

Avoiding Complacency in Kiwifruit Biosecurity



June 2016

Matt Dyck

“Those who cannot remember the past are condemned to repeat it”

George Santayana

1 CONTENTS

2	Executive Summary	4
3	Introduction	6
4	Aims and Objectives	8
5	Literature review	8
5.1	Complacency in biosecurity or readiness planning	8
5.2	Improving implementation of biosecurity practice	10
6	Methodology	12
6.1	Interview process	12
6.2	Selection of interviewees	13
6.3	Selection of biosecurity practices	13
7	Results and Discussion	14
7.1	On-orchard practice is slipping but there is more to this than complacency alone	14
7.2	Biosecurity awareness	16
	Psa has raised biosecurity awareness in the kiwifruit industry	16
	Future biosecurity incursions are considered a significant risk	16
	Grower's role in the biosecurity system is not widely understood	16
	Only when the risk is perceived as imminent will behaviour change	17
	Growers can learn from the experience of others; some don't learn from their own	17
7.3	Biosecurity practices	18
	The practices that don't make a difference are dropped	18
	Sourcing clean plant material	20
	Monitoring and reporting of unusual symptoms	22
	Orchard visitors	23
	Tool hygiene	23
8	The barriers to implementing biosecurity practice	24
8.1	Information overload	24
8.2	Contractors	24
8.3	Cost of implementing practices	25
8.4	Understanding the "why"	25
	i. Understand the risk	26
	ii. Understand how practices mitigate this risk	26
8.5	There is value in a coordinated approach with other industries	26
8.6	Other opportunities to improve uptake of biosecurity practice	27
8.7	What can we learn from Civil Defence Emergency Management?	27
9	Conclusions	29
10	Recommendations	32
11	Acknowledgements	32
12	References	33
13	Appendices – Interview Questions	35

2 EXECUTIVE SUMMARY

Psa has increased biosecurity awareness in the kiwifruit industry, and is reinforced by recent fruit fly incursions and biosecurity communications by industry bodies. Kiwifruit growers believe that a future biosecurity incursion is a significant risk to their investment in kiwifruit, if not the greatest risk. Yet on most orchards, biosecurity practices have slipped from where they were several years ago.

The aim of this study is to determine if growers are becoming complacent in biosecurity practice over time. If so, how do we overcome this to ensure that the kiwifruit industry is prepared for a future biosecurity incursion?

Interviews were held with kiwifruit growers, post-harvest grower services representatives and biosecurity subject experts to understand grower attitudes to biosecurity practices and why certain practices were no longer being implemented, especially in “Recovery Regions” where Psa had been present the longest. A subject expert from Civil Defence was also interviewed to learn how they overcome complacency when preparing the public for emergencies.

The results of the study indicate that growers in Recovery Regions are retaining those practices seen to make a difference in mitigating the impacts of Psa. Some growers believe the initial protocols implemented for Psa are excessive for the current environment and the decline in practice is not a result of “complacency” but rather a “new norm” appropriate for the current level of risk.

However, this reflects the Psa-centric paradigm of the industry. For most growers thinking about “risk” does not extend beyond Psa at least not in terms of their own on-orchard practices. The role growers can play in mitigating the impact of future biosecurity incursions does not seem to be well understood and is considered the responsibility of organisations such as KVH and MPI.

Most growers believe they are doing what is necessary to manage “risk” (of Psa). However, this falls below what most subject experts would recommend as a minimum standard to reduce the impacts of a future biosecurity incursion. If every grower maintained a baseline of minimum on-orchard practice even in the absence of an imminent threat, the industry would be more likely to limit the spread of a pest or pathogen before it is detected, and for many organisms that could determine whether eradication is a possibility or not. For growers the financial implications of this can be extremely significant. A biosecurity threat that is not eradicated, creates a challenge that needs to be managed year after year. Impacts to the grower may include loss of orchard productivity and land value, increase in operating costs, market access implications and in some cases, all of the above. Biosecurity practices provide the industry with a form of insurance against a significant business risk.

