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Farm planning for a sustainable future.

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2018 Nuffield Scholar

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He maungārongo ki te whenua
He whakaaro pai ki ngā tāngata katoa
Hangā e te Atua he ngākau hou
Ki roto, ki tēnā, ki tēnā o mātou
Whakatōngia to wairua tapu
Hei awhina, hei tohutohu i a mātou
Hei ako hoki i ngā mahi mō tēnei rā
Amine

Upon receiving my Nuffield scholarship I was told that this would be a life-changing experience. This has proved to be true – providing so much in many ways which are hard to describe. I am particularly grateful to Nuffield New Zealand and partners for the support and confidence placed in me and I look forward to building on these relationships into the future.

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To my whanau – especially my wife Jessie, our children Ezra, Micah and Sarai, as well as my parents Rob and Robyn; thank you for your patience and support through what has been an incredible, challenging and hugely inspiring year for us all.

I am also especially grateful to my employer Ravensdown for all the support and encouragement – without which none of this would be possible.

Disclaimer

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Executive Summary

New Zealand farmers are being confronted by the need to improve multiple environmental outcomes while still returning a profit. How the primary sector continues to evolve to deliver sustainable returns for farmers responding to increasing environmental pressures, is one of the defining challenges of our time and the focus of this Nuffield research.

The purpose of this study was to investigate tools to facilitate optimisation of farm systems and improve sustainable outcomes in New Zealand agriculture.

The main recommendations to come from this study include:

1. **Farm Environmental Planning should be prioritised, appropriately resourced and supported as a primary means to drive sustainable outcomes in New Zealand agriculture. Critical to this are a number of enabling components:**

    a. Farm Environment Plans (FEPs) should seek holistic objectives – considering environmental, economic as well as social and cultural aspects. Within this, environmental considerations should be broader than often articulated, considering traditional aspects relating to water quality and soil conservation, as well as indigenous biodiversity, ecosystem services and greenhouse gas emissions at farm and catchment scale.
    b. Investment from industry as well as regional and central government should be aligned to aid in the design, delivery and implementation of FEPs and farmer support via targeted environmental stewardship incentives should be explored.
    c. To encourage innovation and farmer aspiration, FEPs should be enabled outside of regulation, with processors (e.g. meat, wool, milk companies) and industry bodies taking a leading role as well as providing a link to market and the consumer.
    d. Farmers should be linked with trusted advisors who are able to provide ongoing, tailored and farm specific advice prioritising long term outcomes and farmer investments as part of the FEP.

2. **Sustainable Management Practices (SMPs) should be promoted and supported to help provide farmers with clarity regarding on-farm management.**

    a. SMPs should be developed in collaboration with a wide group of stakeholders (e.g. farmers, industry, regional councils, government, iwi and environmental NGOs) where possible to ensure wide support and collective buy-in.
    b. Implementation guidelines for SMPs should recognise the dynamic and varied New Zealand farming context.

3. **Climate Smart Agriculture should be socialised by the New Zealand agricultural industry as a valuable component of farm environmental planning – prioritising the 'triple win' of increasing productivity, enhancing resilience to the effects of climate, as well as reducing greenhouse gas emissions.**

4. **New Zealand farmers should be supported by relevant industry groups to have access to appropriate farm systems modelling tools and specialist support to inform land use and land management decision making.**

    a. Farm systems modelling informed by robust science should be recognised as a critical component of farm environment planning. Farm systems modelling targeting holistic and sustainable outcomes can help guide farm environmental planning and inform critical decision making with regards to land use suitability and farm design.

5. **Effective farmer extension at both farm and catchment scale to enhance farm sustainability and ensure effective uptake of relevant technologies should be prioritised by the New Zealand government.**

    a. Government investment into the agricultural sector needs to go beyond traditional research and development (R&D), and prioritise effective extension and farmer support (research, development and extension – RD&E). Comprehensive extension will be critical to enable sustainable management practices at both farm and catchment scale.

The future of New Zealand farming is laced with both challenge and opportunity; however, sustainable agriculture is not some far off, unattainable goal. To truly optimise farm systems in New Zealand, we must take a holistic approach, utilising a range of enabling tools to help farmers make informed decisions regarding both land use and management practice.

Scholar bio

I look back with fondness to my early years growing up in the small rural community of Little River, Banks Peninsula. I was raised on a small sheep and beef farm which has no doubt helped to shape much of who I am today and the values I hold dear. That is where my brother and I learnt from a young age exactly where our food came from – whether it was red meat, fish, vegetables or fruit, and how important our relationship with our environment was to enable this. And so from the early days I have always had a passion for both working and caring for our land – the whenua.

Tertiary studies first took me to Massey University in Palmerston North where I pursued a Batchelor of Science with a double major in Agricultural Science and Ecology which built on two fundamental interests in my life – producing food as well as care for our natural environment. From there I continued my studies at Lincoln University where I completed a Master of Applied Science in International Rural Development, as well as a Graduate Certificate in Antarctic Studies at Canterbury University. Summer work at that time involved practical roles on arable and dairy farms throughout Canterbury and proved to be a great opportunity to learn and develop new skills as well as broaden my perspectives of our diverse agricultural sector.

My working career has been just as varied as my studies, including roles facilitating Farmer Field Schools in the Solomon Islands, through to crop protection R&D, and environmental extension with sheep and beef farmers throughout the South Island. I am currently employed by Ravensdown where I work as Senior Farm Environmental Consultant in a rapidly growing environmental consultancy.

All of which brings me to where I am today as a New Zealand Nuffield scholar. I hope you enjoy reading my report and that it offers some insights of benefit towards your own journey.

"Ko te pae tawhiti whai kia tata ko te pae tata whakamaua kia tina."
Seek out the distant horizons, cherish those you attain.

Introduction

The roots of agriculture run deep in Aotearoa - New Zealand, with farming having long been the backbone of the country's economy and a significant part of both the cultural and aesthetic landscape. However, agriculture is increasingly coming under pressure to meet demands for improved environmental performance, sustainability of practices, and accountability for the traceability, quality and safety of its products (Ancev et al., 2005). For agriculture to remain viable, the natural resources on which it is based need to be maintained. It needs to be environmentally sustainable to "maintain and enhance the natural capital on which farming depends as well as other ecosystems influenced by farming" (Parliamentary Commissioner for the Environment, 2004).

Sustainable agriculture has been described in a variety of ways but in essence, its goal can be described as meeting society's food and textile needs in the present, without compromising the ability of future generations to meet their own needs (Brodt et al., 2011).

Everyone involved in the food system, including growers, food processors, distributors, retailers, consumers, and waste managers, has a role in ensuring a sustainable agricultural system which enables a healthy environment, economic profitability, as well as social and cultural equity[1].

