INCREASING THE PACE OF CHANGE

Barriers and motivations for adoption in the New Zealand kiwifruit industry

Chrissy Stokes
Kellogg, Course 1, 2015

Executive summary

With export sales in 2014 of over $1.6 billion, the New Zealand kiwifruit industry is one of the great horticultural success stories. However, with a target of $3 billion in export sales by 2025, the industry can't afford to rest on its laurels. Much of the increase in revenue will be due to increased productivity and fruit quality on-orchard, and that does not happen by default. The aim of this study is to understand how we can increase the pace of change within the industry with respect to on-orchard adoption of innovations.

Eight Bay of Plenty kiwifruit growers were interviewed about their perceived motivations for and barriers to adoption of innovations. They identified cost, a lack of evidence, conservatism, and underlying beliefs as key barriers to adoption. The need for operational efficiencies, financial benefits, and needing a solution to a specific significant issue were key motivations to adopt.

A case study of DairyNZ highlighted the use of networks and opinion leaders as key tools for accelerating change.

Two innovations in the kiwifruit industry were studied: the pre-flowering trunk girdle, and root pruning. The attributes of these innovations have significantly impacted their rate of adoption within the industry, and serve to highlight gaps in the current research and extension programmes with respect to how innovations are "sold" to industry.

Based on the information collected in this study, the following recommendations are made:

1. Network mapping could provide some significant insights and gains in the targeting of messages and improve the influencing of laggards;
2. The orchard productivity innovation portfolio should continue to use the "farmer first" model by way of the on-orchard brainstorming group, and should implement a grower review process to evaluate the success of research programmes, thereby "closing the circle";
3. Research trials should embrace the same model, with grower participation and collaboration actively encouraged;
4. The OPC grower trial programme should take a more participatory approach, although this will mean a scaling back of the number of trials that are under way at any one time; and
5. The attributes of an innovation should be considered when setting up research trials and planning extension activities, to take into account the barriers these may cause in the adoption decision process.

The recommendations proposed here do not make anybody's job easier, but will lead to a greater pace of change within the industry, and set us on the path towards the $3 billion target.

Table of contents

Foreword

In my role as an orchard productivity manager in the Orchard Productivity Centre at Zespri, I see first-hand the challenges of "selling" innovations to growers. I was motivated to undertake this research project to better understand how I do what I do, and how I and the rest of my team (OPC, Zespri Innovation, and the wider research community) could do things differently. After all, "If you always do what you've always done, you'll always get what you've always got" (Henry Ford).

Acknowledgements

I would like to acknowledge the financial support of Zespri International Limited to undertake this project.

I would like to thank the kiwifruit growers I interviewed who welcomed me into their homes and their orchards, and shared their honest answers me.

Thank you to Andrew Reid of DairyNZ for making time for me, and to Frank Seidlok and Lisa Callagher of the University of Auckland Buisiness School for resource, a fascinating discussion about collaboration, and for setting me on the right track.

Finally, thanks to Jayne Chamberlain for some great discussions, time to do the research, and giving me the starting point for this project.

Author contact information

Chrissy Stokes
Phone: 0274 926 575
Email: Chrissy.stokes@zespri.com

1. Introduction

In 2010, in response to central government's Business Growth Agenda of "lifting New Zealand's ratio of exports to gross domestic product to 40% by 2025" (Ministry for Primary Industries, 2013), Zespri released a document about "The Zespri Promise… to **triple our export earnings by 2025** to at least $3 billion" (Zespri, 2010b). It stated that "In order to achieve its growth target of $3 billion in export sales by 2025, Zespri will do the following:

- Increase productivity performance…
- Continue to broaden the product portfolio…
- Continue to invest in marketing and innovation
- Increase land used by the kiwifruit industry…
- Maintain … the SPE system…" (Zespri, 2010b)

In September 2010, the Zespri Orchard Productivity Centre (OPC) was launched. Technology transfer had been recognised as a key function within the business, and would be critical to achieving the 2025 goal. The purpose of the centre is to "provide the link between innovation, research and growers to improve on-orchard productivity" (Zespri, 2010a). They are "change agents" (Rogers, 2003).

The discovery of the bacterial vine disease *Pseudomonas syringae* pathovar *Actinideae* (Psa) in Te Puke in November 2010 put a significant dent in progress towards the 2025 goal. Sales dropped from a record of over $1.6 billion in 2010-11 to $1.35 billion in 2013/14 (Zespri, 2014). The flagship variety, Hort16A, developed by plant breeders at the Crown Research Institute, Plant and Food Research, was found to be particularly susceptible to this devastating disease. Volumes of Hort16A fruit dropped from almost 30 million trays in 2011 to just over 24 million within a year (Zespri, 2014), and it became obvious that this variety was not going to be a viable option for New Zealand growers.

Fortuitously, Zespri had commercially released three new kiwifruit cultivars shortly before the arrival of Psa. One of these, Gold3, was quickly seen as the obvious replacement variety for Hort16A, and a massive programme of conversion was begun across the industry. Change of this sort of scale and speed had never been seen in the kiwifruit industry, and OPC has played a critical role in translating and transforming research outcomes both around managing Psa, and growing Gold3 to meet market and customer requirements, into practical tools for growers.

As we move into a stage now where most growers are comfortable that they can manage to grow in a Psa environment and are getting to grips with growing Gold3 successfully, the focus on the 2025 target has been renewed, and the adoption of innovations, whether they come from the research programmes or from growers themselves, will be key in achieving that target. Understanding the barriers to, and motivations for adoption, and how we can use this understanding, will be critical in hastening the pace of change within the industry, and is the focus of this report.

2.0 Literature review

2.1 The New Zealand kiwifruit industry

The New Zealand kiwifruit industry supplies around 30% of the world's globally traded kiwifruit volume, but captures almost two thirds of the value, reflecting the premium position of the New Zealand kiwifruit product (NZKGI, 2015). When Isabel Fraser, the principal of Wanganui Girls' College, visited her sister, a missionary in China in 1903, and brought back to New Zealand with her the seeds of a Chinese native fruit, little did she know that she was beginning an industry that in 2014 returned over $1 billion to the New Zealand economy. By 1948, estimated total commercial production of kiwifruit in NZ was 32 tonnes (Zespri, 2004). The first commercial export of kiwifruit from New Zealand occurred in 1952, when twenty 10-pound trays of fruit were included in a mixed consignment to a London fruit importing company (Zespri, 2004). In 2015, the New Zealand industry is forecast to export over 400,000 tonnes of fruit to over 50 export markets around the world.