Numerous barriers to implementing best practice are identified in the study including information overload, the cost of implementing practices and commercial disincentives associated with some practices. However, subject experts, from biosecurity or Civil Defence, were unanimous in stating that the single greatest barrier to uptake of recommended practice is a lack of understanding of risk, and how specific measures mitigate this risk. Creating this understanding is a fundamental step in the implementation process, but it is only the first step. Different segments of the industry respond to different cues and require different support through the implementation process which may include; guidance on how to implement the practice, testimony from trusted sources such as their peers or opinion leaders, observation that the practices are effective and feedback to reinforce their decision to implement once they have done so.

Literature and subject experts suggest that to facilitate the necessary behavioural change, the industry should establish a working group of biosecurity champions and opinion leaders. Involvement of this group in the development of biosecurity guidelines will ensure they are practical, fit for purpose and have the support and ownership of the industry from an early stage. Industry champions also provide a respected resource to communicate key messages and provide on-going support to growers. When programme champions play an active role in the development of an innovation, spread and implementation is likely to be more effective.

The study makes the following recommendations for the kiwifruit industry:

1. Biosecurity awareness material needs to be made “real” for growers, in terms they relate to such as potential impact to orchard productivity, trade, and orchard value.
2. Industry biosecurity guidelines are required, to indicate the level of practice required for business-as-usual operation in absence of an imminent biosecurity threat or response. These guidelines would provide consistency across the industry, remove commercial disincentives that currently exist, and thereby improve the industry’s ability to withstand a future biosecurity incursion.
3. Guidelines should clearly explain the purpose of a recommended practice and how this mitigates risk.
4. Recommended practices should be practical and easy to implement. Industry bodies should facilitate this process.
5. A network of industry champions and opinion leaders should be created to assist in the development, communication, implementation and on-going support of the biosecurity practices.
6. Care must be taken when selecting industry champions and opinion leaders to ensure selection of individuals with appropriate influence into a diverse range of industry networks.
7. There is value in a coordinated approach with other industries and they should be involved in the development of biosecurity guidelines to provide consistent messages across the horticultural sector.

3 INTRODUCTION

In 2010, biosecurity became very real for the kiwifruit industry when it experienced its first significant incursion, the vine infecting bacteria Psa¹. With no feasible eradication options, Psa has slowly spread throughout New Zealand's kiwifruit growing regions, to the point where 85% of New Zealand kiwifruit orchards are Psa positive and the South Island is the only remaining growing region without the bacteria (KVH 2016).

Classification of Regions

Growing regions are classified as either "Exclusion", "Containment" or "Recovery" based on the level of Psa present in the region (Figure 1).

Exclusion Regions have no Psa, or it has only been recently detected in a confined location. Efforts in these regions are focused on keeping Psa out. Whangarei and South Island are the two remaining Exclusion Regions.

Containment Regions have Psa in limited distribution. Efforts in these regions are focused on minimizing the spread. Hawkes Bay, Gisborne and NW Auckland are the current Containment Regions.

Recovery Regions have widespread Psa. Efforts in these regions are focused on managing Psa and achieving high productivity in a Psa environment. All other kiwifruit growing regions are Recovery Regions including the Bay of Plenty where over 80% of the kiwifruit industry is concentrated.