Farmers have always balanced physical, commercial and environmental factors in their farm management practices (Lemon & Park, 1993). However there is often a conflict between increasing economic returns and managing natural resources sustainably (Herzon & Mikk, 2005), and proof of sustainability is what New Zealand seeks of its farmers. This last point was described well by chairwoman of the New Zealand Farm Environment Trust, Joanne van Polanen in an article published in 2018:

"Sustainability is no longer just a fashionable term bandied about for social validation. Brought into sharp focus by a population of consumers shaped by the nature of their time, it is an expectation. Kiwi farmers increasingly understand this and are seeing opportunities to retain their social licence through sustainable food and fibre production. They can see that New Zealand's future depends on it and are committing to a raft of actions to demonstrate accountability and grow trust."[2]

Recent years have seen a proliferation of tools, techniques and approaches to facilitate sustainable management in agriculture. However, despite the variety of tools available, evidence suggests that relatively few are being widely used and questions are being asked by farmers and other stakeholders about the effectiveness of such tools (EIP-AGRI, 2017). This seems therefore to be a topic worthy of discussion and further investigation with a view to improving understanding and good practice.

The purpose of this study was to investigate tools to facilitate holistic optimisation of farm systems to improve sustainable outcomes in New Zealand agriculture, and involved semi-structured interviews and discussions with a range of individuals including farmers, research organisations, private industry and the public sector over a period of 12 months. Main topics and messaging from these interviews have been collated and grouped to identify key themes which are presented in this report.

[1] https://asi.ucdavis.edu/programs/ucsarep/about/what-is-sustainable-agriculture
[2] https://www.odt.co.nz/opinion/proof-sustainability-what-nz-seeks-its-farmers

Farm Environmental Planning

"Preparation of environmental farm plans can be achieved at all farm scales, and provide the basis for identifying priorities for capacity building in sustainable management practices. Indeed preparation of environmental farm plans could become an important element in advancing sustainable production intensification"[3].

This section seeks to introduce the concept of Farm Environmental Planning and explore international examples to consider what potential learnings there might be, if any, for the New Zealand agricultural sector.

Forms of Farm Environment Plans (FEPs) have, since the 1940's, assisted New Zealand farmers and the councils in catchment management (Blaschke & Ngapo, 2003). Soil conservation programmes dominated early environmental farm plans; however, since the early 1990's, these farm plans have expanded to address a growing range of farm improvements in addition to soil conservation (e.g. water quality, waste, biodiversity, animal welfare, riparian zones, etc).

Farm environmental planning is essentially a mechanism to help identify and document actions and timeframes to achieve a range of desired outcomes. The FEP should provide an assessment of the farms underlying physical resources and help describe a strategic vision and road-map to optimise production in a sustainable manner.

The FEP is farm specific and developed to help farmers increase their understanding of their property and assist with decision making tailored to their specific farm system. Lyttle (2018) describes farm environmental planning as, 'an essential management tool for farmers who need to better manage their contaminant losses, maintain or enhance indigenous biodiversity and cultural values of the environment and to improve water use efficiency'.

Approaches to farm environmental planning vary but typically include two key parts:

- **Risk Assessment** – an assessment of farm management activities and any associated risks to natural resources and the receiving environment.

- **Action Plan** – a description of actions and planned mitigations that will be taken on-farm to address on-farm environmental risks.

In many situations farm environmental planning is supported as a voluntary mechanism to assist farmers in improving sustainable farming practices and pursue sustainable outcomes. However, particularly more recently, farm environmental planning has started to become regulated with many regional councils around New Zealand now requiring farmers to engage in farm planning to comply with regional rules. Within this regulated approach farmers are often also having to engage in a more structured FEP audit process which effectively measures actions and farming practise against regional and national rules and industry agreed Good Management Practices (GMPs).

The following sections include three case studies which explore different international examples of Farm Environmental Planning before considering relevant key learnings and observations.

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3 http://www.fao.org/fileadmin/templates/agphome/scpi/SCPI_Compendium/SCPISustainabilityTools.pdf

Figure 1: Location of the three Farm Environmental Planning case studies: Alberta, Canada; New York State, USA; Victoria, Australia.

Case study 1: Environmental Farm Plan – Alberta, Canada

Figure 2: Headline imagery from the Alberta EFP website – www.albertaefp.com.

The Alberta Environmental Farm Plan (EFP) programme is a voluntary scheme delivered by the Agricultural Research and Extension Council of Alberta (ARECA) on behalf of the Government of Alberta. ARECA is a provincial association of non-profit producer groups dedicated to enhancing the stability and profitability of agriculture in Alberta[4].

An Environmental Farm Plan steering committee initiated the Alberta EFP initiative in 2000 – 2002 with the first workshops offered in February 2003. Through to 2009, delivery of an EFP program was made possible through the Agricultural Policy Framework and the partnership of the Alberta Environmental Farm Plan (AEFP) Company with the governments of Canada and Alberta. Alberta Agriculture and Forestry (AF); formerly Alberta Agriculture and Rural Development, became the contact for EFP in 2010 and, in partnership with participating municipalities and Applied Research Associations, provides EFP-related services to producers. AF also works in partnership with Agricultural Service Boards, Agriculture and Agri-Food Canada, and various other agricultural groups and organizations.

Farmers are provided with technical assistance and guidance to assess their current environmental risk in a workshop, and is completed via an online EFP tool which also includes a range of other resources and support material.

A major incentive for farmers to engage in the Alberta EFP programme is potential access to funding from within the Environmental Stewardship and Climate Change – Producer program. This Program helps producers implement projects and management practices that reduce negative environmental impacts and enhance sustainable production[5]. Funding is available in three categories as outlined below:

Category A: Grazing Management.
(If approved, these are covered at a 30%, 50%, or 70% cost share).

- Activity Code 101 – Riparian Area Fencing and Management
- Activity Code 102 – Year Round/Summer Watering Systems
- Activity Code 103 – Watercourse Crossings
- Activity Code 104 – Grazing Management Strategies/ or Innovative Solutions

[4] https://www.albertaefp.com/
[5] https://www.albertaefp.com/resources/stewardship-funding-for-producers

Category B: Manure and Livestock Facilities Management.
(If approved, these are covered at a 30%, 50%, or 70% cost share).

- Activity Code 201 – Engineering Investigation &/or Feasibility Assessment
- Activity Code 202 – Construction or Upgrade of a Surface Water Management System
- Activity Code 203 – Improved Manure Storage Facilities
- Activity Code 204 – Relocation of a Livestock Facility and Permanent Wintering Site or Confined Feeding Operation
- Activity Code 205 – Improved Land Application of Manure
- Activity Code 206 – Manure & Livestock Facilities Management Strategies/ or Innovative Solutions

Category C: Agricultural Input & Waste Management.
(If approved, these are covered at a 30%, 50%, or 70% cost share).

