietnam to understand how vulnerability develops in coupled social-ecological systems, and considers "not how to reorganise collapsed systems in a more resilient way, but how to trigger precautionary reorganisation without having to suffer collapse and related crisis" (p. 52). Garschagen (2010) considers the role of political, social, economic and legal institutions in mediating system dynamics, and then critiques Holling's model in terms of its failure to adequately account for power relations or decision-making processes. In this way, resilience is an emergent property resulting from adaptation - "actions of multiple actors and usually in response to multiple stresses and stimuli" (Nelson et al., 2007, p. 396).

A number of authors have developed frameworks to account for adaptation and resilience. Berman et al. (2012) examine how institutions mediate the translation of coping capacity to adaptive capacity. Biermann (2010), noting that governance and institutional structures mediate adaptive capacity and system resilience, examines the role of local non-government organisations in building adaptive capacity – a key knowledge gap, given that the local context mediates the effectiveness of adaptation strategies.

For some authors a systems approach is equated with a comprehensive understanding of all relevant factors. A slightly dated report by MoRST (2007) notes that nations, including the UK, USA, Canada and Australia, are investing in integrated biophysical, socio-economic and health modelling capabilities utilising advances in environmental monitoring and systems

theory as large-scale and long-term datasets are becoming more readily accessible. For Fiksel (2006), a systems approach will progress sustainability, given its attention to multiple scales, system dynamics, complexity, variability and uncertainty, stakeholder perspectives and conceptualisations of systems resilience – aspects that are ignored or downplayed in reductionist approaches. A range of systems methodologies has been referenced in the literature. Fiksel (2006) provides illustrative examples of systems approaches to modelling and intervening in complex systems including: agent-based simulation; system dynamics modelling; ecological engineering; scenario-based dynamic modelling framework covering transportation, water, energy and health sectors; thermodynamic life cycle analysis; and adaptive management processes.

Specific New Zealand applications of systems thinking include:

- Nolan and Crowe (2010) apply Soft Systems Methodology to facilitate reflexive dialogue about the introduction of biofuels policy;
- Fairweather (2010) applies a novel combination of cognitive mapping methodology and q sort method to model farmers' understandings of the influence of biophysical, social and economic factors on farm ecosystems.
- Kalaugher et al. (2012), viewing a farm as a complex socio-ecological system, utilise Soft Systems Methodology to show how 'top-down' quantitative biophysical models and 'bottom-up' qualitative social research can be used to understand and address climate change adaptation options in context.

In contrast to specific applications of systems approaches to sustainability and climate change, Ostrom and colleagues (Ostrom, 2009a, 2010, 2012) have developed a 'polycentric' approach. This challenges the basic assumption that a global problem like climate change requires a global solution – "single policies adopted only at a global scale are unlikely to generate sufficient trust among citizens and firms so that collective action can take place in a comprehensive and transparent manner that will effectively reduce global warming" (Ostrom, 2009a: ii). A polycentric approach encourages experimentation and collaborative learning by multiple actors at multiples scales.

Folke et al. (2003, p.353) note the need "to build knowledge and incentives into institutions and organizations" as a "fundamental challenge … to sustain societal development." Ison (2010) argues that systems thinking is critical to policy and practice for addressing the complexity and uncertainty associated with a climate change world, and explores why a systemic approach has yet to be widely adopted.

9.3 LINKING SYSTEMS APPROACHES TO LEVELS OF COMPLEXITY

One way to structure the key findings from this literature review is to use the Cynefin Framework (Kurtz & Snowden, 2003), which conceptualises complexity in terms of five domains (see Figure 1 below):

- Simple – ordered domain of known cause and effect relationships;
- Complicated – ordered domain of knowable cause and effect relationships;
- Complex – unordered domain of multiple cause and effect relationships characterised by ambiguity and unintended consequences;
- Chaotic – the disordered domain of no discernible cause and effect relationships; and
- Disordered – where classification is not possible (excluded for the purposes of this review).

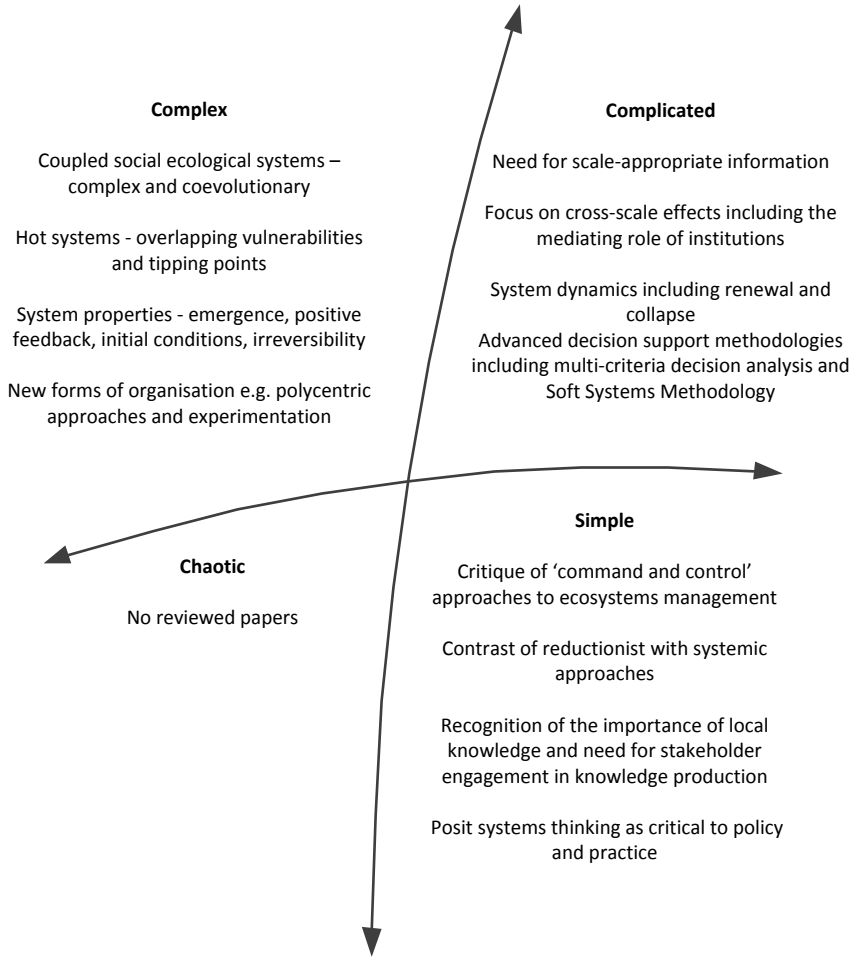

Figure 1: key insights from literature review

9.4 RESEARCH GAPS

We note the recommendation of Lynn et al. (2010, p.18) that, "because social systems are vulnerable to seemingly minor biophysical and socio-economic changes, [the IPCC] continues to mandate the participation of social scientists in its assessments." The need for New Zealand to incorporate research on social systems in its response to climate change is supported by reports from the Ministry of Research Science and Technology (MoRST, 2007), Regional Councils (2009), and, by implication, by Kalaugher et al. (2012), O'Brien et al. (2009), Danhofer et al. (2010), Campbell (2009) and Fairweather (2010). In the words of MoRST (2007, p. 3): "Although New Zealand research needs to be linked to and informed by international research, New Zealand's distinctive environment means that we require New Zealand based research to develop local solutions and opportunities." What follows is a selection of areas for research signalled from the local and international literature that might warrant New Zealand based research. We have organised the research areas into three groups: conceptual or methodological development; understanding context and the field of practice in order to guide the design and implementation of interventions; and research on how to better implement and apply insights.

Conceptual and methodological development

There are a number opportunities apparent in the literature to further develop and contextualise thinking around social-ecological systems and resilience. Nelson et al. (2007) and Walker et al. (2004) raise the need to better understand types of adaptive capacity needed for system transformation and renewal (as distinct from system adjustments). Walker et al. (2004) explore the meaning, significance and interaction of three attributes linking humans and nature: resilience, adaptability, and transformability. Darnhofer et al. (2010) identify key questions as what leads to resilience in a complex adaptive system, and which variables should be measured to study resilience. They have established some 'rules of thumb' as a first attempt, but these require further development and testing in the New Zealand context. O'Brien et al. (2009) focus on the need for better understanding of power imbalances embedded in socio-ecological systems.

Ostrom (2012) seeks a theory of global change the "offers a better explanation of micro-level initiatives." Ostrom (2010) proposed the utility of 'polycentric' approaches, but noted that they are not to be seen as a panacea. The applicability and limits of such approaches need to be explored. Another conceptual framework that needs to be explored further is the 'hot systems' approach of Lynn et al. (2010), particularly, they would suggest, as a way of understanding vulnerability and adaptive capacity. Folke et al. (2003) prompt the question of how to create opportunity for self-organisation toward social-ecological sustainability, while Berman et al. (2012) seek to understand how to understand and conceptualise the temporal trade-offs between coping and adaptive capacity.

The literature suggests several areas for important methodological development and testing. Janssen and Ostrom (2006) identify the major challenges for social science as being around issues of scale and issues of generalisability. They explore the use of modelling, and particularly agent-based modelling in relation to qualitative methods, but signal the need for further work in this area. Kalaugher et al. (2012) developed a mixed methods framework, which they trialled in a study of dairy farming in New Zealand, but signal the need for further testing and development of the framework.

A number of authors suggest the need for methods of measurement, evaluation, monitoring, and identifying key attributes of resilient and adaptive capacity. Nelson et al. (2007) seek ways to evaluate system resilience, and ask, are resilience characteristics fungible? And, are there minimum levels (for such characteristics)? Ostrom et al. (1999) note the need to develop ways to enhance and monitor forms of communication, information and trust which underlie effective adaptive management. Fiksel (2006) looks for policy formulation tools which recognise the complex, interconnected state of socio-ecological systems, including visualization methods and metrics. And Berman et al. (2012) note the need to identify "concealed adaptive capacity" in communities.

Dialogue approaches are a further area of methodological development. Kalaugher et al. (2012) see farmers as important interdisciplinary partners with researchers, and seek dialogue approaches that will externalise tacit knowledge. Fiksel (2006) recommends developing ways to integrate dialogue among industry, government and academia, with a view to encouraging a more cooperative approach.

A report for the New Zealand Regional Councils (Regional Councils, 2009) notes the need "to incorporate system complexity in the identification and understanding of links between landuse activities and receiving environments."

9.4.2 Understanding and designing for context

We found two areas for further research under this topic: the role of institutions and practices in relation to response to climate change; and understanding the social and institutional influences on land based decision-makers.

Areas for research into the role of institutions include: how to introduce awareness of ecological systems into commercial thinking (Fiksel, 2006); how to improve the focus on rural communities (Berman et al., 2012); how communities can "leverage coping capacity" for future climate change (Berman et al., 2012); how to live with change and uncertainty (Folke et al., 2003); the importance of diversity for reorganization and renewal (Folke et al., 2003); and, the need to account for power relations and the role that stakeholders play in decision-making processes in relation to political, social, economic and legal institutions (Gerschagen, 2010). Nelson et al. (2007) raise the question of how institutions are influenced by, and influence, environmental change discourses and ideologies.

Areas for research into social and institutional influences on land based decision-makers include: the significance of the complexity of everyday life (Sotolongo, 2010); the need to understand the characteristics of social systems, human biases, and processes of self-organisation influencing farmers (Darnhoffer et al., 2010); understanding and enhancing the "capability … to gain a reputation for being trustworthy and reciprocating the efforts of others to cooperate ..." (Ostrom, 2009); and, the role of non-government organisations in fostering adaptive capability (Biermann, 2010).