In the foreword to the *New Zealand Centennial Kiwifruit Journal 2004*, former New Zealand Prime Minister Helen Clark states:

> *What has been admirable about the kiwifruit industry is the manner in which it has responded to challenges…. In the early 1990s the industry experienced a debt crisis when prices and volumes crashed in an over-supplied European market. Falling returns and a vine removal incentive payment resulted in many vines being ripped out of the ground.*
>
> *The debt crisis instilled in the New Zealand Kiwifruit Marketing Board and the wider industry the importance of innovation and the need to research to support it. The Board sought new varieties and new ways of commercialising its operations. The results have been spectacular….*
>
> *The kiwifruit industry has demonstrated that the application of the latest technology helps maximise the value of the product and the efficiency of the industry. It has grasped that its future lies in continually repositioning up the value chain in everything it does…*
>
> *We can … lay claim to being a dynamic 21st century economy and society, underpinned by enterprising people who build success around research and smart and creative ideas.*

In 1988, growers voted to establish a unified, disciplined, one brand, single seller marketing strategy – the single point of entry (Zespri, 2004). In the early 1990s, the industry was in strife, with a huge amount of debt, and as a result, in 1997 Zespri International Limited was formed as a subsidiary of the New Zealand Kiwifruit Marketing Board, to focus on delivering and marketing the product (Zespri, 2004). The industry is now based on "grower ownership, grower control", and has four main cornerstones:

> **In-market structures**, built on direct customer and retail relationships;
>
> **Branding** to secure price premiums and a place on the shelf;
>
> **Year-round marketing** to provide category management and control shelf space and positioning, and
>
> **Innovation** in "research, development and commercialisation of new products, varieties, quality standards, market information and intelligence to inject excitement into the category and better enable growers to supply product to customer needs."
>
> (Zespri, 2004).

The industry has a strong history of innovation. "Innovation has become a constant maxim both for those directly involved in the kiwifruit industry and for those companies that supply services to it" (Zespri, 2004). Zespri has a

dedicated team of innovation leaders, who each manage a research portfolio. Innovation investment is across five platforms:

- New cultivar development
- Sustainable production systems
- Psa innovation
- Sustainable delivery of fruit
- Value addition/creation

Within the sustainable production systems platform, the focus is to optimise kiwifruit production and improve growers' returns, and encompasses two key portfolios: orchard productivity, and crop protection. The orchard productivity portfolio covers research on yield, taste, establishing new varieties, optimising pollination and reducing nutritional inputs. (Zespri, 2014).

2.2 The current innovation/extension model

2.2.1 Innovation

The innovation leader responsible for the orchard productivity portfolio has the task of identifying, prioritising, contracting and managing relevant research projects across areas that could help to increase productivity and profitability on-orchard. Ideas for research projects come from a variety of sources, including growers, post-harvest technical staff, the OPC team, and scientists. In the last 12 months, an "on-orchard brainstorming group", made up of people from each of these areas, has been formed. The purpose of the group is to help to identify and prioritise key research areas within the portfolio.

Once projects have been prioritised, the innovation leader puts together a project proposal with an external research team, and works to develop costings. A sub-committee of the Zespri board of directors approves projects based on their fit with the overall long term strategy of the company. Projects are then contracted to third party providers, such as Plant and Food Research, Plant Protection Chemistry NZ, and university research teams. Trials are usually carried out on commercial orchards, where appropriate. Deliverables of these projects often include popular articles for the New Zealand Kiwifruit Journal, a bi-monthly publication that serves as a vehicle sharing science findings with industry. Reports are also available to growers on request, and are not usually published directly to a website.

2.2.2 Grower trials

The OPC team has a staff member dedicated to running grower trials. Unlike the projects contracted by innovation leaders, which often look to gain a deeper scientific understanding, grower trials aim to answer a simple question with a robustly designed, replicated trial. Trials are carried out on commercial orchards. The written outputs of these trials are short reports available on the Zespri grower website, www.zespricanopy.com.

2.2.3 Orchard Productivity Centre

The role of OPC is to take science findings from innovation trials, grower trials, and monitoring and data analysis outputs (generating knowledge), and transform these into technical communications, in the form of documentation and events (sharing knowledge), with the end goal of changing grower behaviour. The centre operates as a key communication channel for empowering ZESPRI growers to make continuous productivity and quality improvements and increase orchard profitability. OPC's activities are overseen by a steering committee made up of leading growers and technical staff from the post-harvest sector, and the objectives for the team are around increasing average trays/hectare (the measure of productivity used across the industry) and average fruit dry matter (DM), year on year.

2.3 Extension

The fundamental function of the OPC is extension: "… extension is a general term meaning the application of scientific research and new knowledge to agricultural practices through farmer education. The field of 'extension' now encompasses a wider range of communication and learning activities organized for rural people" (Wikipedia, 2015). This education takes the forms of 1) best practice kiwifruit production, and 2) new innovations.

There are two key aspects to the successful adoption of an innovation: the attributes of the innovation itself, and how different adopter categories respond to the innovation attributes. Rogers (2003) described the attributes of innovations:

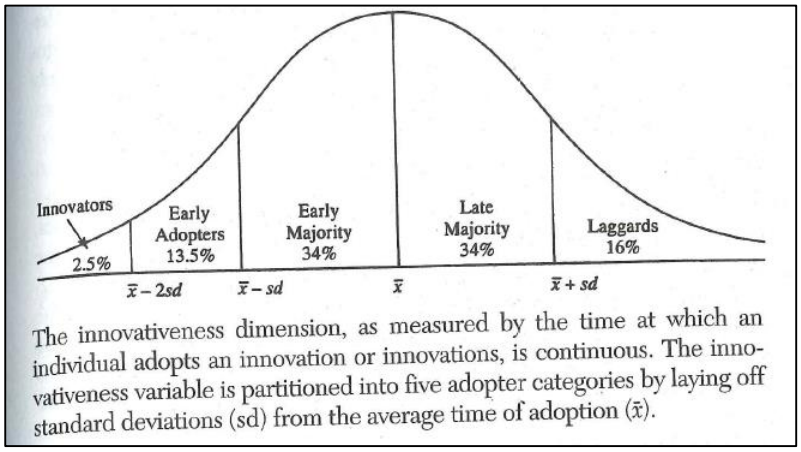
- Relative advantage (how much better is it than the idea it supersedes?)
- Compatibility (how consistent is it with existing values, past experiences and needs?)
- Complexity (how difficult is it to understand and use?)
- Trialability (how easy is it to experiment with on a limited basis?)
- Observability (to what degree are the results visible?)

Rogers (2003) explains that "innovations that are perceived by individuals as having greater relative advantage, compatibility, trialability and observability and less complexity will be adopted more rapidly than other innovations."