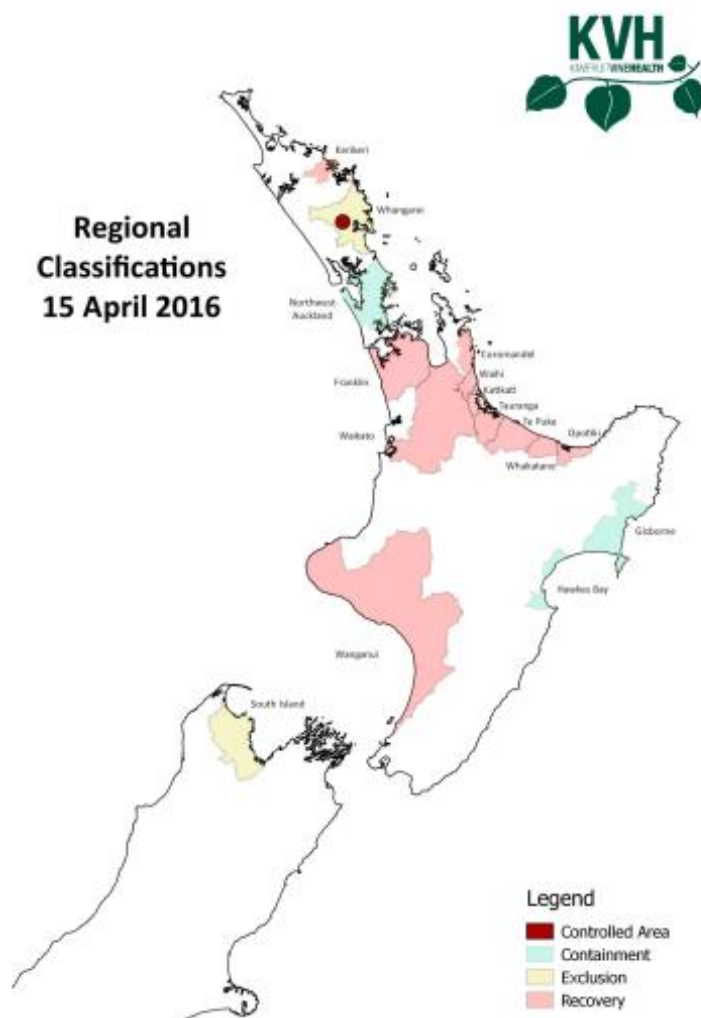


Figure 1. New Zealand kiwifruit growing regions by Psa status, Exclusion, Containment and Recovery

It is thought that the total cost of Psa to the kiwifruit industry could exceed \$800 million in lost production and growth, and over 2,000 full time jobs (Greer and Saunders 2012). The incursion has had significant social costs, concentrated in those communities heavily reliant on the industry.

An independent review into the Psa-V response, found that the high cost of the Psa-V incursion was because (i) Psa is a significant disease and (ii) "the New Zealand kiwifruit industry was simply not

¹ Psa is an abbreviation for the bacteria *Pseudomonas syringae actinidiae*. The particular strain found in New Zealand is often referred to as Psa-V, to indicate the virulent form of this bacteria.

prepared for the incursion of a serious biosecurity pest” (Birnie and Livesey 2014). While the industry knew that Psa was causing significant impacts to kiwifruit offshore, there was a lack of planning and preparedness, and even basic hygiene practices were not in place for many industry players (Birnie and Livesey 2014).

The hygiene recommendations of Birnie & Livesey (2014) emphasize that to be of maximum effectiveness, hygiene and movement controls need to be in place before a pest or pathogen arrives and not just after it is discovered:

“Parts of the kiwifruit industry appear to mistakenly assume that more stringent movement and hygiene controls are only needed during a response to bacteria like Psa-V. This ignores the risk that a new pest or pathogen affecting the industry might arrive in NZ and spread for some time before it is discovered. The more a pest can be contained in the very initial stages of any new incursion, the potentially greater the possibility of being able to eradicate it. Some clearly believe that this was the case with Psa. It is likely that if better movement and hygiene practices had been in place across the industry prior to the arrival of Psa-V, it would not have spread as fast (or as far) as it did. In our view, there does seem to be a case for:

- I. Basic hygiene and movement controls across the industry as business as usual practices, given this risk and the extra costs the industry almost certainly bore by not having them in place before Psa-V arrived.*
- II. An industry-good role in providing the most up to date guidance on good movement control and hygiene practices to orchards and pack-houses (and nurseries).*

To be of maximum effectiveness, hygiene and movement controls need to be in place before a pest or pathogen arrives and not just after it is discovered. The risks around this could be more explicitly explained to industry so they can see a clearer justification for (i)”.

When these recommendations were written in 2014, there was growing scepticism and complacency towards biosecurity, particularly in the Bay of Plenty where Psa had been present the longest. Today in 2016, there is anecdotal evidence that this complacency is continuing to grow. Left unattended, practices could soon decline back to pre-Psa levels, leaving us no better prepared for a future biosecurity incursion. But how do we maintain a high level of biosecurity practice in absence of a perceived imminent threat?