9.4.3 Application and Implementation Research

Three areas of research were suggested by the literature: supporting decision-making, the significance of participation in decision-making, and on vulnerability; and supporting research and science integration, and inter-disciplinarity.

Research to support decision-making was called for by Leach et al. (2010), who called for a rigorous approach to system dynamics to provide a "usable guide to action." Darnhofer et al. (2010) noted the need to operationalise resilience thinking, to develop guidance to farmers and see the farmer as a decision-maker. Fiksel (2006) wanted to see modelling and decision-making approaches that support dynamic, adaptive management rather than static optimisation. And Lynn et al.(2010) raised the question of how to apply a 'hot system' approach to decision-making processes.

Calls for research on the significance of participation in decision-making, included: the importance of including vulnerable sections of society and representations of vulnerable socio-ecological systems within decision-making, which is a "highly underresearched area" (Nelson et al., 2007); examination of the role of scientists as expert and as citizens (Norgaard, 2008); exploration of how more open and participatory forms of governance deal with issues of uncertainty and flexibility (Nelson et al., 2007); how to account for power relations and the role that stakeholders play in decision-making processes (Garschagen, 2010); and the need to analyse existing vulnerability indexes (Lynn et al., 2010).

The need for research supporting 'science and research integration' and interdisciplinarity was highlighted by MoRST (2007) – including in relation to how science is carried out (particularly scaling, coordination and integration of science), and the need for systems understanding and integration. Ostrom (2009) is clear about the need to integrate social science with other sciences in understanding how to sustain socio-ecological systems. Fiksel

(2006) and Folke et al. (2003) call, respectively, for transdisciplinary collaboration on issues of social relevance, and the need to combine different types of knowledge for learning.

Research questions:

- What variables need to be measured to assess resilience, adaptability and transformability in NZ land-based sectors? How might measurements of relevant variables indicating resilience, adaptability, and transformability be used to evaluate policy options in interventions?
- What kinds of adaptive capacity is relevant to NZ land-based sectors in relation to CC: what resilience, adaptability, transformability?
- What kinds of adaptive capacity is relevant to NZ land-based sectors in relation to CC: what resilience, adaptability, transformability? How might complex adaptive systems in the landbased sectors be adequately modelled to support policy development, decision-making, and evaluation?
- What are the implications for policy on CC of existing vulnerabilities in the landbased sectors?
- How might the concept of 'hot systems' (interactivity between CC and existing vulnerabilities leading to 'tipping points') be relevant to NZ land-based sectors (e.g. in relation to economic and social vulnerabilities of communities and businesses)?
- What are examples of and opportunities for self-organisation in response to CC and resilience in the landbased sectors?
- How might the key factors for effective adaptive management, communication, information and trust, be enhanced and monitored in NZ landbased sectors?
- What methods and processes will support the integration and interdisciplinarity of science and research relevant to CC in the landbased sectors?
- How might vulnerable populations and vulnerable socio-ecological systems be better represented in decision-making?
- What forms of governance and decision-making are best suited to enhancing response to CC in landbased sectors?

10. Māori specific needs, issues and approaches for social science research in relation to mātauranga, taiao and innovation to address climate change for land based sectors.

"Climate change has the prospect of affecting Iwi and Māori to potentially the same extent as colonisation and in disturbingly similar ways" (Kaupapa Working Group – Climate Change)

"This analogy means Māori are likely to be disproportionately impacted by some of the climate change policy" (pers comm. Chris Insley).

"We have to make sure Iwi Māori are treated fairly and equitably" (pers comm. Chris Insley)[29]

10.1 BACKGROUND AND ISSUES

Projected impacts of climate change on Māori society are expected to be diverse and intense across a range of economic, social, cultural, environmental and political dimensions (Dept. of Prime Minister and Cabinet 2001; Hennessy et al., 2007; King et al., 2010; MfE, 2009, 2007; Te Aho, 2007). Much of the research literature, and discourse around Māori and climate change, indicates that Māori society is highly sensitive and disproportionately vulnerable to climate variations, shocks, and changes - and that many parts of Māori society will be adversely affected (Cottrell et al., 2004; King and Penny, 2006; NZIER, 2003; King et al., 2012; Packman et al., 2001; Te Aho, 2007).

The high vulnerability of Māori to climate change is based on several factors. Firstly a large part (52%) of the Māori economy (BERL Ltd and FOMA 1997; Nana et al., 2011a, b; NZIER 2003; TPK 2002, 2007, 2008) is reliant on primary industry (i.e. agriculture, forestry and fishing), along with the growing tourism and renewable energy sectors (Harmsworth et al., 2010a; King et al., 2010, 2009; Nana et al., 2011a; TPK, 2007). The sector profile (e.g. Funk and Kerr, 2007; Harmsworth et al. 2010a; Harmsworth 2007; Insley and Mead, 2008; Insley 2007; Insley, 2010; King et al., 2012; Nana et al. 2011b; TPK 2008) exhibits a range of high vulnerabilities to climate hazards and related stresses. Large proportions of Māori owned land (>60%) are steep and hilly and thereby susceptible to damage from high intensity rainstorms and erosion, while lowland plains and terraces are vulnerable to flooding and high sediment deposition (Harmsworth and Raynor, 2005). Many collectively owned Māori land blocks in eastern and northern regions of New Zealand are particularly susceptible to drought (Harmsworth et al., 2010a; King et al., 2010), and this risk is expected to increase uncertainties for production and quality (Cottrell et al. 2004; Mullan et al. 2001). The fisheries sector is also at risk to changes such as sea level rise, average ocean temperature, chemistry, acidification, invasive pests, species composition and condition. These changes all pose significant risks to Māori coastal-marine assets (King et al., 2010) and potentially could lower productivity.

Second, Māori have an intimate relationship with their environment through their ancestry and cultural practice (King et al. 2007; Waitangi Tribunal). Māori are inter-dependent on natural ecosystems to sustain customary use, cultural identity, and wellbeing. Therefore any shifts in natural ecosystems, habitats and species from climate change, will greatly impact on

[29] For a useful summary see the news interviews at : **http://www.youtube.com/watch?v=CHo_wMkGBAc**

Māori cultural resources, cultural identity, wellbeing, use and practice (King et al., 2012, 2010, 2007, 2005; King and Penny, 2006; Woodward et al., 2001).

Third, Māori communities represent some of the most vulnerable communities in New Zealand, based on socio-economic characteristics such as: low household incomes; high Māori unemployment in some regions and districts; sub-standard housing; health inequalities; high prevalence of some health illnesses; and many other issues - as widely identified by the Ministry of Health and Stats NZ, (Te Aho, 2007).

Defining and managing climate risks needs to be carried out with Māori organisations, using holistic approaches that contribute to desired Māori outcomes. Utilising both Western scientific and Māori knowledge systems together is most likely to result in positive behavioural change, increased resilience to adapt, and risk management (Hudson and Hughes 2007; King et al., 2012, 2010, 2008, 2007, 2005; King and Penny, 2006). Collaborative and strategic partnerships in business, science, research and government, are essential to identify opportunities and implement innovative technologies (Carswell et al., 2002; Harmsworth et al., 2010a; Harmsworth and Funk 2006, 2004; Harmsworth 2003; Funk and Kerr 2007; Insley, 2010, 2008; Insley and Meade 2008; Penny and King, 2009). Land management practices will have to adapt to future regional climates to support both the Māori and New Zealand economy (Harmsworth et al., 2010a,b,c,d,e, 2007; Insley, 2010; King et al., 2010; Tait et al., 2007; TPK 2007b).

10.2 KEY ISSUES OF CONCERN TO **MĀORI**

The key issues of concern, and potential research topics for Māori and climate change in the land based sector, are expanded in the discussion below – which was developed from:: discussions at hui organised by climate change research projects; issues raised at the iwi leaders group regional and national hui on climate change; discussions with individuals around the country including, Māori Trustees office, TPK staff and regions, FOMA members, Climate Change iwi leaders group members, Māori landowners, key Māori staff from other CRIs - supplemented by the literature documenting Māori perspectives and issues (see reference section). A large number of issues and potential projects have been identified – see table in the next section.

Climate change will impact disproportionately on Māori due to their vulnerable position in terms of lower socio-economic status, their close cultural inter-connection with the natural environment, and their need to protect customary practices (e.g. mahinga kai, food collection, health, wellbeing, weaving). Therefore any negative shifts in natural ecosystems, habitats and species arising from climate change will greatly impact on Māori cultural resources, cultural identity, wellbeing, use and practice.

Māori have high economic and social dependence in the land based sectors (agriculture, forestry, fishing). The Māori economy is particularly vulnerable to weather pattern changes, such as increasing drought (East Coast and northern North Island and eastern and northern South Island), wetter in the west with increasing storm events likely to affect New Zealand. Temperature increases may be around 2-4 degrees in both Island's in the next 100 years. (Harmsworth et al. 2010a, b, c, d, e, Harmsworth et al. 2007, Harmsworth and Raynor 2005).

Many Māori settlements and rural communities are in coastal and low lying areas, prone to changing weather patterns and sea level rise. There is a likelihood of increasing erosion and erosion rates, sedimentation, and flooding from intense severe rainstorms (i.e. increasing

frequency and magnitude) in many catchments. Over 70% of Māori land is hilly to mountainous. There is a likelihood of increasing erosion from intense severe rainstorms (i.e. increasing frequency and magnitude) on this land, especially steep hill slopes (>22°) on erosion prone rock types. Sea level rise will cause many problems in low lying coastal communities especially lower and adjacent tidal estuaries and floodplains. Some marae are vulnerable on the coast in low lying valleys.

High dependence in agriculture, horticulture, farming, and forestry means that Māori will face high biosecurity risks from climate change, with increased threats from pests, insects, disease, which will impact (or damage) to varying degrees on agriculture and indigenous ecosystems.

For some Māori, with collectively owned land it can be difficult to effectively participate in the Emission Trading Scheme (ETS). The ETS requires a good understanding of highly technical science knowledge and how to apply it and some owners are in a better position to access this than others.

Taking an overview of the literature and meeting discussions noted above, a number of specific goals can be identified to build Māori adaptation and resilience strategies for climate change, and to help Māori develop programmes/actions for sustainable land management and increased productivity in land based sectors i.e. to "future proof land" from climate shocks, including:

- improve understanding of climate change impacts on Māori land based sectors and help develop strategies to mitigate climate change shocks and implement opportunities,
- provide better access to climate science and technical information in a form that supports Māori strategies, programmes and actions, including participation in the ETS,
- increase access to research funding and knowledge, and in a language and form that Māori can utilise,
- build Māori research capability and capacity at the iwi/hapū level through appropriate resourcing, knowledge networks, interaction-participation, and training/skills development in key areas (e.g., farm systems management, carbon and nutrient management, ETS, carbon credits).

Future social science research should including understanding and designing social research of relevance to, and benefit to, Māori. Approaches for Māori involvement in research and policy should be based on kaupapa Māori principles (related to Māori issues, kaupapa Māori methods, research by Māori for Māori), such as:

1. Understanding resilience from a Māori perspective? How can Māori adapt to climate change? What are the key actions from a Māori perspective?
2. Increased participation of Māori in climate change programmes (e.g. collaborative research, collaborative learning, adaptive management).
3. Increased Māori led programmes of research and action.
4. Training programmes for Māori – tailored to Māori.