- Activity Code 301 – Improved Pesticide Management
- Activity Code 302 – Improved Nutrient Management
- Activity Code 303 – Plastic Rollers
- Activity Code 304 – Shelterbelts
- Activity Code 305 – Wetland Assessments
- Activity Code 306 – Agricultural Input and Waste Management Strategies/ or Innovative Solutions

The Alberta EFP programme has an active presence on social media with a Facebook page dedicated to informing farmers and producers about upcoming events, as well as an up-to-date website which includes a range of supporting resources.

Figure 3: Advertising at an EFP workshop held at Wetaskiwin, Alberta in December 2018.

Case study 2: Whole Farm Planning – Catskill/Delaware watershed, New York State, USA

The challenge of providing its citizens with a clean, abundant, and inexpensive supply of drinking water has been an on-going challenge for New York City (Isakson, 2001). In 1990, New York City officials were faced with the challenge of devising a management plan that protected the largest surface water supply system in the world from the increasing danger posed by point-source and nonpoint-source water pollutants. After several years of intense negotiations involving numerous stakeholders, a watershed management strategy was devised in 1997. The new plan, officially known as the New York City Watershed Memorandum of Agreement (MOA), places the City at the forefront of watershed management.

Whole Farm Planning (WFP) in the Catskill/Delaware watershed of New York State is administered by the Watershed Agricultural Council (WAC) with funding from the New York City Department of Environmental Protection (DEP). The WAC describes Whole Farm Planning as a 'holistic approach to farm management used to identify and prioritize environmental issues on a farm without compromising the farm business itself'[6]. Potential risks to the water supply are identified and addressed through careful structural planning to reduce or avoid the transport of agricultural runoff into farm streams.

The process of developing a WFP begins when a farmer signs a voluntary participation agreement with WAC and agrees to develop a Whole Farm Plan in conjunction with a Planning and Implementation Team. Each team is multidisciplinary, and may have representatives from the USDA Natural Resources Conservation Service, Cornell Cooperative Extension and county Soil and Water Conservation Districts (see Figure 4).

Member	Role in the Whole Farm Planning Process
Farmer	The focus of the Watershed Agricultural Program. Participation is voluntary.
USDA Natural Resources Conservation Service	A source of technical and scientific expertise for WAP, especially regarding BMPs. Has a long history of commitment to locally-led conservation efforts.
Soil and Water Conservation Districts	Grassroots organizations created by each individual county in New York State during 1950s. Mission is to supply technical expertise to farmers on soil and water conservation issues.
Cornell Cooperative Extension	Provide technical and managerial expertise to assist farmers in meeting their missions and objectives. A part of New York State's land grant university, Cornell University.

Figure 4: Members of the Whole Farm Planning Team and their Contributions (Isakson, 2001).

[6] https://www.nycwatershed.org/pdfs/WAC_EV_Impact_in_DC_.pdf

The WFP process is entirely voluntary and the DEP pays 100% of the cost to create and implement WFP recommendations (in the Croton watershed of New York State, landowners are covered too, but generally contribute up to 50%, depending on the cost guidelines). Often, additional funding sources will also be involved to pay for farm improvements as outlined in the WFP, with supplementary financial options open to landowners such as:

- USDA NRCS Conservation Stewardship Program (CSP)
- USDA NRCS Conservation Reserve Program (CRP)
- USDA Farm Service Agency Conservation Reserve Enhancement Program (CREP)
- USDA NRCS Environmental Quality Incentive Program (EQIP)
- USDA NRCS Wildlife Habitat Incentive Program (WHIP)

Somewhat incredibly, (in most cases) farmers do not pay for most farm improvements as outlined in the WFP that benefit water quality – the City of New York does. How does it pay for the city to fund this? Put that down to a beneficial relationship between the ~9 million downstream residents of New York which use over 3.7 billion litres (1 billion gallons) of potable water each day, who are entirely reliant on farmers' upstream maintaining good freshwater quality. Such a high level of both financial and technical support has resulted in an incredibly high, >90% level of farmer engagement in the voluntary WFP program (J. Darling, personal communication, December 5, 2018).

The process of completing a WFP, initially involves the Planning and Implementation Team visiting a farm to identify and assess potential sources of fresh water pollutants, using a custom Environmental Review/Problem Diagnostics tool. The Team also then reviews technical and financial options with the landowner/farmer and drafts a WFP which is presented to Watershed Agricultural Program peers and managers for review. The landowner/farmer then signs the Participation Funding Agreement agreeing to implement their "plan" following a Best Management Practice (BMP) prioritization process and funding availability.

The WFP process is very focussed on conserving and enhancing freshwater quality (and potentially quantity) including an assessment of nutrients (particularly phosphorus), sediment, pathogens and other toxic substances such as agrichemicals and fuels which has resulted in a strengthened agricultural presence in the Catskills, improved management practices by the farmers, and improved water quality[7].

[7] https://sustainabledevelopment.un.org/content/dsd/dsd_aofw_mg/mg_success_stories/csd6/nyc_wsfp.htm

Case study 3: FarmPlan21 – Victoria, Australia

Agriculture Victoria suggests that Whole Farm Planning started in Australia during the 1950's[8]. These plans were primarily aimed at mitigating soil erosion and utilised the United States of America's Department of Agriculture's eight-class land-capability classification. These plans were prepared largely by government extension officers with varying input from landholders. They focused mostly on physical erosion-control works and to a lesser extent they addressed property layout, water conservation, tillage methods, pasture and crop development and tree planting programs.

During the 1980s farm planning had a resurgence partly due to the Potter Farmland Plan. In 1984, The Ian Potter Foundation became involved in its first major rural project: The Potter Farmland Plan, and allocated $250,000 a year for three years to establish demonstration projects on 15 farms in Western Victoria[9]. The project aimed to show that by working with farmers and using readily available techniques, some of the main causes of land degradation could be addressed and rural land could be managed to gain maximum production, while still working within the bounds of sustainability (Campbell, 1991). Participating demonstration farms aimed to show how ecological considerations could be incorporated into farm planning to improve productivity and redress land degradation.