Role of Kiwifruit Vine Health

Kiwifruit Vine Health (KVH) has been established as a dedicated biosecurity body for the kiwifruit industry, responsible for the long term management of Psa and preparing the industry for future biosecurity incursions. Under this mandate, KVH was the first industry signatory to Government Industry Agreements for Biosecurity Readiness and Response (GIA) and is now working in partnership with the Ministry for Primary Industries (MPI), and other primary sectors, for biosecurity readiness and response activities. GIA signatories, have a formal role, alongside government, to prepare for and manage biosecurity risks to their industry (GIA 2016). In this role, KVH has also been encouraging or requiring other sectors to adopt practices that will reduce biosecurity risk to our industry, such as nurseries, bee keepers, transporters and ports of entry. Before we can expect changes from other sectors, it is important to demonstrate that we are effectively managing risk within the industry.

Since 2012 and especially in the last couple of years, KVH has been trying to shift industry focus from a “Psa-centric” paradigm to one of preparedness for the next biosecurity threat. There are at least 70 known biosecurity threats to kiwifruit worldwide, and many more likely exist that have either not yet

been discovered, reported or exposed to kiwifruit as a host (Everett, Manning and Blouin 2014). Any of these threats could be the next biosecurity incursion to challenge the industry and at least a handful which could cause impacts on a similar scale to Psa. On-orchard biosecurity practices limit the spread of pests, and the more a pest can be contained in the initial stages of any new incursion the potentially greater the possibility of being able to eradicate it – all other things being equal (Birnie and Livesey 2014).

Preparedness for future biosecurity incursions is seen as an industry priority for kiwifruit and other primary industries. Each year KPMG survey New Zealand agribusiness leaders and biosecurity consistently ranks as the number one strategic issue facing this sector (KPMG 2015). KPMG's comment in their 2015 report reflect a common attitude to biosecurity; "despite biosecurity being the number one priority identified in our survey, there was little discussion on the topic during the Roundtables. The need to maintain world-class bio-protection systems is seen by most as a given" (KPMG 2015).

In a recent survey of 230 horticultural growers across New Zealand, biosecurity was considered the second biggest issue facing growers' businesses, second only to health and safety (Halliday 2016). Kiwifruit growers especially seem very engaged in biosecurity and are generally supportive of KVH's role (Birnie and Livesey 2014). Most growers are willing to fund activities to prevent future incursions, however these values and priorities are not always reflected in their own on-orchard biosecurity practices.

4 AIMS AND OBJECTIVES

The aim of the study is to determine if growers are becoming complacent in biosecurity practice over time. If so, what is the cause of this and how do we overcome it to ensure that the kiwifruit industry is prepared for a future biosecurity incursion.

The study has three research objectives to achieve this aim:

1. *Determine if kiwifruit growers are becoming complacent in biosecurity practice over time.*
2. *Identify the key barriers that prevent best biosecurity practice being implemented by growers.*
3. *Identify the opportunities to improve uptake of biosecurity practice.*

This study focuses on grower behaviour and attitudes, it will not attempt to review or develop best practice guidelines or explore the biological basis for recommended practice. However, it will seek to understand if further work is required in these areas as subsequent work programmes.

5 LITERATURE REVIEW

5.1 COMPLACENCY IN BIOSECURITY OR READINESS PLANNING

There are no studies in the public domain specifically on avoiding complacency in kiwifruit biosecurity, and very few studies on on-orchard biosecurity in horticulture. Most studies on implementation of biosecurity practices relate to the animal sector, however these offer insight relevant to this study. In fact, the focus of this study is really about effectively communicating and changing a population's behaviour to make them more prepared for an unlikely but potentially catastrophic event, and therefore there is also a lot of commonality with readiness planning for other events such as natural disasters or terrorism.

The majority of research related to emergency management deals with response rather than preparation (Paek, et al. 2010). In the United States of America, billions of dollars have been allocated for improving public preparedness for emergencies and terrorism events, however little is known about how to actually influence the public's preparedness. (Paek, et al. 2010). Awareness of risk is commonly believed to be a primary driver for preparedness, however some studies have found no association between awareness of risk and levels of preparedness (Paek, et al. 2010). A 2002 poll of more than 8000 residents of Los Angeles County showed that despite high perceived risk in which 60% believed a terrorist attack was likely within the next year, only 37% had emergency supplies or plans (Paek, et al. 2010). In this instance, lack of perceived effectiveness of readiness planning may have been a significant deterrent, however other studies have also shown awareness on its own will not necessarily result in action.