The following initiatives are proposed for future social science research on Māori and climate change – across mātauranga, taiao, and innovation:

- Translating climate science and technical information in a form that supports Māori strategies, programmes and actions i.e. taking science knowledge and converting it to

Māori programmes of actions, innovative solutions and technologies for Māori **(innovation, improve uptake)**

- Research, education and building capacity for Māori in order to finding innovative solutions, actions, and technologies for climate change **(innovation)**
- Utilise and understand mātauranga Māori, Māori values and central concepts such as kaitiakitanga for land based sectors (**mātauranga)**
- Understand climate risks in order to adapt to climate change, and develop specific Māori strategies, programmes, and actions to improve resilience and behavioural change **(innovation, taiao)**
- Training programmes for Māori – tailored to Māori (land based sectors) **(mātauranga, innovation, taiao)**

10.3 SOCIAL SCIENCE RESEARCH QUESTIONS RELATED TO THE LAND BASED SECTORS

Potential projects related Māori in the land based sectors are identified in the table below. The biophysical science/ management issues are noted, along with the key social science research questions, as highlighted in the green box.

Project	Biophysical science / management and policy issues	Social science questions
Land based strategies for climate change (Future proof landscapes)	Future proof landscapes/Māori-land Mitigate risk in vulnerable erosion prone steep hill country Reduce flood risk through integrated catchment management strategies on land Diversified land use Understanding pasture management and farm management systems for climate change (increasing droughts, storm events)	How can Māori land owners develop improved access to, and understanding of, scientific knowledge and technology? How can mātauranga Māori knowledge be integrated with Western knowledge for more effective land management? How can Māori contribute to risk management through collaborative learning?
"Managing farm agri-business in a changing climate – the "opportunities and challenges for Māori landowners"	o Projected climate changes by region for Māori land based sectors o How to identify risk o What are the market drivers (international and national frameworks) o A summary of the latest research on reducing livestock emissions o National and regional examples of predicted changes (for sheep, beef, dairy and cropping, horticulture, forestry) o Required approaches to risk management in agriculture o A "take-home" resource kit for	How do Māori understand the risks of climate change and the impacts on the Māori land based economy? How do Māori understand adaptation and resilience? What actions do they wish to take? What is required for behavioural change among Māori land owners? What kind of information or training would be most effective for Māori owners/managers in the land based sectors?

	Māori to meet climate change challenges.	
Biosecurity threats on Māori land	Identify biosecurity threats on Māori land and to primary sectors Reduce biosecurity risk through land based strategies and partnerships with MAF and CRIs	How do Māori understand the biosecurity risks arising from climate change, and how this can this be effectively applied to management approaches in the Māori land based sector?
Building resilience for Māori communities	Understanding Māori perspectives and programmes of action	What does resilience and adaptation mean to Māori? How do various schemes, programmes and actions build resilience and adaptation for Māori in land- based sector communities?
International- Pacific Islands and resilience and adaptation to climate change	Learning from issues, programmes and communities carried out in Pacific Islands Use of customary knowledge for adaptation to climate change. Developing programmes of action and research within a Pacific context Learning from other island states (flood control, sea level rise, spatial planning, prediction/risk etc) The role of indigenous /customary knowledge in adapting to, building capacity and responses to climate change	How can indigenous knowledge, mātauranga Māori, contribute to adaptation and resilience in the land based sectors? How can the indigenous scientific knowledge of Māori be integrated with the knowledge of other indigenous communities, in adaptation to climate change? How might collaborative learning /shared learning with other Pacific communities be used to reduce climate change impacts on Māori rural communities in Aotearoa New Zealand?
Complementary measures for energy self-sufficiency	Less dependence on national energy, the national grid, multi-national energy companies Move towards less fossil fuels, more renewable natural energy Māori non-economic values Investigate alternative energy To achieve Māori aspirations in self-sufficiency (Tino Rangatiratanga, Mana Motuhake) Move away from national grid Building resilience/improved resilience of	How are Māori in the land-based sectors affected by current patterns of energy supply and future energy changes? Do Māori in the land based sectors wish to become more self- sufficient in their energy use? If so, how can Māori land owners and managers achieve self- sufficiency -

	communities with less dependency on fossil fuels and national grid Local energy generation /solar wind, small scale hydro, tidal	and what technologies/ management systems are or could be applied in the land based sectors?
Recognition of, and understanding of Ecosystem Services and biodiversity credits	Recognition of Ecosystem services and biodiversity in climate change programmes and the ETS (pers comm. Tina Porou, George Asher Ngāti Tūwharetoa) Better recognition of ecosystem services connectivity and of under the ETS (e.g. the role of biodiversity credits) Understanding non-monetary values Explore biodiversity credits, nutrient trading (response to nitrate issues) Recognise retirement of land: native bush, wetlands, planting erosion prone land, riparian planting, etc. Riparian strips, etc.	What are Māori perspectives on ecosystems and the implications of this understanding for resource use in the land based sectors? How do Māori see and value 'ecosystem services'? How could Māori valuations help generally with climate change strategies and programmes of action?
Land Use flexibility Kyoto, Offsetting carbon under the ETS	LUF achieved through 'Offsetting' To offset carbon emissions in one area to another and promote versatile land use Deforestation in one area and afforestation/reforestation in another. "This would allow deforestation liabilities for pre-1990 forests to be waived, so long as a carbon equivalent area of new forest is planted elsewhere. This would significantly reduce the deforestation cost to pre-1990 forest land owners and the impact that has on land value" (Tim Groser). Can this be catchment based? Should this be carried out in catchments (pers comm. Tony Petch Waikato Regional Council) or across catchments? How does it link to water quality? and improved catchment management? Sustainable land use?	What are the particular issues for Māori in the land based sectors relating to the ETS? What are Māori interests, perspectives and understandings of offsetting? How do these perspectives get included in programmes of action in the land based sectors?
Dealing with future impacts	Deeper analysis of the extent to which projected impacts on Māori society can be dealt with in the future is required; as too is the need to improve the integration of information from other scientists, policy analysts, and decision-makers to strengthen the conclusions reached and to help facilitate actual plans and actions that respond to complex realities. Such work will need to include consideration of investment requirements, the availability of technology, societal responses, inter-generational equity, planning frameworks, as well as the possibility of absolute limits	To what extent is Māori dependence on the land based sectors creating a unique vulnerability for Māori from climate change – and is this likely to increase in future? How is the recent growth of the Māori economy in the land based sectors creating future risks or benefits for Māori? What opportunities for the land based sectors do Māori

	to adaptation.	foresee, arising from climate change? How might the economy generally be affected by future scenarios for the Māori economy based on the landbased sectors? What can be learnt about the effectiveness of current programmes initiated by or for Māori in the land based sectors – and how might such programmes be designed and evaluated in future?
Māori water resource systems, climate change + policy	Further work is needed in this vital system to provide critical information that will assist whānau/hapū/iwi and Māori businesses to make informed decisions about future needs, allocation, and adaptation measures for commercial and non-commercial water resource uses.	To what extent is the Māori land based sector particularly affected by issues in water quality and use? What is our understanding of Māori objectives, priorities and management plans for water protection and use in the land based sectors? How are Māori contributing to general changes in the governance of water and how might this affect the landbased sectors in future?
Raising Māori - climate change awareness	Communicating the complexity of risks surrounding potential climate change is challenging. Few people have the expertise/skills (or time) to understand the underlying science and thereafter to evaluate climate-related proposals and controversies. Public educational initiatives that raise awareness about climate change and key concepts (that can be confusing amidst the flood of information now available) would be valuable. Further, given that perceptions of risks are known to be important in influencing communities' actions, tailored information as well as the 'right people' would greatly assist effective communication in the future.	How do Māori understand the risks of climate change to the landbased sectors? How can scientific and management information be translated in an effective way for Māori audiences? What initiatives are Māori taking themselves to foster learning and collaborative management approaches in the landbased sectors to adapt to climate change?

In addition to the research questions listed above, the discussion around Māori and climate change in the land based sectors raises broader issues around the framing of adaptation approaches generally. Some general research questions that emerge are set out below.

General research questions:

What are the risks and impacts of climate change on the Māori land-based sectors, including cultural, social, economic and environmental impacts?
How well are these risks and impacts for Māori recognised in relation to impacts for New Zealand generally?
What programmes/actions for adaptation and community resilience exist now in the Māori land based sector, how well are these working and how could they be extended?
How can Māori knowledge of natural systems, including Mātauranga Māori and concepts such as kaitiakitanga be better understood and applied to support resilience in the land-based sectors?
What forms of collaborative governance and social learning are being used for sustainable management in the Māori land-based sectors now and how might these be extended to support climate adaptation?
How might climate change problem analysis and policy development be enhanced through a better understanding of Māori perspectives on the climate and ecosystems?

11. Research questions identified by end users

In addition to the literature reviews above, two end user workshops were held to discuss the aims of a social science research agenda on climate change and what it should include.

11.1 POLICY END USERS

A policy end user was held in April 2012 with representatives from MAF [now MPI], MSI and MED [now MBIE], MFE, Local Government New Zealand, and the Royal Society of New Zealand. The meeting identified issues under the following headings[30]:

What are the important social dimensions of CC?

'We need to understand the changes that climate change will bring to rural communities, including land use changes. We need better understanding of the links between climate change and other hazards, and how resilience is built in the community, particularly through social networks.'

'A big social question is that local authorities should be making substantial investment in climate mitigation and adaptation, but how can this be justified socially? How as a society do we divide up responsibility for CC? Who bears liability for impacts (e.g. storms, floods?) What is the role of private individuals, government or insurance? Local government is thinking about who is liable and who pays – but no one wants to pay. [The issue is being socialized]: "let the buyer beware". [More social research and policy work] is needed to understand and reach agreement on issues of cost, liability and insurance.'

'We need a socio-economic analysis of the land based sector and the implications of CC. For example: Given that NZ is a major exporter, what will the impacts on this sector mean for future exports and for those communities? What is the ownership pattern in the sector? What is the role of institutional investors? What incentives are there for investment e.g. buying farms on flood plains? How we do we achieve structural change of a land based economy and how this will impact on identity e.g. New Zealand as a dairying nation? Who will be the winners and losers?'

'How do we reduce emissions? The status quo can't remain but how do you transition from unsustainable practices? The best strategy is to target influential CEOs etc. Need to translate CC into a business and investment issue now – the science is [already] here.'

'How to bridge the gap between future climate scenarios and present day action? Sea level change may not occur until 2050 – 2100, but how can we start behaviour change now? Behavioural change requires knowledge, awareness, enabling technology, incentives. More understanding is needed on how to effectively communicate about possible impacts so that action can be based on knowledge.'

'How do you bring the public along with CC? CC deniers have influence e.g. local government may wish to invest money in flood protection but may get resistance from those who deny CC.'

[30] Comments cited here are grouped and taken from verbatim quotes in the discussion, and are not individually attributed. Some linking ideas and paraphrasing by the authors is included in [square brackets].

‘What [framing and ideas] are people using to understand the issue and the action needed? “Sustainability” is coming back into use but we need a boundary object to bring players around the table to discuss the issue. [What is the role of government]: as a facilitator or a determinant? [A facilitation role] would provide the opportunity for people to have those conversations. Landowners are watching what is going on – waiting for government to solve the problem. [Traditional patterns of political influence] are not always helpful – what will pull us together?’

Why has social science around climate change become important?

‘Why wouldn’t social science be relevant? We need to understand what this means for our communities.’

‘People realise now that the problems are biophysical but the solutions are social. No one has been listening to the biophysical scientists. They are shocked and horrified – the problems are clearly defined but the solutions are not being picked up. It was assumed that knowledge of biophysical impact would drive behaviour change – it didn’t. [Social science] is needed even more because of the urgency of the situation. Ten years ago the climate scientists said “move quickly”, but now it is “too late”. What can we do? We need to proactively address CC threats.’