Rogers (2003) proposed a model whereby farmers are separated into adopter categories on the basis of their innovativeness (Figure 1). The categories are:

1. Innovators. These people are venturesome. They have an interest in new ideas, and are risk-takers: "the innovator must be able to cope with a high degree of uncertainty about an innovation at the time he or she adopts." They must be willing to accept failure, and may not be respected by other members of a local system.
2. Early adopters. These people have "the highest degree of opinion leadership" and are often considered as "the individual to check with before adopting a new idea." They are not too far ahead of the average, and are "the embodiment of successful, discrete use of new ideas." They give an innovation "a stamp of approval… by adopting it."
3. Early majority. The early majority adopt ideas just before the average member of a system, and are seldom opinion leaders, but they are an important link in the diffusion process, providing "interconnectedness in the system's interpersonal networks." Their key characteristic is that "they follow with deliberate willingness in adopting innovations but seldom lead."
4. Late majority. Adopting just after the average member of a system, "adoption may be both an economic necessity for the late majority and a result of increasing peer pressures." Relatively scarce resources mean that much of the uncertainty about an innovation must be removed before the late majority feel it is safe to adopt.
5. Laggards. These people are traditional, and are the last to adopt. Their point of reference is the past, and they tend to be "suspicious of innovations and of change agents." Their resistance to innovations may be completely rational from their viewpoint, as they have limited resources and need certainty of success before they will adopt. They are extremely cautious.

Figure 1. Adopter categorization of the basis of innovativeness (Rogers, 2003)



The innovativeness dimension, as measured by the time at which an individual adopts an innovation or innovations, is continuous. The innovativeness variable is partitioned into five adopter categories by laying off standard deviations (sd) from the average time of adoption ($\bar{x}$).

Rogers (2003) also describes other characteristics of adopter categories, including

- *Socioeconomic characteristics* such as time in formal education, literacy, social status, upward social mobility, and the size of the farm unit;
- *Personality variables* such as empathy, dogmatism, dealing with abstract concepts, rationality, intelligence, the ability to cope with risk and uncertainty, attitudes to change, fatalism and aspirations;
- *Communication behaviour* such as social participation, interconnectedness, contact with change agents, and seeking knowledge about innovations.

2.4 Research and extension models

2.4.1 Top-down / transfer of technology

Chambers and Ghildyal (1985) describe the "transfer of technology" model as

> *deeply embedded in the thinking of many professions and disciplines around the world. It is part of the structure of centralised knowledge in which power, prestige and professional skills are concentrated in well-informed 'cores' or centres. These cores or centres generate new technology which then spread (or do not spread) to the peripheries... Scientists in experiment stations, glasshouses and laboratories generate, or test, new technologies and then pass them over to extension services to transmit to farmers.*

This model works for many situations and provides some benefits:

- "gaining professional recognition and … minimising risk of not gaining it through failed experiments, in-laboratory and on-station work in controlled environments" (Chambers and Ghildyal, 1985)
- Where sophisticated and/or expensive research methods or equipment are needed
- Where the need for extension of the research outcomes is limited (eg plant breeding)

The downfalls of this model in terms of development and extension of innovations can in some cases be significant. This top-down model is now considered mostly inappropriate for the development of on-farm technologies as it emphasises a hierarchical system of technology development which does not take into account the contextual knowledge of farmers, and the benefits that come from the networks utilised in models that put scientists, farmers and extension agents into more collaborative roles.

2.4.2 Farmer first and last / Farmer back to farmer

An observation that "we scientists often perceive technical problems through different eyes to farmers" (Rhoades and Booth, 1982) seems to be a turning point, where research and extension shift from a top-down model, to one where instead of "doing research *about a problem*" scientists moved to doing "research to *solve a problem*" (Rhoades and Booth 1982). This is a paradigm shift, where no longer are researchers the experts, and farmers simply instructed in how to apply new technologies or techniques, but farmers' needs come first, and they evaluate the final product or process. This type of research has often been multidisciplinary, and starts with a common definition of the problem (Rhoades 1982). Farmer evaluation is the "last judgement" of success

or failure: “the validity of the research findings and process… rested on whether farmers were willing to test and use the technology at their own expense and time” (Rhoades and Booth, 1982). Chambers and Ghildyal (1985) state that “the normal “transfer-of-technology” model for agricultural research has built-in biases which favour resource-rich farmers whose conditions resemble those of research stations. [The farmer-first-and-last model] starts and ends with the farm family and the farming systems.”

2.4.3 Participatory

Participatory research (PR) or participatory action research (PAR) focusses on building the capacity of farmers to develop their own solutions. Hagmann, Chuma, Murwira and Connolly (1999) described the process:

> *Building of farmers’ management and problem solving capacity requires joint learning through practical field work. Teaching of ‘external’ knowledge and technologies is insufficient if the knowledge is not directly applied and tried out by the farmers themselves. Capacity can be gained by learning through experience…Leaning new ways of solving problems has to start with farmer’s needs and priorities. This way, learning becomes an iterative process of action and reflection. Action leaning… encourages reflection and can increase farmers’ analytical capabilities.*

Some of the important factors that PR recognises are:

- That “a participatory approach necessarily acts in a complementary way to existing strategies. It is not intended to replace mainstream research and extension efforts, but to assist in their effective operation through existing institutional structures” (Scoones and Cousins, 1989);
- That “dialogue with farmers, farmer experimentation… are the major elements to improve development and spreading of innovations, thus the efficiency of extension” (Hagmann, Chuma and Murwira, 1996);
- That “outsiders are unable to determine the “best practices” for rural people” (Hagmann et al, 1999);
- That “the research agenda needs to be fuelled by farmers’ needs” (Hagmann et al, 1999), and
- That “the spreading of innovations depends on the interaction between rural people and their social organisation” (Hagmann et al, 1999), and

Participatory research “strongly demands a common effort to relate the contextual knowledge of farmers to the abstract knowledge of scientists” (Ponzio, Gangatharan and Neri, 2013). Famers are no longer simply the “beneficiaries” of research, they are seen as the “consultant and collaborator” (Scoones and Cousins, 1989), with the local knowledge that is necessary for technologies to succeed. One of the key strengths is seen “to reside in exploring local knowledge and perceptions” (Cornwall and Jewkes, 1995) and that “it is capable of better addressing farmers’ problems that very often are not recognized using conventional nonparticipatory approaches” (Ortiz-Ferrara et al, 2007).