Leventhal, Singer and Jones (1965) conducted what is now a well-known study to understand what would influence university students to take up an offer for a free tetanus vaccination. The results of the study indicated that communication material containing detail and graphic images resulted in an increased awareness and intention to get vaccinations, however this did not correspond into action and did not influence the number of students who received vaccinations. The factor that did influence actual vaccination rates was providing the students with a specific plan explaining when and where to get vaccinations. The conclusion of the study was that although action was unaffected by fear level, some level of arousal was necessary for action to occur and then provision of simple guide improved uptake.

For this reason, biosecurity experts rank awareness as one of the most effective biosecurity measures, because a degree of awareness will facilitate the implementation of other biosecurity practices and without at least a minimum level of awareness no further action will result. Kuster et al. (2015) assessed the perceived effectiveness and importance of 30 on-farm biosecurity measures, according to livestock disease specialists. Of all measures evaluated, education of farmers was perceived to be the single most important and effective measures for protecting Swiss cattle and swine farms from disease. Farmers are the first to recognise and report disease outbreaks and education of farmers is a fundamental tool in disease eradication. For highly contagious diseases in particular, early detection and notification by farmers may have an enormous impact on disease mitigation (Kuster, et al. 2015).

Kuster et al. (2015) also found that larger holdings are more likely to suffer greater economic losses in the event of a disease outbreak and was one reason why larger operations are more likely to apply a stricter biosecurity management than smaller operators (Kuster, et al. 2015).

Despite the plethora of biosecurity recommendations, published scientific evidence on the effectiveness of individual biosecurity measures is limited. (Kuster, et al. 2015). The limited examples of proven efficacies, combined with the lack of relevant education are potential reasons for infrequent or non-compliance to biosecurity measures (Kuster, et al. 2015).

Another contributing factor is that much of research efforts are focused on technical risk assessments relating to pathogen detection and control, which don't necessarily provide an adequate guide for the more practical strategies that would be undertaken by growers to manage plant disease on-orchard (Mills, et al. 2011). What is needed are risk management strategies that are tailored to account for the practical balance between managing risk and operating a horticultural business (Mills, et al. 2011).

5.2 IMPROVING IMPLEMENTATION OF BIOSECURITY PRACTICE

Improving the uptake of biosecurity practice in the kiwifruit industry is essentially about achieving mass uptake of a new idea across a population. This is the underpinning concept behind the “diffusion of innovations” theory.

Diffusion of innovations theory

The central tenant of the diffusion of innovations theory is that the adoption of new ideas by a population follows a predictable pattern over time (Greenhalgh, Robert and Bate 2008). The pattern, illustrated in Figure 2, is that the adoption of new ideas is initially slow in the “lag phase”, then “takes off” in an acceleration phase before decelerating and finally tailing off as the last few individuals who are going to adopt finally do so (Greenhalgh, Robert and Bate 2008).

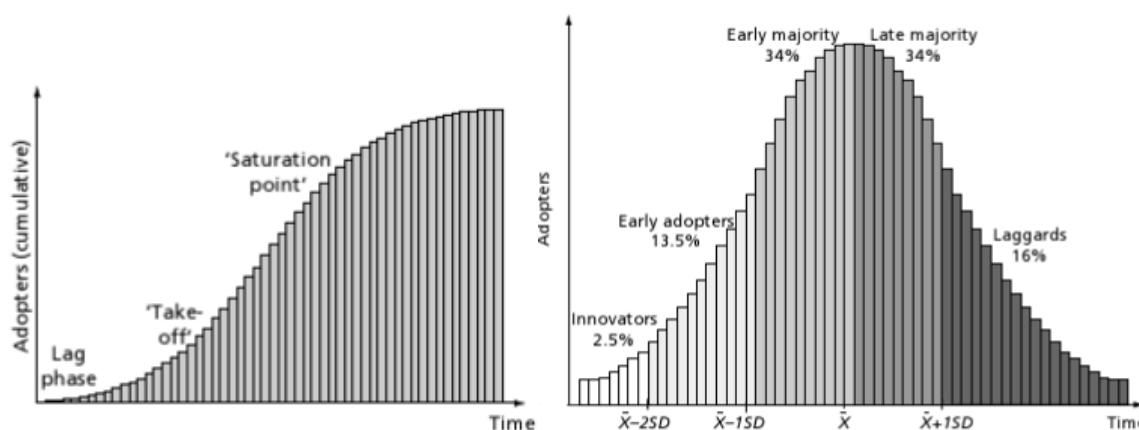


Figure 2 Adoption of innovation over time (left), types of adopters over time (Greenhalgh, Robert and Bate 2008)