‘Other countries are doing things and expect New Zealand to do something too e.g. Kyoto.’

‘[We need to understand better how social change happens]. It is not simply a lack of ‘political will’ - the problems are at all levels. [It is important to understand processes of social discourse]. With CC there is no boundary object unlike for example The Treaty of Waitangi. The underlying issue we are addressing is not fixed or agreed. The term ‘sustainability’ was out for a while and then ‘resilience’ was in.’

‘Resistance to change comes from seeking to maintain our current lifestyle.CC is a social problem and definitively includes economics. Economic drivers are missing in terms of the policy puzzle. Uncertainty around impacts and time frames impedes change. People need to say ‘this is the bit I can do’ – then it all comes together coherently. ‘

What topics should be covered in a New Zealand Social Science Research Agenda for Climate Change in the land based sectors?

‘The 5 bullet points in the ‘RURALS’ project brief look like ideas looking for a home – what is the rationale? The focus on drivers of change and communication needs more detail e.g. communication to whom? Why is it hard to convince people to change their behaviour? Communication approaches vary, and some are not dialogical.’

‘[Social science could look critically at the overall governance of climate change including policy frameworks and interventions]. We need a distillation of the ideas coming from different programmes, e.g. mitigation, adaptation, business opportunities. Policy needs to be supported by research e.g. MAF work underpinned by research and focused on tech transfer (the ‘peak’ stakeholder group developed programme priorities). The production of science is itself a social activity.’

‘The key issue is how to transition the land based sector to a future where the climate is greatly changed? We need to make it clear we are moving from one state to another state. We

need to be taking a systems view – interactions with policy, investment etc. For example, how can we include economic drivers such as the risk investment decisions made by individuals?'

How can the social science research strategy be implemented? What would make it realistic, useful and relevant?

'It needs to address problems that end users are facing and needs to be translatable to end user language/way of thinking. Science-policy translation is difficult. Need to connect the strategy to policy.'

'Social research is needed to support policy. The land based sector is important – what is it that I as a policy maker have to do to support the land based sector? [Social science will also show how the policy process itself is working and producing change.] What are the best policy levers – is it information, regulation, technology or investment etc? Need to show how one programme fits with other programmes.'

'Strategy development will build capacity and support for taking action around CC. Biophysical science research is coming up and government needs a greater understanding about what CC will mean for the land based sectors (beyond immediate ETS issues).'

'The strategy should be seen as relevant and going beyond MSI and MAF to other governance groups including industry, NZ Climate Change Centre, local government, Federated Farmers.'

'Climate policy will gain greater legitimacy by participation – all sectors are different and have different definitions about participation. [One approach] is to give people options and then the sector feels there is the opportunity to participate. How can new governance approaches enable us to make trade-offs e.g. water and economics?'

'The strategy will help funders prepare research questions for the next funding round. Please make it focused – timeline needed etc. Identify research themes in simple language.'

'It needs to include evaluation, not just at the end but on-going.'

11.2 MULTI- STAKEHOLDER WORKSHOP

An interactive workshop with 30 participants from government, industry, farming, Māori, biophysical science, social science was held in early June at the Ministry of Science and Innovation.

Participants were invited to propose research questions that would support effective action in New Zealand on mitigation, adaptation and developing new opportunities. They were then given the opportunity to see how the international social science research agenda for climate change is being developed - notably through a draft International Social Science Council research agenda - and to identify where those research questions were relevant to New Zealand and the land based sectors, and to prioritise their top questions. To generate a final overview, participants were also asked to highlight the 'big questions' facing New Zealand that should be addressed in future research.

Relating the international research agenda to New Zealand

The ISSC draft paper *Transformative Cornerstones of Social Science Research for Global Change* (Hackmann and St. Clair, 2011) identifies an "emerging consensus on a set of questions" on what it calls "the transformative cornerstones of social science" (p. 8). In total it identifies 71 questions, grouped under six headings:

- Historical and contextual complexities
- Consequences
- Conditions and visions for change
- Subjective sense-making
- Responsibilities
- Choice and decision-making.

Participants in our stakeholder workshop were given the opportunity to consider these questions and to collaboratively rate them for importance in the New Zealand context and the 'knowledge gap' that they represent. Seven areas of research were identified and associated questions, as follows:

(i) Dealing with differences across geographical, cultural, personal professional contexts and identities.
The role of social and cultural identities in how climate change is experienced, and how people cope with and recover from its impacts.
Contextual drivers of behaviours that contribute to climate change.

(ii) Measuring success: improving the outcomes of specific actions and instruments.
How might the outcomes of specific policy initiatives be monitored and measured?

(iii) Identifying social boundaries and tipping points.
The consequences of climate change for basic social fabric of life and how people and institutions understand and anticipate the risks of social boundaries and tipping points in relation to global climate change.

(iv) Living with global change: taking stock of threats and impacts across different groups and regions.

(v) Coming to grips with policy processes and political will.
Questions around what drives or constrains commitment to policy action and how the framing of climate change and the role of scientific knowledge might shape policy.
Questions on who shapes policy and decision-making, how decisions in the face of uncertainty are made, and the influence of assumptions and blind-spots about the future on decision-making.

(vi) Making knowledge work.
How different forms of knowledge, local, indigenous, and academic, have access to and influence on decision-makers, and how knowledge can be better 'delivered' and used.

(vii) Building relevant institutions and structures.
What governance and decision-making institutions and structures are needed in relation to different levels of decision and a commitment to democracy?

(viii) Fostering global and inter-generational justice.
Questions around the extent to which structures and policies enhance or undermine inequalities and injustice.

Other themes from the ISSC paper were also highlighted as important by the workshop attendees. The following is a summary of topics chosen by three or more participants:

- Potential linkages between climate change and other global social crises, and between vulnerability to such crises.
- What can be learned from studying the historical trajectory that has led to systems and behaviours that lie behind climate change?
- Questions around framing climate change, and responses to climate change, as ethical problems, and how to include ethical considerations into evaluative measurement.
- How might normative considerations of justice for disadvantaged and vulnerable people, and for future generations, and of cooperative ways of working be legitimately expressed.
- The nature and role of values, beliefs, needs and worldviews in determining responses to climate change.

What are the big issues facing New Zealand that might be addressed through social science research?

This question produced a strong response from the participants and generated a list of questions and comments that reflect much of the literature review findings discussed earlier in this report. This question list provides a snapshot of how the climate change problem is being considered and how social research is being understood and expected to contribute on those issues. We have therefore grouped these responses under 5 headings: challenges for society; instrumental research questions; emerging research topics; methodological issues; and the role of social science.

Challenges for society:
Whose problem is climate change and whose problem will it become?
Awareness raising and public communication strategies.
Countering individualism – people thinking more about the community than themselves.
Countering consumer culture.
Demography (population size density, distribution) how will this be affected by climate change?
How do we bring about the necessary moral revolution?
How do we change the social norm from personal (and property) rights to personal and collective responsibility?
How do we change the social norm to one of intra- generational and inter-generational equity?
How can we bring about the understanding that the right decisions might not be the one people most agree with?

Instrumental research questions:
How to improve the uptake of climate science and make it useful for practices and actions?
How to incentivise changes in behaviour, through what types of mechanisms?
How do we win hearts and minds? Selling climate change impacts to the masses?
How can environmental impact areas such as climate change issues be effectively engaged with individual producers and consumers?
Two way communication between levels –policy-research- farmers - how to improve it?
Investigate steps to provide collaborative governance at all levels- we need to start working together on these big issues – at level of parliament as well.
What combination of economic incentives and non-economic drivers of behavioural change is appropriate (in a given context)?

Tools – for climate change – what tools (measurement) are required by whom for what and how achieved? Skills: what skills are required by whom, for what and how achieved?
Emerging research topics and themes:
What are the key drivers for change in farm management?
How can aims and objectives of land uses (rural) and urban society converge for tackling climate change for long term sustainability for NZ?
Linking the land based sector, such as farmers, into more collective and co-ordinated responses
Understanding the drivers of change in agriculture.
What determines farmers attitudes to risk and uncertainty?
What values underpin farmers' decision making in NZ? (do these vary between family farms/corporations and others?)
Are incentives and imperatives geared appropriately to induce the right/desired results, and avoiding unfortunate consequences?
Issues around equity and ethical dimensions.
Capability and capacity of current institutions to meet challenges of CC
Culture change - how to achieve changes in the culture and human behaviour commensurate with the need to mitigate/adapt to CC
How do existing discourses around climate change obscure possibilities and vulnerabilities, thereby reducing resilience of society?
How to create common goals/vision amongst NZers?
How can we rapidly improve social discourse mechanisms to create a cohesive social narrative?
How to best get local communities, RCs, ROs and government working together i.e. on common trajectory?
What are institutional barriers to change?
Are we clear about all we want to see happen from particular incentives and imperatives?
What are the underlying beliefs about human progress, materialism, growth etc that replicate/entrench 'business as usual'?
Identifying and resolving the unique social science dimensions in NZ – what is different from international?

<u>Methodological questions:</u>
When should research engage the general public or average person - and when should it target its engagement at the exceptional or different cases?
When does social science need to be interdisciplinary (with natural sciences) and when can it work alone?
Behaviour change practice theories vs agent based theories.
Integrating different aspects of climate change research between disciplines.
Make better use of the knowledge we already have in policy and decision-making.

<u>The role of social science:</u>
Importance of having a 'people dimension' to the physical science outputs for climate change.
What long term effect will social science have to influence the uptake [of new approaches] by the producers of greenhouse gases?
How/when will social science stop being a contested category?
Do funders see social science as important contributors to NZ's knowledge pool?
Will they fund solely social science projects [or does SS have to fit into other projects]?
Will recognition of social science as an important source of knowledge be reflected in having people with the capability to review social science funding proposals properly?
How can we take ordinary people along with us on high level analysis?
How can society build greater understanding of how changes are and can occur in society?

12. Wider themes and issues to address in the research Strategy

12.1 GENERIC THEMES IN CLIMATE CHANGE RESEARCH

In the international arena, particularly now in the IPCC, it is recognised that social issues permeate the issue. However, as Reisinger (2010) observes, there has not been nearly enough social science research conducted yet to to support decision-makers and meet the demands of responding to climate change. He notes that some work has been done on:

- Socio-economic drivers of GHG emissions
- Integration of adaptation into development
- Socio-economic determinants of vulnerability to climate change impacts
- (some) behavioural and ecological economics applied to mitigation cost analysis
- Policy design and effectiveness of technology diffusion and learning-by-doing cycles.

More work is needed, according to the IPCC, on: adapation needs and options; adaptation planning and implementation; opportunities, constraints and limits, the economics of adaptation; and climate resilient pathways. See Appendix 5 for details.

In the next section of this report, we will draw on the theme headings from the international literature to create a structure for a NZ Social Science Research Agenda for Climate Change, with a focus on the land based sectors, including outcome areas and objectives. To conclude this present section, however, we focus on how such questions can be efficiently addressed, including methods, strategic priorities and making the better use of what we already know.

12.2 METHODS AND APPROACHES FOR UNDERSTANDING THE COMPLEXITIES OF CLIMATE CHANGE

As highlighted above, much of the social science research on climate change to-date has been quantitative (questionnaire surveys), and commonly focused on psychological (in particular, individual) beliefs and knowledge, and demographic factors which influence risk perceptions and motivations. While this research has provided some important insights, it also has a number of limits. Often there is a tendency in these studies to underplay the role that contextual factors (e.g., social, cultural, economic and political) play in both shaping perceptions of risk and motivating (in)action (Bickerstaff, 2004; Irwin et al., 1999; Wilkinson, 2001). The focus tends to be on the deficiencies or 'irrational' assumptions behind the bias or error in the thinking of individuals (Bickerstaff, 2004; Irwin et al., 1999; Wilkinson, 2001). As a result such studies tend to provide only restricted insight into the "basis of variation between places and social groups" (Bickerstaff, 2004, p. 828; Irwin et al., 1999).