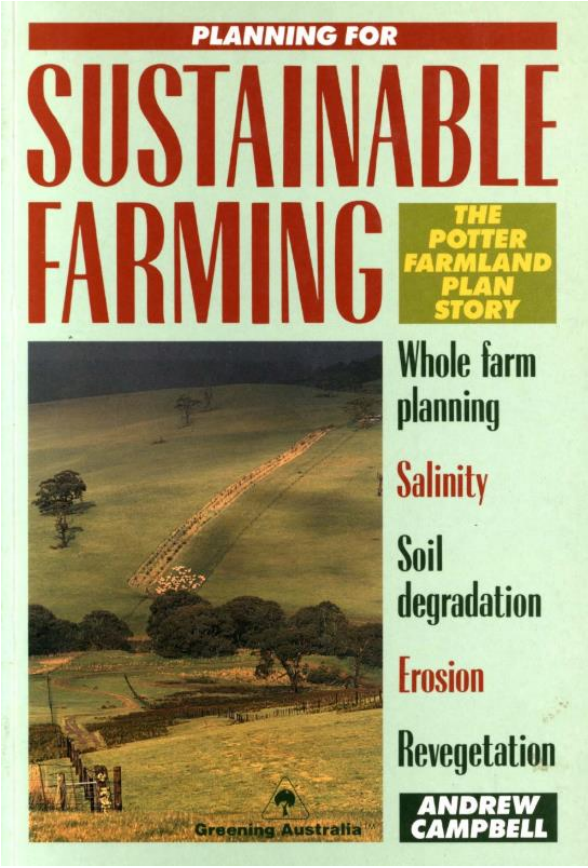

Figure 5: Cover from Andrew Campbell's book – Planning for Sustainable Farming: The Potter Farmland Plan Story (Campbell, 1991).

[8] http://agriculture.vic.gov.au/agriculture/farm-management/business-management/whole-farm-planning
[9] https://www.ianpotter.org.au/news/blog/potter-farmland-plan/

Farm Plan21 currently provides farm planning services to farmers across Victoria and stands for 'Farm Planning for the 21st Century'. It aims to help farmers achieve profitable, sustainable farming businesses and began as a pilot project in 2008. By the end of 2010, Agriculture Victoria comments that over 823 farmers had participated in 79 courses[10].

FarmPlan21 farm planning services work with farmers to achieve their environmental and farming goals by offering group farm planning training via workshops to build the knowledge, skills and networks necessary to support informed farm business decisions. The FarmPlan21 course aligns to the national training competency – 'Develop a whole farm plan' and includes advice on improving farm productivity, natural resource management and adapting to climate change. Government departments, private and industry experts deliver the FarmPlan21courses in collaboration. They discuss specific management issues with the farm planning group and assist farmers develop their farm plan. The farm plan includes a detailed action plan, both written and electronic, and uses aerial imagery and computer mapping programs.

[10] http://agriculture.vic.gov.au/agriculture/farm-management/business-management/whole-farm-planning/farmplan-21

Key learnings – Farm Environmental Planning

It has been a fascinating experience delving into a range of quite unique approaches to Farm Environmental Planning as introduced in the previous sections. Here a number of key observations and learnings are explored as they might add value within the New Zealand agricultural context.

This section does not attempt to prescribe the process of Farm Environmental Planning, but rather explore key concepts and themes of relevance to the New Zealand agricultural sector considering Farm Environmental Planning as a tool to improve sustainable outcomes.

- **Support and resourcing**
  All three case studies presented were able to function because a high level of industry, local and/or national government support. This is particularly evident in the Whole Farm Planning approach in New York State. Yes, this is definitely a unique situation with such a large urban population entirely dependent on the condition of catchment water quality, but even so it is quite incredible to observe what can be achieved, voluntarily, when such significant resource and support is made available.

  Developing high quality FEPs can be achieved in a range of ways; however, at least some point on the journey it should involve specialist on-on-one support and engagement on-farm, providing expertise to help inform tailored, site specific solutions and action plans well aligned to family and community values. There is also clearly an opportunity around providing targeted incentives relating to on-farm actions. This should definitely not be a form of farm subsidy (e.g. production payment or export incentive), but could be via a targeted environmental stewardship fund focussed on addressing catchment specific or regional needs and priorities. Feedback from farmers in the various international examples described, was that a level of contestable funding upon completion of a FEP (to be used in the implementation of targeted actions as outlined in the FEP action plan) was a major driver of engagement and practice change.

- **Holistic outcomes**:
  For long term success, FEPs should seek to improve holistic outcomes (environmental, economic, and social/cultural). Environmental outcomes should not be the sole focus as would likely result in unintended consequences and potentially drive unsustainable activities. Challenges associated with aligning competing objectives need to be addressed as part of the FEP and accounted for in timeframes and investments within the action plan.

  Environmental: should be forward thinking and consider more than just the more traditional aspects associated with soil conservation and water quality. Indigenous biodiversity, greenhouse gas emissions and an assessment of ecosystem services should all be considered within the wider context of business/family goals and objectives.

  Economic: The FEP must remain a nimble document and should not be weighed down with a detailed financial analysis of the farm system; however, it should consider the farm financial position when designing and prioritising land management decisions.

  Social/Cultural: Farm management should be considered as part of the wider catchment and recognise community values and priorities, with special significance

given to cultural values and aspects of significance. Cultural considerations should be recognised as they relate to farm and natural resource management, reflecting regional differences around aspects such as mahinga kai, wahi tapu and wahi taonga.

- **Voluntary vs regulatory**
  The voluntary vs regulatory approach to farm environmental planning is a compelling debate and one worth exploring further. On one hand, traditional farm environmental planning is promoted as a voluntary mechanism for farmers to engage with. This has obvious benefits in that farmers have a much greater level of ownership in the process. Farmers are typically more engaged with this approach; however, it is often criticised for a perceived low level of farmer participation. This perceived low level of participation, is one reason behind FEPs becoming mandated in regulation by an increasing number of regional councils throughout New Zealand.

  The New York State example of Whole Farm Planning is unique – with huge social pressures and immense financial support, but to get over 90% engagement in a voluntary scheme is impressive. While the high level of funding made available to support farmers in that catchment to complete and implement farm plans is not at all realistic in the New Zealand context, it does illustrate that high levels of engagement are possible outside of regulation.

  The very real concern in making FEPs mandatory is the risk of them increasingly becoming a 'tick box' exercise, completed increasingly for someone else's benefit. Aspirational goals are toned back and the bare minimum becomes the norm. What was once an inclusive adaptable tool reflecting site specific needs and demands of a farm, becomes at risk of being scaled back for a 'rubber stamp'.

- **Measuring outcomes**.
  While FEPs enjoy widespread support from many within the farming sector, measuring improvements in environmental outcomes as a direct result of the farm environmental planning process is something that is inherently challenging. While FEPs clearly have the ability to facilitate farm management improvements and change, there are often many variables contributing towards the improved picture.