The “lag phase” is driven by groups of people known as the “innovators” and “early adopters” who collectively represent only 16% of any given population, however have a strong influence on the remaining 84% (Greenhalgh, Robert and Bate 2008). This theory suggests 15-18% market penetration is required to reach a “tipping point”, where you enter the ‘take-off’ or acceleration phase and achieve large scale adoption of the innovation (Sinek 2009). Therefore, influencing the “innovators” and “early adopters” is seen as a critical step to gain momentum for the innovation. Simon Sinek, ethnographer and leadership author, has dedicated a large portion of his career to explaining that human behaviour is driven by the “why”, not the “what” or “how” (Sinek 2009). Communicating the reasoning is especially important for the “innovators” and “early adopters” and therefore the most effective way of creating behaviour changes is to communicate messages that tap into the reasons behind why we do something, as influencing innovators and early adopters has a strong influence on the remainder of the population (Sinek 2009). These ideas are not new and the diffusion of innovations theory has been heavily studied over the past 60 years with over 4000 publications over a broad range of applications (Wejnert 2002, cited in (Kelly 2012)). Greenhalgh, Robert and Bate (2008) produced an entire book reviewing over 1000 publications on this topic relating to the diffusion of ideas for health service organisations, indicating the depth and complexity of this field. Getting “innovators” and “early adopters” to adopt new ideas is more complicated than simply communicating the reasoning behind these ideas, although that may play a fundamental role.

People are not passive recipients of information, but are complex beings that can respond with a number of actions or feelings, and therefore adoption is not an event, but a process (Greenhalgh, Robert and Bate 2008). Adoption is generally considered to be a five stage process consisting of the following stages (Ryan and Gross 1943, cited in Greenhalgh, Robert and Bate 2008):

1. Knowledge - awareness of the innovation.
2. Persuasion - attempting to form favourable or unfavourable attitudes to the innovation.
3. Decision - engaging in activities that will lead to a choice to either adopt or reject the innovation.
4. Implementation - putting the innovation to use, or rejection.
5. Confirmation - seeking reinforcement of the decision by observation of its impact.

However, Greenhalgh, Robert and Bate (2008) found that another less well known concerns-based adoption model (CBAM) was more applicable to the health sector, and seems to be a good fit for the implementation of biosecurity practice also. The CBAM model suggests three key issues:

1. *Concerns in the pre-adoption stage:* Pre-requisites for adoption are that intended adopters are aware of the innovation, have sufficient information about what it does and how to use it, and be clear about how the innovation would affect them personally e.g. in terms of costs.
2. *Concerns during early use:* Successful adoption is more likely when the adopter has continued access to information about what the innovation does, and to sufficient training and support on task issues, i.e. about fitting in the innovation with daily work.
3. *Concerns in established users:* Successful adoption of an innovation is more likely if adequate feedback is provided to the intended adopter on the consequences of the innovation and autonomy and support to adapt and refine the innovation to improve its fitness for purpose.

(Greenhalgh, Robert and Bate 2008)

Disseminating information

How do we make this work in practice?

“Whilst mass media and other impersonal channels may create awareness of an innovation, interpersonal influence through social networks is the dominant mechanism for diffusion” (Greenhalgh, Robert and Bate 2008).