Surveys of risk typically suppose that "attitudes remain stable and consistent over time, that these attitudes underpin how people think about and act in response to […] risks, and take for granted that the objective risk existed independently of society, history or culture" (Bickerstaff, 2004, p. 828). The insights from qualitative and social-cultural research show that perceptions of risks are usually not stable, but rather they "change in different social settings and in relation to new knowledge and experience of life events" (Bellaby, 1990; Irwin et al., 1999; Wilkinson, 2001, p. 9). The literature highlights the need to consider risk and motivations to act in context, because climate change:

> will not be expressed or experienced separately from anything else, as a stand-alone entity. Climate change will have expression in localized and temporally specific weather processes recognizable in the present. It will also become enrolled in processes such as drought relief arrangements, carbon trading schemes, altered financial instruments, fluctuating prices of inputs such as fuel and fertilizer, public discourse, and legislation, among others" (Head et al., 2011, p. 1091).

Although psychological studies have broadened the conceptualisation of risk (see Rohrmann, 1999; Slovic, 2000), and of motivations (see Barr and Gilg, 2007; Darton, 2008; Jackson, 2005), to include broader social, cultural and political factors, the quantitative, questionnaire-based research approaches most commonly used within these fields have "inherent limitations when it comes to capturing complex processes of social interaction" (Bickerstaff, 2004, p. 830; Hargreaves, 2012; Irwin et al., 1999). Given the significant amount of quantitative and psychological research on risk perceptions and motivations - and the discussion about the limitations of these approaches - it is recommended a mixed approach to such research should be taken in future. There is a substantial need for more and continued qualitative research (e.g., interviews, focus groups, workshops); participatory research (e.g., workshops, participatory action research (PAR) (see Kindon, et al., 2007), reference groups[31]); and collaborative inter/trans-disciplinary research[32] between social scientists, biophysical scientists, communities (e.g., farmers, growers and foresters, their families and local communities) and public, private and industry organisations (e.g., DairyNZ, Horticulture NZ, ZESPRI, Federated Farmers; New Zealand Forest Owners Association).

12.3 PRIORITY THEMES FOR FUTURE SOCIAL SCIENCE RESEARCH TO ACHIEVE BEHAVIOUR CHANGE IN THE LAND BASED SECTORS

The comprehensive review in the sections above identified a number of issues, key themes and research questions. There are six themes that appear to be important for future research in New Zealand:

1) Understanding the role of mental models, language and discourse on behaviour change e.g. shifting away from debates on the causes of 'climate change' to discourses around weather variability, and resilience and opportunities with sustainability.
2) More and on-going locally grounded studies to better understand adaptive capacities and vulnerabilities of farmers, growers and most urgently foresters at both the individual and sector level.
3) Better methodologies and theoretical approaches to capture the complex, and dynamic nature of 'everyday life' practices of farming, growers foresters and how these are affected by and can lead to social change.
4) More research on the role of networks and social capital in resilience and social change.
5) Specific research on Māori issues, needs and perspectives related to mitigation and adaption.
6) More research on effective communication and engagement programmes and on how collaborative engagement and dialogue can improve policy and achieve sustainability outcomes.

These themes have been noted in the development of the Outcomes and Objectives for the research Strategy, which are presented in the final chapter of this report.

[31] MfE already have a number of advisory, working groups and stakeholder groups in relation to climate change: Agricultural Technology Advisory Group, Research, Innovation and Technology Transfer Working Group, Business Opportunities Working Group, Adaptation Technology Working Group, The Peak Group (Stakeholders), Forestry Stakeholders Reference Group and Primary Growth Partnership (pastoral and arable production, horticulture, seafood, forestry and wood products, food processing).

[32] Similar approaches are being promoted by the Land Water Forum (2012). There is perhaps also scope to increase the involvement of existing research organisations within universities, in particular, ARGOS which is founded on this model.

As mentioned above, more attention should be given to qualitative, participatory and collaborative inter/trans-disciplinary approaches, projects and programmes. First, there is a need to better understand what the implications are of shifting debates away from the causes of climate change to dialogues around weather variability/climate variability (Head et al., 2011). As highlighted in this review there are a number of practices which farmers, growers and foresters have and will continue to employ in response to both climatic and non-climatic risks - even if they do not 'believe' in climate change per se. The beliefs that members of these sectors hold about climate change "is only partly relevant to the processes by which they mediate this complexity in their daily lives. Any strategies that aim to simply educate farmers about the 'facts' of climate change will likely miss the point and also risk undervaluing existing adaptive capacities" (Head et al., 2011, p. 1104). To what extent do current responses align with goals of climate change mitigation and adaptation? If they do not, what opportunities exist for ensuring they align better without entering into unproductive discussions about climate change? What scope is there for existing scientific knowledge about climate change to be translated into local level information required for decision-making? What are the implications of understanding of climate risk and vulnerability from this perspective? Does the notion weather/climatic variability sufficiently capture the uncertainties and unknowns associated with climate change (e.g., the likelihood of extreme and high impact events)?

Second, there is a growing literature both in New Zealand (e.g., Hennessy et al., 2007; Manning, et al., 2011; Nottage, et al., 2010) and internationally (see Parry, et al., 2007) around notions of adaptation, vulnerability and resilience. Much of this work has focused on developing generic lists and proxy indicators of vulnerability and adaptive capacity. Such approaches tend to be 'top-down' rather than 'bottom-up' and, therefore, do not necessarily understand "vulnerability from the perspective of the vulnerable" (Eakin, 2005, p. 1936). As Eakin (2005, p. 1934) and Head et al. (2011) have illustrated, lists and proxy indicators "alone are inadequate measures of [adaptive] capacity" as adaptation is highly context-dependent. In New Zealand, a few locally grounded studies (Cradock-Henry, 2011; Kenny, 2010; van den Dungen et al., 2011a, 2011b) have examined how multiple risks interact to render farmers and growers more or less vulnerable in particular places and at particular times. More and on-going research and engagement of this nature is required to better understand their adaptive capacities and vulnerabilities farmers, growers and foresters. In particular, to date there has been very little research undertaken on the forestry sector in New Zealand.

Third, there is a need to complement approaches which focus on linear accounts of behaviour change, with other methodologies and theoretical approaches which capture the complex, embodied, contextualised and dynamic nature of everyday life, practices of farming, growing and forestry and social change. The need to do so is clearly demonstrated by the ARGOS (Agricultural Research Group on Sustainability) project which is a longitudinal study of over 100 farms and orchards in New Zealand using different market audit systems. As the researchers observe: the "complex patterning of the ARGOS data can only be understood if the social practice of organic, integrated or (even more loosely) conventional production is understood as being co-produced by four dynamics: subjectivity/ identity, audit disciplines, industry cultures/structure and time" (Campbell, et al., 2012, p. 129). Such a reframing "opens up important new opportunities for understanding" the risks, opportunities and challenges of climatic variability and change (Campbell, et al., 2012, p. 129; Shove, 2010a, 2010b).

12.4 DOING NEW RESEARCH AND IMPLEMENTING WHAT WE ALREADY KNOW

One important issue that arose in the multi-stakeholder workshop was the need to act on the knowledge we already have, as well as seeking out new knowledge. This research strategy is a snapshot, as at 2012, of issues and priorities in the international and New Zealand literature on social science and climate change, with a focus on the land based sectors. It is worth noting the social research priorities that were recommended in a similar report for MPI [formerly MAF] twenty years ago (Fairweather, 1992). [33] This report called for research to address both the "description of technology change in both farming and allied industries, and the social impacts following changes in technology." The use of technology also had to be linked to farm structural changes and to rural community changes:

> …for example, biotechnology may lead to major changes in the character of production, and its application could be a telling example of the way farmers' control over their production process is changed. Off-farm technology changes such as with telephones and fax machines have impacts for rural dwellers. Also relevant are the political and economic processes by which agricultural technology is developed, applied and adapted by farmers. No longer adequate is the view that technology by itself impels innovation or that technology change is necessarily benign. Needed is careful analysis of who benefits from new technology (p.13).

Another issue was: "the impact of technology, or farming systems as a whole, on the physical environment, and an examination of who pays for environmental damage. An important issue for research is examination of all the environmental consequences of farming technology along with assessment of who benefits and who pays" (p.13). Fairweather also highlighted the need to understand "farmers' awareness of environmental issues in their day-to-day management." He noted that:

> while a general awareness of environmental problems may exist it does not mean that these are translated into on-farm practice. Further, it is well known that farmers often claim to have a steward role but we do not know if this embraces modem environmental issues, and whether they accept the significance of issues identified by urban people. At issue is farmers' willingness to change management in ways that are compatible with sustainable agriculture. Appropriate methods include surveys and in-depth studies of management practices (p.17).

A major issue for social research raised in the 1992 report was: "understanding the management decision making of those farmers who do not seek professional help. It appears that this group are motivated by unorthodox factors, and they appear to have different sources of information on which they are making decisions. Appropriate [social research] methods include focusing study on all types of farmers in ways that are sensitive to unorthodoxy" (p.17).

The question of who 'farmers' are was also raised:

[33] 'Topics for Rural Social Research' John R. Fairweather. Agribusiness and Economics Research Unit Discussion Paper No. 132. March, 1992 (Funded by MAF Policy Unit, Wellington, New Zealand).

> Given that farmers are a diverse group and that many are not traditional, full-time farmers, it is becoming relevant to consider who is the appropriate target of policy. If in some areas there is a large proportion of part-time farmers who collectively account for a significant proportion of total production or a significant proportion of land used, then it becomes necessary to formulate policy in ways that account for diversity. Appropriate methods include analysis of official data by way of defining the significant structural changes in all regions of New Zealand and using other techniques to better understand the non-traditional types of farmer. (p.17)

The report concluded that given the complexity of changes in New Zealand rural society it was "timely for MAF to consider an appropriate social research agenda. With the precedent set in other countries and current recognition given to the relevance of social research, MAF is already embarked on a new direction for policy formation (p.20- 21)

Reflecting a systemic approach, the report said research was needed at five levels: farm, rural community, international linkages, consumers – and also proposed an additional topic of "public perceptions and opinions", noting that 'knowledge of these subjects would be relevant to formulating effective policy aimed at fostering healthy rural communities (p.19).

Remarkably, all of these themes feature in the current review and remain priorities for the research agenda. One observation might be that there is an apparent lack of action to prioritise and implement the findings from such research. This raises a substantive research question in its own right: what enables the transfer of social science knowledge into policy and the integration of social research in the design of programmes and other social interventions?

Research questions:

What are 'best management practices' for reducing emissions in the land based sectors: how are these understood and used in New Zealand now?
How might 'best management practices' be evaluated and extended in the land based sectors?
How can social science research contribute to the design and uptake of 'best management practices'?
What is understood generally about the social dynamics of technology transfer, uptake, use and diffusion – and how might this knowledge be applied to innovation in the landbased sectors?
To what extent are actors in the land based sectors relying on technological fixes for climate mitigation, as opposed to adopting new farming practices and systems?
What are the drivers that lead to some farmers and foresters improving their practices whereas others do not?
How do farmers and foresters understand the nature of their farming activities and the impacts on the environment and climate change?
What mental models are used by different actors, and how do these lead to more or less adaptive and resilient behaviours?
What practices and technologies are being aimed at mitigation [reducing the causes of climate change] as opposed to adaptation [adjusting to change as it comes] and how do people in the land based sectors understand and operationalize those response strategies?