Some of the main downfalls of PR are:

- The “pursuit of greater relevance has often led to compromises in research designs, unclear results and frustration amongst farmers, commercial agronomists and Research Development and Extension (RDE) agency researchers” (Lawrence, Christodoulou and Whish, 2007);
- It requires extensive collaboration which, while a positive, takes much more time, resource and effort: “it is a very demanding process that evolves when two spheres of action – science and practice – meet, interact, and develop and understanding for each other (Bergold and Thomas, 2012); and
- That “the process of conducting research is as important as the research outcome” (Krishnaswamy, 2004) which can mean that much more resource is needed for a single project than with other models.

2.5 Collaboration

What emerges clearly in the literature on the more recent models for research and extension is the critical role that collaboration plays. Some of the benefits of growers or grower groups being in a network with researchers are described in Table 1. These cover multiple levels of collaboration, but there is benefit on both sides. Some of the key benefits and constraints of collaboration are described below.

Table 1. Benefits and constraints of research collaboration (Gianatti and Carmody, 2007).

Benefits	Constraints
Greater access to target audience through increased exposure to grower group members	Research environment is constrained by rules, regulations and reporting
Improved information flow and feedback between all partners	Ownership of knowledge in collaborative projects
Ensures the research is relevant to growers and the local farming system	Poor communication between partners
More efficient use and sharing of resources	Recognizing different levels of rigor in research
Builds trust and ownership between partners to accelerate adoption	Scarce amount of time and resources for all partners
Increased networking opportunities and sharing of ideas	Complexity in transaction costs make it difficult to meet stakeholders needs

Siedlok, Hibbert and Sillince (2015) state that "collaboration across knowledge domains is recognised as a source of competitive advantage." It's not easy though: "while collaboration between communities can advance learning and innovation, differences between the practices of communities seeking to collaborate have been described as obstructing these outcomes" (Siedlok et al, 2015).

2.6 Opinion leaders and influence within networks

Opinion leaders play an important role in any network. They are able to "influence other individuals' attitudes or overt behaviour in a desired way with a relatively high frequency" (Rogers, 2003). With scarce resources, change agents often target opinion leaders, "because the opinion leader magnifies the change agent's efforts" (Rogers, 2003). The other benefit that change agents can gain by utilising and linking themselves to opinion leaders is "the local sponsorship and sanction for the new ideas that are introduced" (Rogers, 2003). They can improve the credibility of the change agent simply by their association.

Opinion leaders can be "overused" though – they may come to be viewed as "too innovative in the eyes of their followers … thus, a change agent can "wear out" the credibility of opinion leaders by making them too innovative" (Rogers, 2003).

2.7 Barriers to adoption

Ngenang (1997) investigated the decision making process for adopters and non-adopters of innovations, and found that "farmers would not accept any information or an innovation which did not fall within their own conceptual construct framework or outside the range of convenience of their cognitive structures." The key differences between the adopters and non-adopters in this study were that adopters recognised the value that the innovation had to their whole farm system, and to their profitability, while non-adopters focussed on high cost, inconvenience and hassle, risk and complexity.

Similarly, in a 2014 study by Reimer and Prokopy, the motivation for adopters to participate in an environmental programme were perceived "off-farm" or community benefits, and operational benefits such as improved soil quality, while the barriers to adoption described by non-adopters were principally lack of knowledge and lack of motivation. Farm size was positively correlated to the likelihood of participation in the programme, while management requirements were a significant barrier for some farmers.

Innovative Brazilian farmers in a study by Pereira (2011) were segmented into four groups:

- The Professional Farmer (PF, aims to run the farm in a professional way)
- The Committed Environmentalist (CE, emphasis on long-term sustainability of the farming system)
- The Profit Maximiser (PM, focus on technical issues to pursue economic and lifestyle objectives) and

- The Aspirant Top Farmer (ATF, seeking excellence and recognition for this).

The types of technologies adopted by each group varied, with the more production-oriented (PF, PM and ATF) adopting more production technologies, while the CE type had highest rates of adoption of environmental technologies.

2.8 Critical incident technique

The Critical incident technique (CIT) is a set of procedures for collecting observations of behaviours and then classifying them so that they are useful in addressing practical problems (Islam, 2014). The technique was developed by John Flanagan in the 1940s and 50s, and published for the first time in 1954 (Flanagan, 1954). The subject is asked to describe a specific, or "critical" incident, which is then investigated more deeply through questioning.

One of the studies that informed Flanagan's work, carried out by the United States Aviation Psychology Programme in which he played a part, described their objective as "the determination of critical requirements. These requirements include those which have been demonstrated to have made the difference between success and failure…. The cooperating individual described a situation in which success or failure was determined by specific reported causes." (Flanagan 1954).

3.0 Methodology

Interview questions were developed to determine the views and practices of kiwifruit growers with regards to adoption of technologies on-orchard. Growers were first asked to name the innovations they knew of, and which of these they had adopted themselves. The critical incident technique (CIT) was then used to explore motivations for adoption of a technology they had chosen to implement, and the barriers that they perceived that resulted in their own non-adoption of a specific technology. Growers were asked to describe the characteristics of innovators and early adopters, and then of laggards (as defined by Rogers (2003)) and then to place themselves on the Rogers adoption/innovation curve, and explain their placement. Their key sources of information about growing kiwifruit were also explored. Background data was collected on their history growing kiwifruit, formal training in horticulture, the extent of their other primary industry involvement, and the size of the area that they have direct influence over (hectares).

Eight grower interviews were conducted in May 2015, with candidates selected based on their orchard(s) performance in the previous two seasons. All eight growers are based in the Bay of Plenty. Four key segments were identified: Hayward growers with (1) average performance (around the 50th percentile for yield and dry matter) or (2) high performance (around the 75th percentile), and Gold3 growers with either (3) average or (4) high performance. There were two growers in each category. These segments were selected to try and represent four types of growers.

Table 2. Characteristics of grower segments.

Characteristics of each segment		Performance	
		Average	High
Variety	Hayward	1. Traditional grower, moderately successful	2. Traditional grower, successful
	Gold3	3. Innovative grower, moderately successful	4. Innovative grower, successful

Each grower was introduced to the topic with a statement that they would identify some innovations, and look at two in detail with a view to trying to understand some of the motivations for, and barriers to adoption of

innovations on-orchard. Interviews were conducted in person (one on one) and recorded for later transcription. The data from each interview was summarised by question, and analysis carried out across each segment to identify similarities and differences in motivations and barriers.