  One key consideration concerning this is the importance of clear measuring and recording. While many environmental outcomes take some time to improve at a measurable scale, having clear benchmarks and records before and during the process is important. As mentioned earlier, the WFP program in New York State was able to relate improvements in environmental outcomes directly to the farm planning process and aligned farmer support. Two key measures that should be considered in this process include:

    - trends in environmental outcomes
    - the uptake and adoption of Sustainable Management Practices

  Domestic research considering improvements to environmental outcomes directly attributed to Farm Environmental Planning has been described by Manderson et al., (2013), who identified key results attributed to the Sustainable Land Use Initiative (SLUI) in the Horizons region of New Zealand including:

- Erosion rates are reduced closer to natural levels
- A rural sector or regional economy which is more resilient to future major storms
- Lowland communities which are protected from the effects of upstream hill country erosion
- Improved water quality in the region's rivers (HRC and MAF, 2007).

Sustainable Management Practices

At present, many New Zealand farmers are confronted by the need to implement transformational change to improve multiple environmental outcomes while still returning a profit. Supporting them on this journey industry groups, regional councils and central government have developed the Good Farming Practice Action Plan for Water Quality, acknowledging a range of Industry Agreed Good Management Practices. This has been useful in providing clarity and collaborative industry support for farmers around agreed standards, with flexibility to tailor solutions through tools such as farm environment plans.

Many other countries have programmes to promote the voluntary adoption of sustainable management practices in agriculture which is supported by the Food and Agriculture Organisation (FAO), which considers the establishment and implementation of Sustainable Management Practices – also referred to as Beneficial Management Practices (BMPs), Good Management Practices (GMPs), Good Farming Practices (GFPs) or Good Agricultural Practices (GAPs) – as one of the most important steps in achieving environmental sustainability in the context of sustainable agricultural production intensification[11].

In some countries, this goes beyond a strictly voluntary approach with legislation in place requiring particular measures in order to protect biodiversity as well as soil, water and air quality. Sustainable Management Practices (SMPs) are often promoted through extension services and field technicians, demonstration sites, stewardship and recognition programmes, and through cross-compliance, whereby farmers receive financial or other benefits for adopting beneficial management measures and complying with environmental regulations or standards.

Numerous guidelines are available globally on how to implement SMPs in agriculture and while SMPs need to be developed for site-specific conditions and to address farm specific environmental priorities, many available guidelines and sustainable practices are often directly transferable to a wide range of farming systems or are transferable with some adaptation.

The following sections present two case studies which describe and elaborate on examples of 'SMP' programmes before exploring some key learnings and observations.

11 http://www.fao.org/fileadmin/templates/agphome/scpi/SCPI_Compendium/SCPISustainabilityTools.pdf

Case study 1: SmartcaneBMP – Queensland, Australia

Since 2014, Smartcane BMP has been working with cane growers in Queensland, Australia to record and verify farm practice improvements. The SmartcaneBMP programme includes eight modules that cover many aspects of farming and business management and are based around a simple checklist to help farmers identify options for further improvement[12]. Farmers are able to work through the eight BMP modules by themselves or with assistance from a local BMP facilitator.

As part of SmartcaneBMP, cane growers have the option of becoming accredited, which allows them to be independently recognised for their farm management. Accreditation involves completing Modules 1, 2 and 3, (soil and nutrients, irrigation and drainage, and weeds, pests and diseases) as well as being independently audited. Modules 4–8 aren't required for accreditation; however, they still cover important aspects relating to farming and can help identify opportunities to improve practices in other parts of the farm business.

Below is a brief summary of each module in SmartcaneBMP, found online at www.smartcane.com.au.

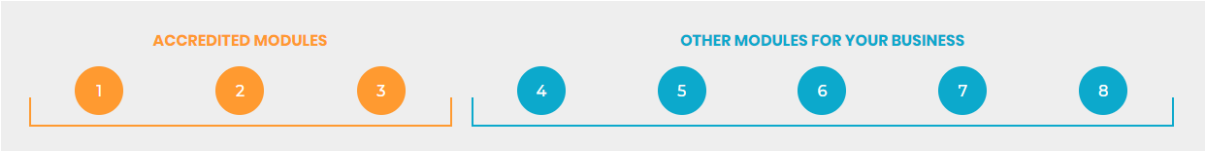

Figure 6: SmartcaneBMP modules.

Smartcane BMP modules:

1. **Soil health and nutrient management**

   Look at ways to improve soil health and overcome constraints to yield.

2. **Irrigation and drainage management**

   Increased efficiency means power savings, water savings, and reduced risk of chemicals and nutrients leaking from paddocks.

3. **Weed, pest and disease management**

   This module covers selecting the right products for your farm, understanding regulations and label requirements, and methods of applying chemicals.

4. **Planting and harvesting**

   Looking at the bookends of crop management, this module covers best practices for planting and harvesting.

5. **Farm business management**

   Understand how your business is performing by looking at cost of production, cashflow and profits, and make plans for the future.

[12] https://smartcane.com.au/

6. **Natural systems management**

   Protect the wetlands, waterways, riparian zones and native vegetation on your land to conserve native species.

7. **Workplace health and safety**

   Take advantage of useful resources that clearly describe your responsibility for workers, contractors and visitors, and help you take appropriate actions to meet your obligations.

8. **Pathway to sustainable sugar**

   For accredited growers, this module covers the additional criteria required for global sustainability standards.

Case study 2: Grazing BMP – Queensland, Australia

Grazing BMP is a Best Management Practice (BMP) program established for the grazing industry in Queensland, Australia which is being developed and implemented by the Fitzroy Basin Association, Department of Agriculture and Fisheries, and AgForce[13].

Grazing BMP aims to assist landholders to improve the economic and environmental performance of their enterprises through self-assessment against best available information and management principles at three levels – above, minimum and below standard for the whole farm business. From this assessment action plans can be developed to assist landholders to focus and prioritise on the most profitable and sustainable practices as well as identifying potential training requirements.

Grazing BMP uses a voluntary online self-assessment tool to develop and implement a best management practice program which seeks to enable producers to:

- identify and access training to improve knowledge and skills which will enable adoption of best practice
- accurately monitor and report upon improvements in management practice at a range of levels
- benchmark their own practices against industry accepted best practice, and design and implement actions to improve.

The program consists of five modules covering major aspects of the farming enterprise including:

1. Soil health
2. Grazing land management
3. Animal production
4. Animal health and welfare
5. People and business.

An online reporting function also allows for instant comparison with the rest of the industry. Data safety is paramount – each producer is allocated a username and password on a secure website.

Further information can be found online at https://www.bmpgrazing.com.au/.

[13] https://www.bmpgrazing.com.au/

Key observations – Sustainable Management Practices

SMPs clearly can have a useful role to play in providing clarity and direction to farmers around recommended farm management practice. The Grazing BMP case study, effectively illustrates how SMPs can be linked to a risk assessment process which could fit well within a broader FEP process and move assessment of good management practice beyond a 'yes' or 'no' tick box exercise.