13. Conclusions and Recommendations for a New Zealand Social Research Strategy for Climate Change in the Land based Sectors

13. 1 OVERVIEW

Social research can be used to design, deliver and evaluate policy programmes and social interventions and to create more effective ways of changing individual and societal behaviours. At the same time, social science is also valuable because it can take a 'bird's eye view of the whole socio-ecological system, and ask higher order questions about the nature of the system and how it might change. A fundamental question to ask is "what are we changing *from* and what are we changing *to* and why?" Once that has been determined then there are applied questions about the transition required – how to get there, by when, what resources are needed and determining the key players.

This report suggests that there is a need to keep both the big picture and the detail coherently linked. As stated in the MfE BIM (2011) there is a need for a uniting vision and framework, not least because of the multiple interdependencies that cut across geographic (local, regional and global) and temporal scales. Additionally, the problem of climate change is a collective problem but one that is experienced very differently by people both within and between countries and regions, and the dynamic and uncertain nature of change will require different kinds of responses and different time frames for action. There has been, and will continue to be, an important focus on land use activities and the primary productive sector, not least because of continuing and increasing pressures on water and energy resources.

The need for on-going biophysical science is well recognised, but there is increasing awareness that understanding the political, social and cultural environment is also important if we are to weather what Gardiner (2006, p.397) refers to as "a perfect moral storm".

13.2 OUTCOMES AND OBJECTIVES FOR A NEW ZEALAND SOCIAL SCIENCE RESEARCH STRATEGY FOR CLIMATE CHANGE IN THE LAND BASED SECTORS

The RURALS project has identified a wide range of questions for social science research to investigate, in order to understand and inform New Zealand's response to climate change in the land based sectors. These questions have been listed throughout this report – see the green boxes.

Taking these questions into account – along with the literature reviews and the results of our stakeholder engagement workshops - we have developed a set of research outcome areas and research objectives for the Strategy, which we present below.

These outcome areas and objectives – along with the detailed research questions – have been combined in a full list for an on-line engagement tool developed for this project. This will enable an on-going discussion within the social science research community, and between researchers and the wider stakeholder community, on the important social science task ahead for New Zealand.

In reading the list below, it should be noted that the objectives are not organised in priority order, and work has already been undertaken in some areas (marked with asterisk [**]). Detailed engagement with stakeholders on specific research questions or hypotheses and relative priority is recommended.

Outcome areas

A. **Innovation, dissemination and up-take of practices** in New Zealand land based sectors that will mitigate and/or adapt to the effects of climate change.

Social Science Research Objectives

1. Develop **models and approaches for monitoring, evaluation and analysis** to support innovation and practice-change in land based sectors that mitigate and/or the effects of climate change. **
2. Identify **examples of 'good practice'** in land based sectors in mitigating or adapting to climate change: How are these understood in their sector? How might they seed practice-change more widely? **
3. Understand the economic, social and other **incentives for and constraints on practice-change** in land based sectors, and how this understanding might be translated into policies and practices. **
4. Understand the **nature and role of networks, knowledge sharing, tools and skills** at local, regional, sector and national levels in responding to climate change. **
5. Understand in relation to climate change in land based sectors the **mechanisms of and potential for innovation, practice-change and technology transfer**, at different scales.
6. Identify and understand **examples of effective stakeholder engagement** programmes relevant to engagement with stakeholders in land based sectors, including Māori. How can these be evaluated and extended for climate change mitigation and adaptation?
7. Identify examples of and opportunities for **self-organisation** in response to climate change in land based sectors.

B. **Market development** based on production practices in New Zealand land based sectors that mitigate the effects of climate change.

Social Science Research Objectives

1. Understand **consumer attitudes and behaviour** in relation to climate change and land based practices. **
2. Develop and test ways to **incentivise consumer behaviour** in relation to climate change and land based practices.
3. Understand and further develop **innovation pathways for alternative exports** that mitigate and/or adapt to climate change.
4. Develop and apply conceptual frameworks for **linking producers, retailers and consumers** as a whole system impacting on mitigation of and adaptation to climate change. **
5. Understand the international **social and consumer trends around food, food security and timber production**, and how such trends might impinge on New Zealand producers and the positioning of New Zealand as a producer economy. **

C. **Policy support** on New Zealand's strategic direction in relation to climate change and its implications for land based sectors.

Social Science Research Objectives

1. Develop **systemic frameworks** for evaluating interventions, and to show how policies and practices around climate change in the land based sectors are perceived by citizens and key markets; how they interact, reinforce or disrupt one another; and the possibility of unintended consequences. **
2. Demonstrate the **systemic relationship** between climate change policy in the land based sectors, and other government policies and practices, such as water, energy and land use.
3. Develop frameworks to understand the relationship between management of **immediate imperatives and commitment to longer term outcomes**.
4. Develop **methods to model complex adaptive systems** influencing response to climate change in land based sectors, as a support for policy development and decision-making.
5. Understand **what drives or constrains commitment** to policy action.
6. Understand the **role of framing and the role of scientific knowledge** in shaping policy.
7. Understand the **potential and limitations of policy interventions**, including regulatory and price based approaches to behaviour change in land based sectors.
8. Understand the trade-offs and tensions between **costs and benefits** of responding to climate change in land based sectors.

D. **Understanding the challenge of climate change** from multiple perspectives (e.g. Māori, co-benefits, ethical and justice perspectives, intra- and inter-generational responsibility, and responsibility for the commons) in order to support engagement.

Social Science Research Objectives

1. Understand the needs and implications of climate change policy on **Māori**, including mātauranga Māori in the land based sectors.**
2. Understand **Māori aspirations, opportunities, and understanding** of key concepts in relation to climate change. **
3. Understand **linkages between climate change and other social issues** (including national and global inequalities, food security issues, resilience and vulnerability), as it affects land based sectors.
4. Develop frameworks for understanding climate change in terms of **responsibility for a common resource** and collective responsibility in land based sectors.
5. Describe the dominant **ways in which climate change is understood and debated** in land based sectors, how producers understand the impact on the environment of their activities, and how these understandings might affect polices and practices.
6. Understand the implications of **demographic projections and scenarios** for climate change and responding to climate change in the land based sectors.
7. Understand the **contextual drivers of behaviour** in land based sectors that contribute to climate change.
8. Understand the **relative threats, opportunities and impacts** for different communities, and how people and institutions understand and respond to climate risks.

E. **Innovative approaches to decision-making, governance and participation** that span from national to local levels of governance and incorporate stakeholder and Māori perspectives.

Social Science Research Objectives

1. Evaluate and develop **models of collaborative governance and common commitment** applicable to responding to climate change in land based sectors.
2. Understand how decision-makers in land based sectors make **decisions under conditions of uncertainty**.
3. Understand any distinctive approaches to decision-making, governance and participation that are used in **Māori land based sectors**. How might these approaches be extended to support climate change mitigation and adaptation?
4. Understand how **different forms of knowledge**, local, Māori, and academic have access to and influence on decision-makers, and how knowledge can be made more accessible and useful.
5. Discover in what way **power relationships in socio-ecological systems** affect the development, implementation and evaluation of policy interventions on climate change in land based sectors; and develop approaches to represent vulnerable populations and socio-ecological systems in decision-making.
6. Develop a systemic understanding of actors, institutions and **factors influencing practices** and informing decision-making in the land based sectors.

F. Understand **factors that impact on resilience, adaptability and transformability**[34] in the land based sectors.

Social Science Research Objectives

1. Identify the variables that need to be measured to assess **resilience, adaptability and transformability** in land based sectors.
2. Understand **constraints on resilience, adaptability and transformability** in land based sectors.
3. Develop and test **monitoring and analytical methods** to demonstrate resilience, adaptability and transformability in the land based sectors.
4. Understand particular **impacts of climate change for Māori resilience**, adaptability and transformability, including impacts on culture, settlement patterns, health and financial prosperity.
5. Understanding particular **impacts of climate change for community resilience**, adaptability and transformability, including impacts on culture, settlement patterns, health and financial prosperity.
6. Understand the role of social and cultural identities in **how climate change is experienced**, and how people cope with and recover from its impacts.
7. Determine the effectiveness and potential enhancement of key elements in adaptive management in land based sectors: **communication, information and trust**. **

G. Effective approaches to **trans-disciplinary and participatory research methods** and policy formation that integrate the expertise of bio-physical and social scientists, Māori, policy development, and land based stakeholders.

Social Science Research Objectives

[34] "…resilience thinking focuses on three aspects of social–ecological systems (SES): resilience as persistence, adaptability and transformability" (Folke et al., 2010). Resilience is the tendency of a SES to essentially recover. Adaptability is the capacity of a SES to adjust. Transformability is the capacity to establish a new stable state. See too: Walker et al. (Walker, Holling, Carpenter, & Kinzig, 2004).

1. Develop and test **methods for involving land based sector practitioners** (e.g. farmers, foresters and businesses) in research and policy development. **
2. Identifying and articulating the **scope for social sciences** to contribute to climate change research in collaboration with other sciences. **
3. Improved understanding and application of **Māori knowledge of natural systems**, including mātauranga Māori and concepts such as kaitiakitanga, to support climate change mitigation and adaptation in land based sectors.
4. Understand **barriers to Māori access to expertise and knowledge** to support climate change mitigation and adaptation.
5. Develop approaches to mediate **different kinds of expertise** contributing to climate change policy development in land based sectors.

13.3 STRATEGY IMPLEMENTATION AND REVISION

For the Strategy to have its due influence, several ingredients are required:

- An institutional home or guardian of the strategy process.
- Sufficient funding designated for social science projects or social science components in wider projects.
- On-going collaboration between those commissioning and funding research, sector stakeholders and research providers to develop specific research questions, hypotheses and projects that realise the value of social science research.[35]

A staged implementation process is outlined below for central and local government, land based sectors, research funders and research providers in order to co-create the identified research outcomes:

1. MPI adopts the strategy and promotes it to stakeholders (policy, funding, land based sectors, research providers).
2. The Ministry for Business, Innovation and Employment (MBIE), MPI, Ministry for the Environment (MfE), Local Government New Zealand and the Royal Society of New Zealand (RSNZ) use the strategy as a key tool for shaping, commissioning, and assessing social science research on climate change in the land based sectors.
3. The Social Science and Humanities Committee of the Royal Society of New Zealand is invited to endorse the strategy. The RSNZ is invited to promote the Strategy to the New Zealand social science community working through the New Zealand Climate Change Centre (NZCCC). This promotion would include: a) a special session on social science at the major research conference being planned by NZCCC in 2013; and b) an annual stakeholder workshop, in collaboration with MPI and MBIE, to elucidate and prioritise the outcome areas and research objectives.
4. Further refinement and development of the research priorities can be achieved through an on-line tool developed with this Strategy, which enables stakeholders, including industry government and researchers, to interact with one another. This tool will need to be maintained as part of implementation of the strategy. It is proposed that the tool be hosted through the electronic social science hub, eSOCSCI Hui Rangahau Tahi.
5. The findings of the annual stakeholder workshops will supplement the on-line feedback to influence solicitation of and proposals for social science research on climate change in relation to New Zealand land based sectors.

[35] The framework proposed in the NSF Advisory Committee for Environmental Research and Education (Pfirman & the AC-ERE, 2003, p. 9) is useful It focuses on the framing of questions or problems for investigation, integration of research activity, meta-analysis to define the state of knowledge, and the availability of scientific data, models and conclusions.