4.0 Findings and discussion

4.1 Interviews

4.1.1 The four segments

4.1.1.1 Hayward growers, average performance

Segment one, Hayward growers with average performers, had both been in the industry for over 30 years. They were growers when the industry went through some very tough times, and managed to hold on to their orchards and businesses, although both had side-line horticultural operations to provide some additional financial stability during the worst of the debt crisis of the 1990s. Neither had formal education in the horticulture area, and had "learnt in the school of hard knocks." Both also grow crops other than kiwifruit. One grower was an owner-operator who did all the work himself on his orchard, the other an orchard manager for a post-harvest company who also owned or part-owned several orchards himself. The first identified himself as a "workaholic and a bit of a perfectionist", and said he didn't have time to go to field days, or to read industry publications. The second said he talked to lots of people about it before making a change, but had been in the industry for a long time and was wary of moving too fast on anything. These growers identified their key barriers and motivations as below.

Table 3. Motivations for adoption: Segment One

Motivations for adoption	**Evidence**
Financial – being "hit in the pocket" by non-adoption	"I didn't want to lag behind." "The next year we were forced into it."
Needing a solution to a specific significant issue	"We've got to do something differently."
Peer/network pressure	"I stayed away from it for a few years, but we were lagging behind, so I got on board."

Table 4. Barriers to adoption: Segment One

Barriers to adoption	**Evidence**
Cost	"You spend a lot of money on these things."
Lack of evidence	"I don't see the effectiveness of it." "I'm not convinced enough." "I've seen it done… and production next season was crap."
Underlying beliefs	"I'd rather let Mother Nature do it." "It's just not natural."
Perceived lack of need to change	"I don't feel we're under a lot of … pressure here."
Conservatism	"I'm a little bit more cautious now."

4.1.1.2 Hayward growers, high performance

Segment two were growers who had both had formal education to degree level in horticulture. One had been in the industry for over 30 years, the other 9 years. Both had a sole focus on kiwifruit, one as an owner-operator, the other as an orchard manager for a post-harvest facility. Both identified their grower associate network as a key source of information and support for making a decision. The younger was just starting to develop this network, but named several prominent people he went to for advice. They identified their barriers and motivations as below.

Table 5. Motivations for adoption: Segment Two

Motivations for adoption	Evidence
Desperation – change or fail	"Desperation – if this didn't work we were out of the industry." "I had negative equity in the orchard – something had to change."
Perceived advantage of new techniques	"I could see the level of effectiveness against the other treatments." "Science trials showed it worked better than anything else, so we gave it a go."

Table 6. Barriers to adoption: Segment Two

Barriers to adoption	Evidence
Answerable to clients	"I have to try and convince the grower."
Seen on other sites and didn't like	"It seems hugely invasive. I don't know what the level of damage is."
Reputation of the company at risk	"As a manager… that could have some effects down the line for the company."
Perceived down-side outweighs potential gains	"It might be good for dry matter but not for the canopy." "I went up to X's orchard and I thought "Jeez, there's some damage here." "You're reducing root area, so you might reduce fruit growth, fruit size." "Might have lasting effects."

4.1.1.3 Gold3 growers, average performance

This segment had two very different growers. One had a long history in the kiwifruit industry, having trained as a cadet and been a grower for over 30 years, now overseeing a very large orchard management company, and the other having trained and worked as a financial accountant with the intention of growing kiwifruit long term, now managing 16 hectares of kiwifruit planted by his parents. The first is involved in some other crops, and said he thought the data for several innovations he had not adopted for lack of evidence was probably out there, but he was too busy to find it. The second has a sole focus on kiwifruit and has been involved in a Zespri pre-commercial trial programme. He has "an informal network of growers who I rate" and makes use of this network frequently. Their barriers and motivations are listed below.

Table 7. Motivations for adoption: Segment Three

Motivations for adoption	Evidence
No down side	"Wasn't much of a risk." "There was no down-side."
Need to be above average in everything	"You have to be above average in everything you do. I do it because you have to be above average. "

Table 8. Barriers to adoption: Segment Three

Barriers to adoption	Evidence
Lack of evidence	"I haven't seen the data. It might be there but I haven't had time."
Answerable to clients	"I have to be answerable for every decision."
Conservatism	"I'm very conservative."
Site constraints	"If Armillaria wasn't a factor I would definitely try it."

Underlying beliefs	"I would rather do it another way." "I don't want to do it here. Too invasive." "Similar risks to what I thought girdling was five years ago." "You only stress vines as much as you have to to get over the line." "If you started from year dot and did it every year, it would be fine." "There's no such thing as a free lunch."

4.1.1.4 Gold3 growers, high performance

Both growers in segment four have been working in the industry for 11-12 years. They both grew up in orcharding families, and after time working away, have come back to run and work in the family business. One has a management degree. Both have been involved in Zespri pre-commercial trial programmes, and manage large areas of kiwifruit. Both these growers identified their networks as key to their decision making, and valued the contact with innovators and early adopters they gained through the pre-commercial programme. One said his network was a group of "people I look up to, people who get good results," the other had "a network of people that you respect their information will be correct." Their barriers and motivations are listed below.

Table 9. Motivations for adoption: Segment Four

Motivations for adoption	**Evidence**
Maintaining high performance	"We want to sustain high levels."
Cost of non-adoption	"We can't afford not to."
Drive for efficiency in a large operation	"The bigger you get the more efficient you have to try to make things."
Early adopter advantage in returns	"X was doing trials on mum and dad's orchard."
Perceived advantage of new techniques	"I could see the merits."

Table 10. Barriers to adoption: Segment Four

Barriers to adoption	**Evidence**
Mess	"Mess – I don't like the orchard ripped up."
Lack of evidence	"I'm not convinced on the evidence."
Perceived lack of need to change	"I don't see a need to right now." "I'm not sure we need to constantly damage the roots so much.

4.2 Case studies

4.2.1 Case study one: DairyNZ

DairyNZ is the industry organisation that represents all New Zealand dairy farmers. It is funded through a milk-solids levy, and has the mandate to "support on-farm change, create on-farm opportunities, build capability and mitigate risk to achieve the industry's strategic objectives" (DairyNZ, 2015b). The key barriers to adoption for dairy farmers, as stated by the General Manager for Extension, Andrew Reid (Personal communication, 8 June 2015), are an individual's appetite for risk, and the relevance of the technology to their personal short and long term goals.

The organisation has a large extension team, who work in the field with farmers to help them become more successful. A range of strategies are used to roll out innovations, which are often developed by researchers working with small teams of farmers (A Reid, personal communication, 8 June 2015):

- The use of opinion leaders as part of a demonstration farm program. Farmers who have extensive relationships within the community, a high level of credibility and are articulate, are showcased in their communities through this program (A Reid, personal communication, 8 June 2015).
- Network mapping. A database of the relationships between farmers is utilised to influence laggards who are unlikely to be influenced by DairyNZ directly. By working with the influencers, these laggards are indirectly targeted (A Reid, personal communication, 8 June 2015, DairyNZ, 2015c). The stated aim of the project is to "develop farmer networks into a tool that can be used by DairyNZ to reach and engage with farmers more effectively (DairyNZ, 2015c).
- Segmentation of farmers by farm size and farming systems to ensure that extension messages are relevant (A Reid, personal communication, 8 June 2015).
- Regional plans and regional objectives. These plans are developed by input from local farmers, rural professionals and DariyNZ staff. (DairyNZ, 2015a).