One other observation, is that SMPs need to be well informed by science and linked to a greater assessment of outcomes at catchment scale. This is needed to ensure that desired/required environmental outcomes are in fact being met in line with an adoption of SMPs. If SMPs are not well informed by science and considered within the wider farm and catchment context, a very real risk exists whereby widespread adoption of SMPs still falls short of desired outcomes and/or community expectations – potentially jeopardising years of farmer investment as well as the trust of wider stakeholder groups.

Another key observations is the importance of setting up robust means to benchmark farmers from the outset if any sort of progress or measurement of practice change is desired. Any complications around how accurate that initial data collection might be, will challenge any ability to measure adoption and practice change into the future.

Climate Smart Agriculture

The concept of Climate Smart Agriculture (CSA) is one of increasing interest as countries around the world grapple with the challenges, threats and opportunities presented by climate change. As the agricultural sector in New Zealand wrestles with ways to address its contribution towards climate change – while also being productive in the face of increasing climate extremes, CSA is a novel approach worth exploring further.

Climate smart agriculture is effectively an integrated approach to managing farming enterprises (e.g. cropland, livestock, forests and fisheries) that addresses the interlinked challenges of food security and climate change[14]. As described in Figure 7 below, CSA aims to simultaneously achieve three outcomes:

- *Increase productivity*: Produce more food to improve food and nutrition security and boost the incomes of 75 percent of the world's poor who live in rural areas and mainly rely on agriculture for their livelihoods.

- *Enhance resilience*: Reduce vulnerability to drought, pests, disease and other shocks; and improve capacity to adapt and grow in the face of longer-term stresses like shortened seasons and erratic weather patterns.

- *Reduce greenhouse gas emissions*: Pursue lower emissions for each calorie or kilo of food produced, avoid deforestation from agriculture and identify ways to suck carbon out of the atmosphere.

[14] https://www.worldbank.org/en/topic/climate-smart-agriculture

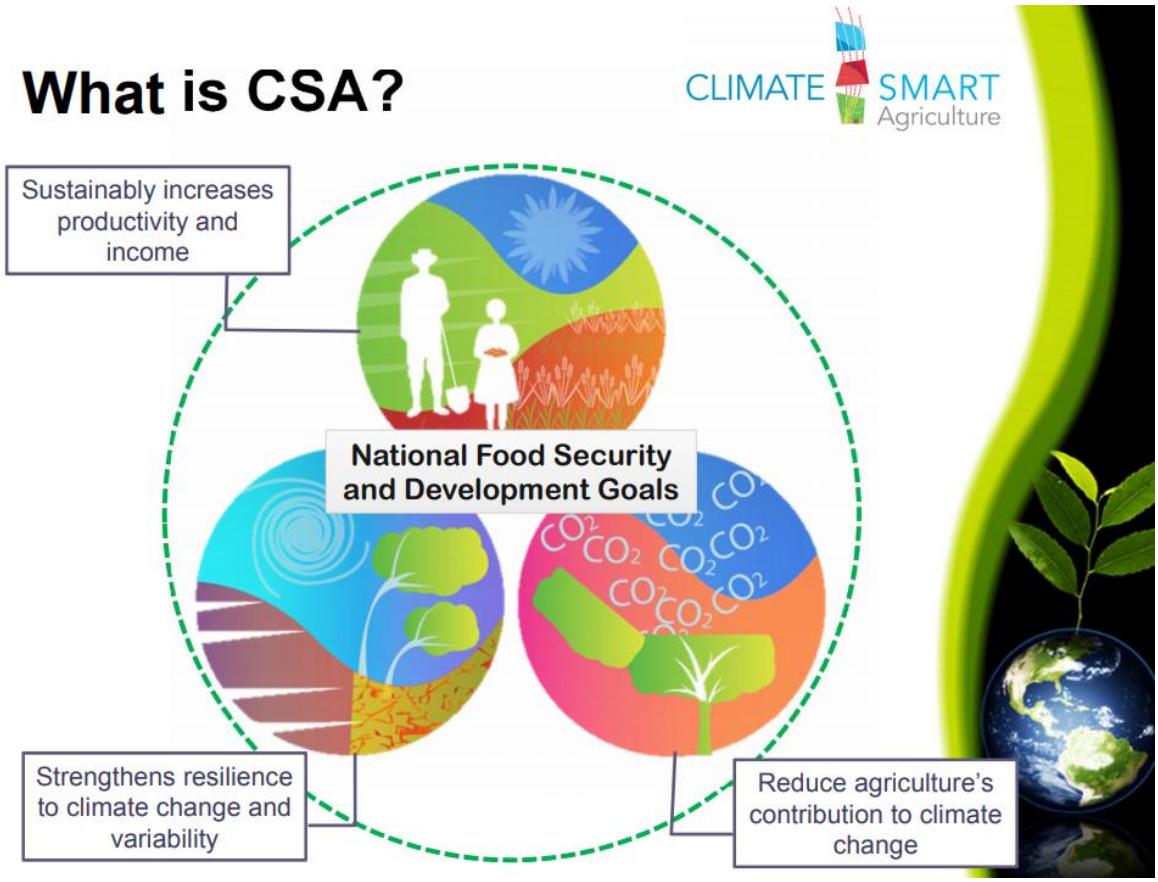

Figure 7: Presentation slide by Irina Papuso and Jimly Faraby, Seminar on Climate Change and Risk Management, May 6, 2013[15].

While built on the existing knowledge, technologies, and principles of sustainable agriculture, CSA is distinct in several ways. First, it has an explicit focus on addressing climate change. Second, CSA systematically considers the synergies and trade-offs that exist between productivity, adaptation and mitigation. Finally, CSA aims to capture new funding opportunities to close the deficit in investment[16].

While the concept is new, and still evolving, many of the practices that make up CSA already exist worldwide and are used by farmers to cope with various production risks. Mainstreaming CSA requires critical stocktaking of ongoing and promising practices for the future, and of institutional and financial enablers for CSA adoption[17].

[15] https://www.slideshare.net/jimalfaraby/climate-smart-agriculture-20675751/4
[16] https://www.worldbank.org/en/topic/climate-smart-agriculture
[17] https://www.climatelearningplatform.org/sites/default/files/resources/climate_smart_agriculture_profile_for_zambia_cgiar_2017.pdf

Key observations – Climate Smart Agriculture

Climate change stands out as one of the most significant challenges of our time, and how emissions from agriculture are treated within domestic policy has long been a topic of much debate. The recently released New Zealand Biological Emissions Reference Group report (2018), suggested that many New Zealand farmers are asking what more they can do to reduce their emissions, prepare for any changes markets may require of them, and reduce their exposure to any future emission price. It also found that while 64% of farmers[18] believe New Zealand agriculture should reduce its greenhouse gas emissions to help combat global climate change; 98% did not know the greenhouse gas emission rates from their farm; and 42% of farmers were not aware of mitigation strategies that could reduce greenhouse emissions from agriculture, other than planting trees.