6. Research consistent with the Strategy is commissioned, carried out and evaluated.
7. The Strategy is reviewed and revised on a three yearly cycle.

This Strategy reflects the issues and state of research at a moment in time. It will need regular evaluation and review in the light of changing policies, priorities, state of knowledge and methodological development. Collaborative review and revision processes on a three yearly cycle are recommended, initiated by the RSNZ working through the NZCCC and in partnership with MBIE, MfE and MPI.

A collaborative review and revision would involve five elements:

- An analysis of how the Strategy has been used and has influenced decision-making in commissioning, funding, proposing and evaluating social science research on climate change in New Zealand.
- Reference to relevant international research approaches, questions and findings.
- A survey of stakeholders (social science providers, policy and funding bodies, land based sector) inviting comment on what they have found most useful in the strategy, what gaps they have noticed, and what would make the strategy more fit for their purposes.
- A multi-stakeholder workshop to identify and prioritise research areas and topics.
- An opportunity for feedback on the emergent themes and draft revised strategy.

13.4 LOOKING FORWARD

Social science research can help optimise responses to climate change in the land based sectors by improving our understanding of personal and social drivers, practices, opportunities and impacts. This research strategy provides guidance on social science research to achieve the Sustainable Land Management and Climate Change Plan of Action aims, to:

- enhance and support adaptation to climate change,
- reduce agricultural greenhouse gases,
- encourage the establishment of forest sinks and the management of deforestation, and
- capitalise on new business opportunities arising from the world's response to climate change.

The Strategy includes an outline of the potential contribution of social science, a distillation of critical objectives that social science needs to help address, and a proposal of how to implement and revise the strategy to ensure best outcomes.

Ultimately, the value of the Strategy will depend not on the authority of its contents but on its usability and use by those making decisions about seeking or providing knowledge through research to support New Zealand responses to climate change in the land based sectors. From use will come thought and dialogue that will define and refine the questions, methods and applications that will constitute the social science contribution to New Zealand.

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Appendix 1

SLMACC RESEARCH PROGRAMME GOALS

- The land-based sectors are economically, environmentally and socially sustainable and continue to improve productivity and the efficient use of natural resources.

- The land-based sectors understand and are able to manage the economic implications arising from climate change.

- The sectors are positioned to take advantage of the economic opportunities arising from climate change and an increased demand for lower carbon products and services (e.g. carbon farming, longer growing seasons, life cycle analysis, etc).

- The sectors and their communities have the necessary information and technology available to successfully prepare for and adapt to a changing climate.

- New Zealand is a recognised world leader in the development of practical technologies and management practices for farmers to measure and reduce agriculture emissions.

- New Zealand is well placed to negotiate appropriate outcomes for the landbased sectors for the post 2012 commitment period.

- The sectors are internationally competitive and land use flexibility is maintained, taking into account the environmental costs of land use decisions.

- Forestry is fully integrated into land use decisions to help deliver sustainable land management outcomes.

- Forests and forest products are widely used in adapting to and reducing the impacts of climate change.

Appendix 2

FROM THE REQUEST FOR PROPOSAL

Purpose and scope of SLMACC

Sustainable Land Management and Climate Change (SLMACC)

Scope

Investments in SLMACC will:

- enhance and support adaptation to climate change
- reduce agricultural greenhouse gases
- encourage the establishment of forest sinks and the management of deforestation
- capitalise on new business opportunities arising from the world's response to climate change.

Purpose

- Targeted-basic and applied research includes impacts of climate change and adaptation to climate change, mitigation of agricultural and forestry greenhouse gas emissions and cross-cutting issues, including economic analysis, life-cycle analysis, farm, catchment and systems analysis and social impacts.
- Policy research to address targeted policy questions is also requested.

Note: National Greenhouse Gas Inventory research is not included

Target outcomes and themes

Proposals for research funding should demonstrate close working relationships with potential end-users responsible for the development of resilience to greenhouse gas emissions (GHG), climate change and associated hazards, to:

- improve understanding of climate change mitigation and adaptation products and practices and business opportunities among policy and decision makers and Māori across central and local government.
- provide timely information necessary for central and local government, policy and decision makers and Māori to respond to adaptation, mitigation and business opportunities.

Theme 3.4: Cross-cutting issues, including economic analysis, life-cycle analysis, farm catchment systems analysis and social impact.

- Economic analysis of mitigation impacts and adaptation measures at farm/forest, national and international scales; carbon markets
- Social science - impacts of climate change and climate change policies on rural communities; interdisciplinary social research.
- Systems analysis at farm/forest level

Theme Research Priority

Develop a social science research strategy for climate change in the land based sectors that addresses:

- the drivers of change including effective communication to increase uptake and ensure investment is well targeted
- how farmers, growers and foresters understand the risks of climate change and how they are motivated to take action;
- the barriers to change or opportunities for behaviour change at the ground/farm level
- the design, implementation and evaluation of climate change programmes and activities at a farm/ground (production system) level and a national level;
- the design and use of systems approaches that encompass production, Maori, sectors, local and central government elements, as well as education, research, science (physical and social) and technology transfer.

Appendix 3

RURALS PROJECT TEAM AND REVIEWERS

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Appendix 4

SECTORS OF INTEREST

1. **Policy:**

MBIE - Science and Innovation
Ministry of Primary Industries
Ministry for the Environment
Treasury
Ministry of Social Development
Department of Conservation
Te Puni Kōkiri
Local Government (particularly Regional Councils)
Iwi authorities

2. **Focal sectors, communities and actors**

Farm owners
Farming organisations
Rural community organisations
Rural businesses
Finance and insurance
Forestry organisations
Iwi authorities
Māori farming and forestry organisations

3. **Funders and commissioners of research**

MBIE - Science and Innovation
Ministry for the Environment
Marsden Fund
HRC
Industry bodies
CRIs
Universities
Local Government (particularly Regional Councils)
Iwi authorities

4. **Providers of research**

Crown Research Institutes
Universities
Private consultants and research organisations

Appendix 5

SOCIAL SCIENCE RESEARCH QUESTIONS AS IDENTIFIED BY IPCC

[from Reisinger, A. (2010)]

Adaptation

14. Adaptation needs and options
    - Synthesis of adaptation needs and options
    - International, national, and sectoral assessments, including National Adaptation Programmes of Action (NAPAs)
    - Measuring adaptation
    - Addressing maladaptation

15. Adaptation planning and implementation
    - Local, national, regional, and global strategies, policies, and initiatives
    - Technology development, transfer, and diffusion
    - Financing for adaptation
    - Insurance and social protection
    - Knowledge sharing, learning, and capacity building
    - Institutional arrangements: public- and private-sector stakeholders and priorities
    - Links between adaptation and development
    - Decision support tools and methods
    - Adaptation status and indicators

16. Adaptation opportunities, constraints, and limits
    - Cross-sectoral synthesis
    - Limits to adaptation, including ethical dimensions and resources
    - Interactions among limits
    - Effects of alternative mitigation pathways on adaptation
    - Ancillary social and ecological effects of adaptation

17. Economics of adaptation
    - Adaptation costs and benefits at global, national, sectoral, and local levels
    - Inter-relationships between adaptation costs and residual damage
    - Economic instruments to provide incentives
    - Using market-based approaches for adaptation decisionmaking
    - Ancillary economic effects

20. Climate-resilient pathways: adaptation, mitigation, and sustainable development
    - Multi-metric valuation
    - Ecosystem services and biodiversity threats
    - Consumption patterns, lifestyles, behavior, culture, education, and awareness
    - Human well-being
    - Adaptation, mitigation, and sustainable development, including tradeoffs and cobenefits

III. PATHWAYS FOR MITIGATING CLIMATE CHANGE

5. **Drivers, Trends and Mitigation**

- Global trends in stocks and flows of greenhouse gases and short-lived species
- Key drivers of global change
- Production, consumption and trade patterns
- Contribution of technological change to mitigation
- Contribution of behavioural change to mitigation
- Co-benefits and tradeoffs of mitigation including air pollution
- Carbon and radiation management and other geoengineering options including environmental risks
- The system perspective: linking sectors, technologies and consumption patterns
- Frequently asked questions

6. **Assessing Transformation Pathways**

- Tools of analysis
- Climate stabilization: Concepts, costs and implications for the macroeconomy, sectors and technology portfolios, taking into account differences across regions
- Integrating long- and short-term perspectives
- Integrating technological and societal change
- Sustainable development and transformation pathways, taking into account differences across regions
- Risks of transformation pathways
- Integrating sector analyses and transformation scenarios
- Frequently asked questions

Appendix 6

SLMACC CLIMATE CHANGE PROGRAMMES AND RESEARCH PROJECTS IN NZ

Organisation	Finish Date	Subject Area	Report Title
EcoClimate Consortium	30 April 2008	Climate change and agricultural production	Costs and Benefits of Climate Change and Adaptation to Climate Change in New Zealand Agriculture: What Do We Know so Far?
AgResearch	30 June 2008	Improved field facilities to study climate change impacts and adaptations in pasture	Improved Field Facilities to Study Climate Change Impacts and Adaptations in Pasture
AgResearch	30 June 2008	Enhanced modelling capability to conduct impact assessments	Enhanced modelling capability to conduct climate change impact assessments
Aqualinc Research Ltd	30 June 2008	Adaptation vulnerability and impacts of climate change on NZ's pastoral systems	Projected Effects of Climate Change on Water Supply Reliability in Mid-Canterbury
Auckland UniServices Ltd	30 June 2008	Vulnerability of NZ pastoral farming to the impacts of future climate change and the soil water regime	Vulnerability of New Zealand pastoral farming to the impacts of future climate change on the soil water regime
Crop and Food Research	30 June 2008	Forage crop opportunities as a result of climate change	Forage crop opportunities as a result of climate change
Earthwise Consulting Limited	30 June 2008	Adaptation - developing case studies in the Kiwifruit Industry	Adapting to climate change in the kiwifruit industry
NIWA	30 June 2008	Impact of climate change on drought and agricultural production	Drought, Agricultural Production and Climate Change – A Way Forward to a Better Understanding
Landcare Research	30 June 2008	Climate change risks to pastoral production systems	Climate change risks to pastoral production systems
Scion	30 June 2008	The effect of climate change on New Zealand's planted forests	The effect of climate change on New Zealand's planted forests. Impacts, risks and opportunities
Scion	31 December 2009	Climate change and fire danger	Improved estimates of the effect of climate change on NZ fire danger
NIWA	March 2009	Frost	Recent frost trends for New Zealand
NIWA	March 2009	Frost	Recent trends in frost in New Zealand

			(a summary of the research report listed on the row above)
NIWA	31 December 2009	Impacts of climate change on soil conditions, river flow and floods	Flood risk under climate change
NIWA	31 December 2009	Climate change and extreme winds	
NIWA	31 December 2009	Climate change and drought risk	
AgResearch	31 December 2009	Climate change and pasture performance	Improving Sustainable Life-time Performance of Pastures: Learning from Extreme Climatic Events
AgResearch	31 December 2009	Subtropical boundaries under climate change	Tomorrow's pastures: subtropical grass growth under climate change
Scion	31 December 2009	Future proofing plantation forests from pests	Factsheet: The threat to New Zealands plantation forests from four pests under a changing climate
MWH	30 June 2010	Climate change on rural water infrastructure	Impacts of Climate Change on Rural Water Infrastructure
MWH	30 June 2010	Climate change on rural water infrastructure	Climate Change Impacts on Rural Water Infrastructure (a summary of the research report listed on the row above
AgResearch	30 June 2010	Climate change and biocontrol	Possible impacts of climate change on biocontrol systems in New Zealand
AgResearch	30 June 2010	Climate change and biocontrol	Climate change and biocontrol systems (a summary of the research report listed on the row above)
GNS	30 June 2010	Climate impacts on hydrological systems	Framework for assessment of climate impacts on New Zealand's hydrological systems
Landcare Research	30 June 2010	Planet to paddocks land-use trends: Impacts of climate change	
AgResearch	30 June 2011	Elevated CO2 and productivity due to climate change	
Landcare Research	30 June 2011	Farm adaptive capacity and finance	
Landcare Research	30 June 2012	Catchment analysis of climate change	