DairyNZ are utilising networks and opinion leaders, and employ a "farmer-first" approach to research. These elements contribute to successful adoption of complex innovations across the dairy industry, and will be key elements of the success of innovation adoption in the current dairy climate, where farmers are aiming to spend less to achieve more.

4.2.2 Case study two: Pre-flowering trunk girdle

One of the impacts of Psa on green kiwifruit varieties is the loss of flower buds due to Psa-bud rot. Between budbreak and flowering, flower buds can develop brown staining. Infected flowers do not open fully, if at all, which results in misshapen fruit, or flower buds that wither on the vine. Crop losses due to budrot have been estimated at over 60% on some orchards, severely impacting on the profitability of these operations. Historical practices by Japanese and Korean kiwifruit growers to limit bacterial budrot have included a pre-flowering trunk girdle, applied 20-30 days before flowering (Koh, 2001).

Trunk girdling is an innovation that was first used in the kiwifruit industry to increase fruit dry matter levels and is a practice where both the outer bark and the phloem cells of the trunk are removed to restrict the flow of carbohydrates produced in the aerial parts of the vine down into the root system. When trunk girdling was first trialled in New Zealand by Basil Cook in the 1980s, it was seen as an extreme technique that would have significant impacts on vine health. The benefits of trunk girdling include:

- Increased flower numbers the following season when applied in late summer (Hopping, 1990);
- Increased fruit size when applied 30 days after flowering (Patterson and Currie, 2011);
- Increased fruit dry matter levels when applied in late summer (Black, Patterson, Gould and Clearwater, 2012).

By 2014, trunk girdling was a well-accepted practice, adopted by the vast majority of New Zealand kiwifruit growers. In June 2014, a report was published describing the success of the pre-flowering trunk girdle in New Zealand (Ryan, 2014) and was subsequently publicised in the New Zealand Kiwifruit Journal (Scarrow, 2014) and in a webinar run by OPC. Growers who had previously experienced high levels of Psa-budrot were quick to adopt the new practice. Its attributes fit well with Rogers' (2003) description of successful innovations:

1. Relative advantage: it was not replacing any existing innovations, and the other options were
    a. Do nothing and possibly lose significant portions of the crop, impacting on orchard profitability
    b. Spray chemicals that were shown in trials to be less effective than the trunk girdle.
2. Compatibility: growers already used the technique in different times of the season to good effect, and were comfortable with the risks inherent in doing so.
3. Complexity: the innovation is relatively simple, and already well understood from its other uses.
4. Trialability: as the trunk girdle is applied to each vine individually, the trialability was high with growers able to easily leave control vines.
5. Observability: visible differences between treated and untreated vines could be seen within weeks of treatment.

4.2.3 Case study three: Root pruning

A research report prepared for Zespri in 2009 (Patterson et al 2009) provided an update on scientific trials over two seasons on the use of root pruning to improve fruit dry matter content. Root pruning is a technique used in crops other than kiwifruit, and "involves the cutting of roots to depths ranging from 0.4-0.9m in a line parallel to the tree or vine row at distances of c. 0.7-0.8m out from the centre line of the row" (Patterson et al, 2009). Subsequent reports have all shown the positive effect of root pruning treatments on fruit dry matter content (Black et al, 2012), but the innovation has not gained momentum within the industry. In grower interviews, seven out of the eight growers chose root pruning as an example of non-adoption. With significant premiums paid for high dry matter fruit, the tools available to increase dry matter should be an "easy sell".

When considered in light of Rogers' (2003) attributes of innovations, some of the possible reasons for this lack of adoption become apparent.

- Relative advantage. Compared to trunk girdling for dry matter, root pruning provides little relative advantage. Several growers stated that they would be happy to try root pruning if the current tools were not sufficient to achieve good dry matter levels, but that at this stage they were satisfied that they did not need to.
- Compatibility. Cutting the roots of the vine appears to be at odds with some core beliefs of the growers about vine health:
    - "We've got to be careful how we treat our plants."
    - "It's too invasive."
    - "That's scary!"
    - "I'm not sure we need to constantly damage the roots so much."
    - "I don't know what the level of damage is."
- Complexity. Because the technique relies on cutting roots in the soil, the extent to which roots are being cut is not visible, and heavy-duty machinery needs to be brought in to carry it out.
- Trialability is much more complex than what is possible with simpler techniques. The impacts of root pruning have been shown to be very different on different soil types, and depends on what proportion of the root system is cut off, which is not able to be easily assessed in a commercial setting. Several growers were concerned that the evidence reported was from trials carried out on only a small number of vines, and not over multiple seasons on the same vines, so any vine health impacts that result from longer-term use of the technique would not be evident.
- Observability. The positive impacts of root pruning are an increase in the dry matter content of fruit. This must be tested in a laboratory setting and is not easily done by growers – therefore there is a cost involved in measuring any differences. Growers are much more likely to be able to observe the negative impacts in terms of vine health than any positive impacts.

5.0 Recommendations

There is no silver bullet in the extension world. Unless we begin to better understand the networks at play in the grower community, the barriers and motivations for adoption and how these relate to innovation attributes, and how to better involve growers in both the research process and the setting of priorities and evaluation of the success of the research programmes, we will not significantly increase the pace of change within the industry. The following four recommendations go some way to addressing these issues.

5.1 Network mapping

Both in the grower interviews, and the DairyNZ case study, the use of networks emerged as a critical factor in the adoption decision making process. A better understanding of farming networks, social networks and the business priorities of orchardists would enable OPC to "better tailor its reach to and support of the different sectors" (DairyNZ 2015c).

A critical part of such a project would be to understand who the "nodes" or opinion leaders are – usually early adopters, these farmers serve as bridges between different groups, and carry information across boundaries between groups. The two growers in segment four (Gold3, high performers) could both be considered opinion leaders, and they and growers with similar characteristics were referred to by growers in the other three segments interviewed here. Identifying these key nodes, and utilising their networks, will be key to increasing the rate of practice change across the industry. They serve as "a role model for many other members" through "decreas[ing] uncertainty about a new idea by adopting it, and then conveying a subjective evaluation of the innovation to near peers through interpersonal networks" (Rogers, 2003).