In an earlier section of this report it was recommended that environmental considerations as part of farm planning should consider more than just more traditional environmental aspects such as erosion and water quality and should incorporate aspects such as ecosystems services, indigenous biodiversity and greenhouse gas emissions. Considering greenhouse gas emissions within the context of climate smart agriculture presents a significant opportunity to consider emissions within a more holistic view which acknowledges the other immediate challenges associated with climate change. The triple win of CSA is of great relevance to farmers and should engender greater support than solely looking at a single aspect such as a reduction of greenhouse gas emissions in isolation.

[18] Survey from 68 mainly sheep, beef and dairy farmers.

Farm systems modelling and optimisation

Traditionally, agricultural research has often focused on field-scale analytical approaches aimed at improving individual farm management practices, i.e. exploitative innovations (Darnhofer et al. 2010). Farm systems research is a discipline that examines farming systems to understand the relationships between the elements of the system and the outcome as a whole (Darnhofer et al. 2012). It is research to investigate the interactions between the components of the system and research is about the system, not the components themselves and so is termed holistic, rather than reductionist.

Farming systems are complex and diverse and, in order to develop appropriate adaptation strategies, such diversity needs to be captured. Farming systems approaches allow one to assess the contribution of different technological or institutional change, or the effect of major influences of change, on the sustainability of the farm system as a whole.

On-farm experimentation is absolutely critical in understanding farm system interactions and how the different parts of a system influence each other and affect overall farm performance. However, this type of research is resource intensive and often time consuming and expensive to conduct. In agriculture, experiments must typically be run over multiple seasons to tease out the effects of environmental factors, to test individual components of the system, and to determine the longer term response to various treatments. This is where farm systems modelling plays a key role. Supported by well-designed field and farm experimentation, modelling can help with our understanding about how the different components of a farm system have influenced particular outcomes[19].

[19] https://www.dairynz.co.nz/about-us/research/farm-systems-modelling/

Case study 6: FarmDESIGN – Wageningen University, The Netherlands

Reconfiguring farming systems to reach various productive and/or environmental objectives while meeting farm and policy constraints is complicated by the variety of farm components involved, and the many interrelations among these components. The FarmDESIGN model, was developed to overcome these limitations by coupling a bio-economical farm model which considers the productive, economic and environmental farm performance, to a multi-objective optimization algorithm that generates a large set of alternative farm configurations (Groot et al., 2012).

Farm DESIGN is a product of the Farming Systems Ecology group (FSE) of Wageningen University and is free to download and use[20]. The model has been used in a wide range of contexts to inform farm land use optimisation. The input database describes characteristics of the various resources that can be found on a farm as described below:

- **Biophysical environment**: soil characteristics and chemical composition, climate, deposition, non-symbiotic fixation and potential erosion rate.
- Socio-economic setting: currency, interest rates, prices of labour, general costs, available labour, fixed labour requirements for farm and herd management.
- **Crops**: agronomy, subsidies, cultivation costs and labour requirement. Each crop can have one or more products.
- Crop products: production per ha, destination (used on- farm e.g. as animal feed, bedding material, green manure, fire-wood, for home consumption), chemical composition, feed value and product price.
- **Rotations**: per rotation a list of crops and their area. More than one rotation can be defined and crops can also be used in more than one rotation.
- **Crop groups**: a list of crops belonging to a group on the basis of similar cultivation practices (e.g., root crops) or same plant family (e.g., Allium family).
- **Animals**: management, labour requirements, weight, production and feed requirements.
- **Animal products**: destination (use on farm as animal feed or for home consumption), chemical composition, feed value and product price.
- **On farm produced manures**: composition, nitrogen losses and degradation parameters.
- Fertilizers and imported manures: amount purchased and composition.
- **Buildings and equipment**: fixed costs for interest and depreciation, variable costs for operation.

Recent additions to the model include the ability to quantify of greenhouse gas emissions (Tier 1 IPCC) and on-farm biogas production from crop residues and manures.

Currently the model is being extended to include a range of human nutrition indicators as well as better integration of the household, including gender aspects that will allow for analysis of the division of labour and revenue distribution among household members. In a later stage the model will be coupled to the spatially explicit Landscape IMAGES model, so that multiple farms within a landscape can be explored. FarmDESIGN including these extensions will then be applied in projects such as the CGIAR Research Programs on Integrated Systems for the Humid Tropics (Humidtropics), Agriculture for Nutrition and Health (A4NH - Nutrition Sensitive Landscapes) and MAIZE and WHEAT.

[20] https://sites.google.com/site/farmdesignmodel/home

Key observations – Farm Systems Modelling and Optimisation

One of the challenges associated with implementing Sustainable Management Practices and Farm Environment planning, is that without measures to calibrate and direct actions there is a risk that the process will not achieve the desired outcomes. To avoid this, FEPs need to be properly guided by robust science as well as informed farm systems modelling which considers a broad range of objectives to deliver truly sustainable outcomes.

Through well informed modelling tools, farm systems analysis allows for the exploration and assessment of future scenarios considering multiple objectives as pursued by the farm business and/or household (as well as other ecosystem services demanded by society) and the trade-offs and synergies associated to those scenarios.

Agricultural Extension

Agricultural extension can be described as the process of sharing knowledge, innovation and technology to improve farming systems[21]. Effective extension is a critical enabling step towards ensuring the successful uptake and adoption of agricultural technologies and in turn facilitating sustainable outcomes. Birner and Anderson (2007), highlight that many countries have recognised the need to revive agricultural advisory or extension services to address 'new' challenges such as environmental degradation and climate change.

The Syngenta foundation supports this, highlighting some key observations with regards to new approaches to agricultural extension, suggesting that "addressing new and growing challenges in agricultural markets, technology and sustainability demands new thinking"[22], and that extension should focus on:

- Participatory approaches to shape demand-driven services
- Multiple providers of extension services, and
- Strategies to develop agricultural innovation systems

Case study 7: Cornell Cooperative Extension – New York State, USA

Cornell Cooperative Extension (CCE) links the research and extension efforts at Cornell University, the Cornell University Agricultural Experiment Station and the Cornell AgriTech, providing the knowledge to maximize New York State's agricultural and natural resources[23].

CCE's regional agriculture teams provide research-based information, programs, and technical assistance to dairy, field crops, vegetable, tree fruit and grape producers all around the state. The extension program has a strong focus on sustainability, putting knowledge to work in pursuit of economic vitality, ecological strength and social well-being, with a focus on bringing local experience and research based solutions together to help New York State families and communities thrive in our rapidly changing world.