NIWA	30 June 2012	Climate change impacts and adaptation analysis for New Zealand's primary sector	

FORESTRY AND CARBON MARKETS

Organisation	Finish Date	Subject Area	Report Title
URS New Zealand Ltd	30 June 2007	Voluntary greenhouse gas reporting feasibility study	Voluntary Greenhouse Gas Reporting Feasibility Study
NZ Institute for the Study of Competition and Regulation	30 June 2008	Forest and forest land valuation	Forest and Forest land valuation: How to value forests and forest land to include carbon costs and benefits
Scion	30 June 2008	The effect of climate change on New Zealand's planted forests	The effect of climate change on New Zealand's planted forests. Impacts, risks and opportunities
Scion	30 June 2008	Life Cycle Assessment (LCA): adopting and/or adapting overseas LCA data and methodologies for building materials in New Zealand	Life Cycle Assessment Adopting and adapting overseas LCA data and methodologies for building materials in New Zealand
Scion	30 June 2008	Forest management for carbon and carbon price risk	Managing New Zealand planted forests for carbon a review of selected management scenarios and identification of knowledge gaps
University of Canterbury	30 June 2008	Carbon trading and forestry decision-making, carbon accounting and forest growth rates	Impact of the ETS on Forest Management
University of Canterbury	30 June 2008	Carbon trading and forestry decision-making, carbon accounting and forest growth rates	Forestry Accounting Options
University of Canterbury	30 June 2008	Carbon trading and forestry decision-making, carbon accounting and forest growth rates	Carbon Accounting: Forest Growth Rates and Changing Climates
URS New Zealand Ltd	30 June 2008	Forest risk management strategies - how can forest owners manage risk and uncertainty associated with carbon prices?	Carbon Risk Management Strategies for Forest Owners in New Zealand
University of Otago	30 June 2008	Voluntary carbon markets - analysis of risks and opportunities: Investigating the social dynamics of emissions trading scenarios	New Zealand Pastoral Farmers and the Mitigation of Greenhouse Gases in the Agricultural Sector

		in NZ's pastoral sector	
The Karo Group Ltd	30 June 2008	Identification and analysis of voluntary carbon market opportunities for the NZ agriculture and forestry sectors	Final Report on the Study on Global Voluntary Carbon Market Opportunities for New Zealand Agriculture and Forestry
University of Canterbury	31 December 2009	Managing risks in carbon forestry	Quantification and Management of the Risk of Wind Damage to New Zealand's Planted Forests
Scion	31 December 2009	Future proofing plantation forests from pests	Future proofing plantation forests from pests
Scion	31 December 2009	Future proofing plantation forests from pests	The threat to New Zealand's plantation forests from four pests under a changing climate (a summary of the research report listed on the row above)
Scion	31 December 2009	Improving the Eucalyptus fastigata growth model	Eucalyptus fastigata carbon sequestration web tool
Scion	31 December 2009	Improving the Eucalyptus fastigata growth model	Development of a carbon sequestration web tool for Eucalyptus fastigata
Scion	31 December 2009	Improving the Eucalyptus fastigata growth model	Above- and below-ground carbon in Eucalyptus fastigata in the Central North Island of New Zealand
Scion	31 December 2009	Reducing harvesting costs	
Landcare Research	30 June 2010	Development of forest productivity surfaces	Productivity surfaces for Pinus radiata and a range of indigenous forest species under current climatic conditions, and exploration of the effect of future climatic changes on Pinus radiata productivity
Scion	30 June 2011	Land use tools	
Scion	30 June 2011	Douglas-fir model enhancement for carbon	
University of Canterbury	30 June 2012	Forestry systems for difficult sites	
Scion	30 June 2012	Future forest systems	
Scion	30 June 2013	Resilient new indigenous forests	

ADDRESSING GREENHOUSE GASES FROM AGRICULTURE

Organisation	Finish Date	Subject Area	Report Title
Bruce D White Consulting Limited	30 June 2006	Climate change policy measures to address agriculture sector GHG emissions	Climate Change Policy Measures to address Agriculture Sector GHG Emissions
Agresearch /PGGRC	30 June 2008	Fermentation systems for rapid and accurate modelling of rumen function	A fermentation system for rapid and accurate modelling of rumen function
AgResearch	30 June 2008	Manipulating rumen fermentation for lower methane emissions	Developing better methods for culturing rumen bacteria: A Summary Report.
Agresearch/ PGGRC	30 June 2008	Ruminant methane-extension of the animal calorimetry facility at AgResearch Grasslands	Ruminant methane – Extension of the animal calorimetry facility at AgResearch Grasslands
AgResearch	30 June 2008	Rapid assessment of nitrous oxide	Rapid Assessment of Nitrous Oxide
Agresearch/ PGGRC	30 June 2008	Assessing the role of dietary carbohydrate to protein ratios on greenhouse gas emissions from pastoral agriculture	Assessing the role of dietary carbohydrate to protein ratios on GHG emissions from pastoral agriculture
AgResearch	30 June 2008	Development of a urine sensor to measure urinary nitrogen concentrations in situ	Urine sensor development project for MAFpol
AgResearch	30 June 2008	Quantifying the variability of the effectiveness of nitrification inhibitors on nitrous oxide emissions	Quantifying the Variability of the Effectiveness of Nitrification Inhibitors on N2O emissions (P21 lysimeter trial)
Diffuse Sources Ltd	30 June 2008	Significance of wetlands in the agricultural landscape as sources of nitrous oxide emissions	Significance of wetlands in the agricultural landscape as sources of nitrous oxide emissions. A review and synthesis of hypotheses
Landcare Research	30 June 2008	Soil Methanotrophy-A Novel methane mitigation Technology	Soil Methanotrophy-A Novel methane mitigation Technology?
Lincoln University	28 August 2008	Nitrous oxide-novel mitigation methodologies	Nitrous Oxide-Novel Mitigation Methodologies: Objective 1 - Hippuric Acid effects on N2O emissions.
Lincoln University	28 August 2008	Nitrous oxide-novel mitigation methodologies	Nitrous Oxide-Novel Mitigation Methodologies: Objective 2 - Biochar effects on urinary-N N2O emissions.
Lincoln University	30 June 2008	Alternative methods of direct rumen methane assessment	Novel methane assessment in ruminants

Lincoln University	30 June 2008	Diagnostic tests for greenhouse gas production	Diagnostic Tests For Greenhouse Gas Production
MWH New Zealand Ltd	30 June 2008	Methane from animal waste management systems	Methane from Animal Waste Management Systems
NIWA	30 June 2008	Agricultural mitigation rapid assessment of methane and nitrous oxide	Agricultural greenhouse mitigation - methods for rapid assessment of methane and nitrous Oxide
On-Farm Research Ltd	30 June 2008	Improving the sheep component of the methane model and provide management strategies for farmers to reduce methane production	Modelling management change on production efficiency and methane output within a sheep flock
AgResearch	31 December 2009	Plant canopy nitrous oxide emissions	Plant canopy nitrous oxide emissions
AgResearch	31 December 2009	Forage/fungal associations for reducing methanogenesis	Forage-fungal associations and effects on methanogenesis
Massey University	30 June 2010	Can cattle do it?: Agriculture: mitigation potential of new or alternative technologies	Assessment of the influence of biochar on rumen fermentation: A laboratory-scale experiment
Landcare Research	30 June 2011	Ammonia from animal excreta	
Landcare Research	30 June 2011	Mitigation technologies for methane	
Dairy NZ	30 June 2011	GHG mitigation using efficient cows	
NIWA	30 June 2011	Paddock to regional GHG management and mitigation of N2O emission	
PGGRC	30 June 2011	Enteric methane mitigation	
PGGRC	30 June 2011	Accelerated ruminant methane mitigation	
Lincoln University	30 June 2011	Negative N2O fluxes - importance to New Zealand	
AgResearch	30 June 2012	Identifying non agricultural and agricultural plant species with anti-methanogenic properties	
AgResearch	30 June 2012	Farm management and GHG for pastoral sector	
PFR	30 June 2012	Closed-loop N-supply biofuel crops	
PGGRC	30 June	Sheep, cattle, and methane	

	2012	predictors: Agriculture: identifying and exploiting genetic variation of GHG emissions	

SOIL CARBON AND BIOCHAR

Organisation	Finish Date	Subject Area	Report Title
Landcare Research	30 June 2008	Carbon stocks and change in NZ's soils and forests, and the implications of post-2012 accounting options for land based emissions offsets and mitigation opportunities	Carbon Stocks and Changes in New Zealand's Soils and Forests, and Implications of Post-2012 Accounting Options for Land based Emissions Offsets and Mitigation Opportunities
Landcare Research	31 December 2009	Review of soil carbon methodologies	Review of soil carbon measurement methodologies and technologies, including nature and intensity of sampling, their uncertainties and costs
AgResearch	31 December 2009	Modelling pastoral soil carbon	Modelling pastoral soil carbon
Lincoln University	30 June 2010	Biochar in grazed pasture systems	
Landcare Research	30 June 2013	Soil carbon stocks and changes	
Massey University	30 June 2013	Soil carbon sink enhancement	

LIVING WITH CLIMATE CHANGE (ECONOMIC AND SOCIAL ISSUES)

Organisation	Finish Date	Subject Area	Report Title
Auckland UniServices Ltd	30 June 2008	Information, decision and action: the factors that determine farmers' environmental behaviour	Information, Decision and Action The Factors that Determine Farmers Environmental Decision-making
AgResearch	30 June 2008	Learning from past adaptation to extreme climatic events: a case study of drought	Learning from past adaptations to extreme climatic events: A case study of drought. Part A: Summary Report
AgResearch	30 June 2008	Learning from past adaptation to extreme climatic events: a case study of drought	Learning from past adaptations to extreme climatic events: Part B: Literature Review
AgResearch	30 June 2008	Learning from past adaptation to extreme climatic events: a case study of drought	Learning from past adaptations to extreme climatic events: A case study of drought Part C: Main Report
AgResearch	30 June	Learning from past adaptation	adapting to a changing climate:

	2008	to extreme climatic events: a case study of drought	Case Study 2: Drought Learning from the past
Nimmo-Bell and Company Ltd	30-Jun-2008	Bridging the gap between environmental knowledge and Research, and desired outcomes to achieve sustainable land management -Phase 3	Bridging the gap between environmental knowledge and research, and desired environmental outcomes to achieve sustainable land management. Phase three.
Lincoln University	31 December 2009	Climate change and international trade	
Landcare Research	30 June 2010	Climate change and Maori land: business opportunities as it affects Maori owned land.	Climate change business opportunities for Maori land and Maori organisations
Viclink - Victoria University	30 June 2011	Implications of alternative GHG metrics - global warming potential and global temperature potential	
MOTU	30 June 2012	Coordination and cooperation: Economic and systems analysis of climate change impacts and adaptation measures	
Landcare Research	30 June 2013	Integrated global environment and economic trade assessment modelling	