Understanding who the key players are, and targeting them, may help to reach some of the late adopters and laggards in the grower community, and accelerate adoption. There are sure to be growers who are opinion leaders who have not yet been identified as such, and utilising these people more may reduce the risk of "wearing out the credibility" of some of the better known ones, who have been used frequently.

5.2 Research models

One of the segment four growers has been involved in several significant research trials, run on his orchard by research organisations contracted by Zespri. His feedback about two projects run at similar times and on closely related topics should result in some change to the way relationships between researchers and growers:

> *The … research with Plant and Food [Research] - what we learnt as growers was amazing. It's not typical of research trials. X was fantastic, sharing information, talking me through it, explaining the results, and in terms of making a better grower, that was good stuff. The other trial was terrible, I'll never do another one unless a) I've got an interest in it, and b) I'm going to get something back out of it. The … trial, I learnt nothing.*

This statement highlights the importance of a strong working relationship between growers and scientists or researchers. In the first trial, the grower was considered as a partner in the research, and his questions, feedback and comments led to improvements in the research design, and therefore more relevant outcomes which he was then in a position to filter out to his network from his position as an opinion leader. The second trial, in contrast, simply used his orchard as a physical resource, and did not take advantage of his willingness to be involved – a top-down approach. As a result, he has no desire to be involved with that research team for further projects and the opportunity for his experiences to provide a "stamp of approval" for the trial has been missed. The farmer-back-to-farmer or "farmer first and last" model used in the first trial was very successful, and could be used as a model for further research.

In the grower trials space, one of the key aims of the programme is building capability: helping growers to solve simple questions and improving their ability to solve these questions on their own. In this space, a participatory model would be more appropriate: while resources are limited, and the number of trials would have to be restricted to account for the increased level of resource needed for each one, involving growers much more in the design, implementation and analysis of their trials could in the longer term result in much better outcomes.

5.3 Farmer first and last

The "on-orchard brainstorming group" is a very positive move forward in terms of getting grower engagement with the research and innovation programmes. Most of the growers involved in this group could be considered as opinion leaders. Further use of the group could be made in evaluating the success of projects and feeding the results out to the wider grower community through them, alongside the more formal extension tools such as field days and written material.

The use of the same (or a similar) group to evaluate the success of research programmes would be a further step that could create some momentum for adoption. This would "close the circle" (Rhoades, 1982).

5.4 Barriers and attributes

The contrast between the rate of adoption of the pre-flowering trunk girdle, and root pruning, is a stark one. The fundamental risks perceived by growers to be associated with adoption of the two technologies are very

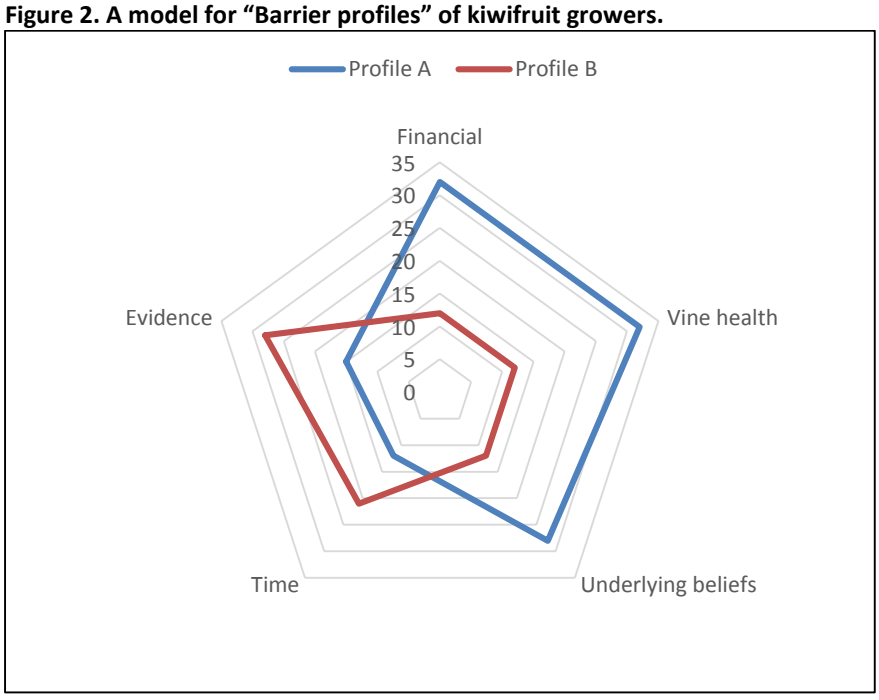
different, partly due to their differing innovation attributes, and this should be taken into account in both research and extension programmes. Where trialability is more difficult, the scale of research trials should perhaps be increased to give more confidence in the results. For innovations where significant costs may be associated with adoption, a cost-benefit analysis may assist with the adoption decision process for growers who have cost as a barrier.

Uncertainty about the negative impacts on vine health emerged as a major barrier to adoption of root pruning. If the industry is serious about using this tool, and mainstream adoption is the goal, commercial scale trials over several seasons which assess both the efficacy and impacts of the innovation would be hugely beneficial in answering some of these questions.

6.0 Further work

The grower interviews reported here have identified some useful information in terms of the barriers to and motivations for adoption. A wider survey of the whole grower community may allow common profiles to be identified, and could lead to the possibility of using these profiles to target messaging. An email survey could be used, and common profiles mapped on a "radar" diagram (Figure 2), which could be used to map the extent to which a particular factor is a barrier for an individual. In the scenario in Figure 2, grower A would need more information about financial aspects and vine health impacts, while grower B needs more evidence that the technology actually works.

Figure 2. A model for "Barrier profiles" of kiwifruit growers.



Segmentation by barrier profile, rather than other metrics, may be an effective tool for communication in some situations.

Understanding how these profiles might differ in regional growing areas (ie outside of the Bay of Plenty) may give some insights into how these areas could be targeted better. Many regional areas have a lack of technical support, growing conditions that are significantly different and often much more challenging than the Bay of Plenty, and have a focus on crops other than kiwifruit. These factors may significantly impact the specific motivations and barriers of growers in these areas.

7.0 Conclusions

In the past five years, the pace of change within the New Zealand kiwifruit industry has been phenomenal. Much of this, however, has not been because growers have *chosen* to change; rather, they have been *forced* to change: management practices, varieties, spray programmes, the list goes on. Now that the industry has settled into a state where they are (relatively) comfortable living with Psa, the rate at which changes in practice occur could be expected to slow. If we are to achieve the target of $3 billion in export sales by 2025, momentum needs to be maintained. We cannot get there simply by planting more kiwifruit – orchards need to be more productive, more efficient, and grow better quality fruit that will attract greater premiums.