CCE is supported by a federal, state, and local government partnership, the national land grant system, and Cornell University.

[21] https://www.mpi.govt.nz/funding-and-programmes/other-programmes/extension-service-model-initiative/
[22] https://www.syngentafoundation.org/agricultural-extension
[23] http://cce.cornell.edu/

Key observations – Agriculture Extension

While a range of strong extension programmes exist in the New Zealand agricultural sector, there remains an opportunity for government to play a stronger role in partnering with industry to support better coordination and targeting of services that focus on sustainable and profitable farming.

A significant opportunity exists for the New Zealand government to more effectively support and enhance agricultural extension programs to ensure farmers are well resourced and supported to utilise information on agricultural sustainability and value creation as part of the farm planning and land optimisation process.

It is encouraging to hear about the Extension Service Model initiative as proposed by the Ministry for Primary Industries in late 2018. If properly structured to complement other existing agricultural extension networks and programs, this could be an effective mechanism to enable the kind of significant resourcing that will be required to support the wide spread uptake of effective farm planning and considered land use optimisation.

Conclusions

This report has explored a number of tools, techniques and approaches designed to facilitate and enable sustainable outcomes in the New Zealand agricultural sector to set farmers up to succeed in the long term, build farmer confidence and inform farmer investments and farm management decision making.

Farm Environment Plans are a key tool to help guide and inform farmer decision making. Through effective farm planning, farmers are able to identify and prioritise key on-farm environmental risks and take ownership for potential solutions and management decisions to mitigate this risk. Farm Environmental Planning is an enabling tool with the potential to facilitate sustainable outcomes in New Zealand agriculture if supported and implemented in the right way. This study has identified a number of aspects that should be considered to enable effective farm environmental planning including:

- FEPs should seek holistic objectives – considering environmental, economic as well as social and cultural aspects. Within this, environmental considerations should be broader than often articulated, considering traditional aspects relating to water quality and soil conservation, as well as indigenous biodiversity, ecosystem services and greenhouse gas emissions at both farm and catchment scale.
- Funding and investment from industry as well as regional and central government should be aligned to aid in the design, delivery and implementation of FEPs. Farmer support via targeted environmental stewardship incentives should be explored further.
- To encourage innovation and farmer aspiration, FEPs should ideally be supported outside of regional or central government regulation, and enabled by processors (e.g. meat, wool, milk companies) and industry bodies, linking them to market and in turn helping to communicate and validate a greater value proposition associated with New Zealand agriculture.

Establishing Sustainable Management Practice guidelines is a valuable enabling step for the agricultural sector, helping to provide farmers with clarity regarding on-farm environmental management. There is a significant opportunity for collaboration in this space – beyond just industry groups but encompassing regulatory authorities, iwi as well as environmental NGOs and other interest groups. Collaboration in this context would encourage greater collective support from a wide range of stakeholders.

Climate change presents significant challenge to New Zealand farmers – with increasingly volatile and extreme weather events predicted, as well as growing social pressures for the agricultural sector to contribute towards greenhouse gas reductions, there is a significant opportunity to consider greenhouse gas emissions within the farm environmental planning process. However emissions should not be looked at in isolation. Climate Smart Agriculture (CSA) is a more inclusive concept which broadly addresses three key aspects of challenge to farmers in this space as part of a 'triple win' which includes; increasing productivity, enhancing resilience to the effects of climate, as well as reducing greenhouse gas emissions. Positioning emissions within the broader context of CSA, will increase their relevance and lead to greater support and willingness to engage.

To help inform land use and land management decision making, farmers also need to be supported with access to appropriate farm systems modelling tools. These tools, informed by robust science should be recognised and supported as a critical part of effective farm environmental planning to set farmers up to succeed in the long term and guide farmer decision making and investment.

And finally, effective farmer extension and support at both farm and catchment scale to support enhanced farm sustainability should be prioritised by government. Government investments into the agricultural sector need to go beyond traditional research and development (R&D) and truly recognise the importance of effective extension (RD&E). A comprehensive, more active extension service which includes increased investment by government in collaboration with industry and sector groups would be a valuable enabler to support the farm environmental planning process as well as the wider uptake of sustainable management practices across New Zealand farms.

Recommendations

The main recommendations to come from this study include:

1. **Farm Environmental Planning should be prioritised, appropriately resourced and supported as a primary means to drive sustainable outcomes in New Zealand agriculture. Critical to this are a number of enabling components:**

    a. Farm Environment Plans (FEPs) should seek holistic objectives – considering environmental, economic as well as social and cultural aspects. Within this, environmental considerations should be broader than often articulated, considering traditional aspects relating to water quality and soil conservation, as well as indigenous biodiversity, ecosystem services and greenhouse gas emissions at farm and catchment scale.
    b. Investment from industry as well as regional and central government should be aligned to aid in the design, delivery and implementation of FEPs and farmer support via targeted environmental stewardship incentives should be explored.
    c. To encourage innovation and farmer aspiration, FEPs should be enabled outside of regulation, with processors (e.g. meat, wool, milk companies) and industry bodies taking a leading role as well as providing a link to market and the consumer.
    d. Farmers should be linked with trusted advisors who are able to provide ongoing, tailored and farm specific advice prioritising long term outcomes and farmer investments as part of the FEP.

2. **Sustainable Management Practices (SMPs) should be promoted and supported to help provide farmers with clarity regarding on-farm management.**

    a. SMPs should be developed in collaboration with a wide group of stakeholders (e.g. farmers, industry, regional councils, government, iwi and environmental NGOs) where possible to ensure wide support and collective buy-in.
    b. Implementation guidelines for SMPs should recognise the dynamic and varied New Zealand farming context.

3. **Climate Smart Agriculture should be socialised by the New Zealand agricultural industry as a valuable component of farm environmental planning – prioritising the 'triple win' of increasing productivity, enhancing resilience to the effects of climate, as well as reducing greenhouse gas emissions.**

4. **New Zealand farmers should be supported by relevant industry groups to have access to appropriate farm systems modelling tools and specialist support to inform land use and land management decision making.**

    a. Farm systems modelling informed by robust science should be recognised as a critical component of farm environment planning. Farm systems modelling targeting holistic and sustainable outcomes can help guide farm environmental planning and inform critical decision making with regards to land use suitability and farm design.

5. **Effective farmer extension at both farm and catchment scale to enhance farm sustainability and ensure effective uptake of relevant technologies should be prioritised by the New Zealand government.**

    a. Government investment into the agricultural sector needs to go beyond traditional research and development (R&D), and prioritise effective extension and farmer support (research, development and extension – RD&E). Comprehensive extension will be critical to enable sustainable management practices at both farm and catchment scale.

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