The role of the Zespri Orchard Productivity Centre is an important one. They aim to facilitate the sharing and adoption of both best practice and new innovations within the industry, and in doing so increase both productivity and profitability of orchards. The use of opinion leaders and grower networks to influence growing practices; better understanding of the barriers that might be associated with the adoption of specific innovations by specific groups; all the way back to the models that are implemented in the research programmes: all these elements will be key to achieving this $3 billion "big, hairy, audacious goal" (R. Pentreath, personal communication, 2010).

References

Bergold, J and S Thomas (2012). Participatory research methods: a methodological approach in motion. *Forum: Qualitative Social Research* 13(1)

Black, MZ, KJ Patterson, KS Gould and MJ Clearwater (2012). Physiological responses of kiwifruit vines (Actinidia chinencis Planch. var. Chinensis) to trunk girdling and root pruning. *New Zealand Journal of Crop and Horticultural Science*, 40(1), 31-41

Chambers, R and BP Ghildyal (1985). Agricultural research for resource-poor farmers: the farmer-first-and-last model. *Agricultural Administration* 20, 1-30

Cornwall, R, and R Jewkes (1995). What is participatory research? *Soc. Sci. Med.* 41(12), 1667-1676

DairyNZ (2015a, 13 June). *DairyNZ Extension Team.* Retrieved from http://www.dairynz.co.nz/what-we-do/services/extension/

DairyNZ (2) (2015b, 13 June). *How we operate.* Retrieved from http://www.dairynz.co.nz/about-us/how-we-operate/

DairyNZ (2015c, 14 June). *Farmer networks implementation (FP1429)*. Retrieved from http://www.dairynz.co.nz/what-we-do/investment/summaries-and-reports/farmer-networks-implementation-fp1429/

Flanagan, JC (1954). The critical incident technique. *Psychological bulletin,* 51(4), 327-358

Gianatti, TM and P Carmody (2007). The use of networks to improve information flows between grower groups and researchers. *Field Crops Research* 104, 165-173

Hagmann, J, E Chuma, and K Murwira (1996). Improving the output of agricultural extension and research through participatory innovation development and extension; experiences from Zimbabwe. *European Journal of Agricultural Education and Extension.* 2(3), 15-24

Hagmann, J, E Chuma, K Murwira and M Connolly (1999). Putting process in to practice: operationalizing participatory extension Agricultural Research and Extension Network, Network Paper No 94

Hopping, ME (1990). Floral biology, pollination and fruit set. In IJ Warrington & GC Weston (Eds.), *Kiwifruit science and management* (pp)71-96. Wellington, New Zealand: Ray Richards Publisher

Islam, AKM (2014). Sources of satisfaction and dissatisfaction with a learning management system in post-adoption stage: A critical incident technique approach. *Computers in Human Behaviour*, 30, 249-261

Koh, YJ, AH Lee, JS Shin and JS Hur (2001). Chemical and cultural control of bacterial blossom blight of kiwifruit caused by *Pseudomonas syringae* in Korea. *New Zealand Journal of Crop and Horticultural Science,* 29, 29-34

Krisnaswamy, A (2004). Participatory research: strategies and tools. *Practitioner: Newsletter of the National Network of Forest Practitioners* 22: 17-22

Lawrence, D, N Christodoulou and J Whish (2007). Designing better on-farm research in Australia using a participatory workshop process. *Field Crops Research* 104, 157-164

Ministry for Primary Industries (2013) Statement of Intent 2013-2018. Wellington, New Zealand: Author

NZKGI (2015). *New Zealand Kiwifruit Book 2015*. Tauranga, New Zealand: Author

Ngenang, AK (1997) Decision processes of adopters and non-adopters of an innovation. (Doctoral Thesis). Lincoln University, Lincoln, New Zealand

Ortiz-Ferrara, G, K Joshi, R Chand, MR Bhatta, A Mudwari, DB Thapa, MA SuWan, TP Saikia, R Chatrath, JR Witcombe, DS Virk and RC Sharma (2007). Partnering with farmers to accelerate adoption of new technologies in South Asia to improve wheat productivity. *Euphytica* 157:399–407

Patterson, KJ, M Currie, P Martin, M Black, P Nicholls, and C Jagielo (2009). Taste improvements in kiwifruit via root manipulation: Year 2 (2008-2009). Auckland, New Zealand: The New Zealand Institute for Plant and Food Research Ltd

Patterson, KJ and MB Currie (2011). Optimising kiwifruit vine performance for high productivity and superior fruit taste. *Acta Horticulturae*, 913, 257-268

Pereira, MA (2011). Understanding technology adoption and non-adoption: a case study of innovative beef farmers from *Mato Grosso do Sul* state, Brazil. (Doctoral Thesis). Lincoln University, Lincoln, New Zealand

Ponzio, C, R Gangatharan and D Neri (2013). The potential and limitations of farmer participatory research in organic agriculture: a review. *African Journal of Agricultural research* 8(32), 4285-4292

Reimer, AP and LS Prokopy (2014). Farmer participation in US Farm Bill Conservation programs. *Environmental Management* 53: 318-322

Rhoades, RE, and RH Booth (1982). Farmer back to farmer: a model for generating acceptable agricultural technology. *Agricultural Administration* 11, 127-137

Rogers, EM (2003). *Diffusion of Innovations* (5th ed.). New York, USA: Simon & Schuster, Inc.

Ryan, T (2014). The effecicay of various products on mature kiwifruit (*Actinidia deliciosa* cv. Hayward) vines for the control of *Pseudomonas syringae actinidiea* (Psa). Retrieved from http://www.kvh.org.nz/vdb/document/99900

Scarrow, S (2014). Reducing budrot losses in green orchards. *The New Zealand Kiwifruit Journal*, September/October

Scoones, I, and B Cousins (1989). A participatory model of agricultural research and extension: the case of vleis, trees and grazing schemes in the dry south of Zimbabwe. *Zambesia* 16 (1)

Siedlok, F, P Hibbert and J Sillince (2015). From practice to collaborative community in interdisciplinary research contexts. *Research Policy* 44, 96-107

Wikipedia (2010, 10 June). *Agricultural extension*. Retrieved from https://en.wikipedia.org/wiki/Agricultural_extension

Zespri (2004). *New Zealand Kiwifruit Centennial Journal 2004*. Tauranga, New Zealand: Author

Zespri (2010a). *Kiwiflier, September.* Tauranga, New Zealand: Author

Zespri (2010b) *Zespri 2025*. Tauranga, New Zealand: Author

Zespri (2014) *Zespri Annual Review 2013/14*. Tauranga, New Zealand: Author