In the literature review completed by Greenhalgh, Robert and Bate (2008), a number of key aspects of communication and influence were identified:

1. *Network structure:* Adoption of innovations by individuals is strongly influenced by the structure and quality of their social networks, with different networks having different types of influence. Horizontal networks are more effective for spreading peer influence (i.e.
2. *Homophily:* Adoption by individuals is more likely if they are homophilous i.e. similar in terms of socio-economic, educational, professional and cultural background – with current users of the innovation. In the kiwifruit industry we have growers from a range of backgrounds, therefore we would want to ensure our networks tap into a diverse range of these.
3. *Opinion leaders:* Certain individuals have particular influence on the beliefs and actions of their colleagues. Expert opinion leaders influence through their authority and status; peer opinion leaders influence by virtue of representativeness and credibility. Opinion leaders can have either a positive or negative influence. There is possibly an opportunity to use both expert and peer opinion leaders to disseminate messages regarding biosecurity practices.
4. *Harnessing opinion leader influence:* Harnessing the influence of opinion leaders is not straightforward. In trials where opinion leaders have been trained to influence the behaviour of their peers, the impact is generally positive in direction but small in magnitude. Failure to identify the true opinion leaders and in particular to distinguish between those leaders who are only

influential for a particular innovation vs those that are influential across a wide range of innovations is one factor that may limit the success of such intervention strategies.

5. *Champions*: Adoption of an innovation is more likely if key individuals within their social networks are willing to back the innovation. When programme champions play an active role in the development of an innovation, spread and implementation is likely to be more effective. This linkage at an early stage needs to be a shared understanding of the innovation and should also work towards shared language for describing the innovation and its impact.
6. *Professional organisations* may play a role in enhancing the social networks and play a facilitating and enabling role in spreading the innovation.

An understanding of the range of factors that influence innovation provides valuable insight into what constitutes best practice in transferring scientific knowledge into practice (Kelly 2012).

6 METHODOLOGY

To answer the research objectives of this study, data was collected from interviews with representatives of the following groups;

- i. **Kiwifruit growers** – interviewed to get a grower’s perspective on whether complacency in biosecurity practice actually exists and to seek their opinions on why this might be occurring and how it might be overcome.
- ii. **Post-harvest grower services representatives**—interviewed to provide insight into the biosecurity practices of the growers that they represent, not their own behaviours. Grower services directly interact with kiwifruit growers on a daily basis and have a good understanding of grower practices and priorities. They represent a large number of growers so interviewing a small number of grower services representatives is an effective way of increasing the sample size of the study.
- iii. **Subject experts** –interviewed to provide a more technical understanding of the barriers to implementing recommended practices, and the opportunities to improve uptake of best practice.

6.1 INTERVIEW PROCESS

An extensive set of interview questions was developed for each of the three groups (growers, grower services and subject experts). Interview questions were kept as consistent as possible between each group, with some minor changes necessary to obtain information specific to that group and achieve the research objectives. Interview questions asked of each group are available in Appendices 1-3 respectively.

Most interviews were done in person, or if this was not possible these were done by phone. Interviews typically lasted 30-50 minutes. All interviews were recorded and transcripts typed out.

6.2 SELECTION OF INTERVIEWEES

Kiwifruit growers

Six kiwifruit growers were selected for interview. These growers were selected at random from a larger pool who met the following criteria:

- Influential and well regarded from a production perspective. In some but not all cases this included representation on industry bodies and/or strong links to post-harvest organisations.
- One grower from each of the following regions to represent a timeline of Psa infection (date of first Psa identification in the region shown in brackets): Te Puke (2010), Tauranga & Katikati (2011), Hawkes Bay (2012), Whangarei (2015), South Island (non-detected).
- Five conventional growers and one organic grower were selected.
- Orchard size was not a selection criteria and ranged from 7 to 60 ha and averaged 34 canopy ha which is well above the industry average of 5 canopy ha.

Grower services representatives

Six grower services representatives were chosen from different kiwifruit post-harvest organisations. These representatives were selected to include major post-harvest organisations and represent growers across all New Zealand kiwifruit growing regions. Collectively the six grower services staff represent around 300 growers across New Zealand, more than 10% of all kiwifruit growers by number.

Interviews with subject experts

Horticulture biosecurity managers

Three biosecurity managers from leading New Zealand horticultural industries were selected to be interviewed as subject experts. These subject experts collectively have a broad range of biosecurity experience across multiple roles, sectors and countries.

Civil Defence Emergency Management

Also interviewed was a manager responsible for preparing the public for natural emergencies to explore the parallels between emergency preparedness and biosecurity preparedness and identify what challenges and successes they have experienced that we might learn from.

6.3 SELECTION OF BIOSECURITY PRACTICES

Interviewees were asked their perceived effectiveness of ten on-orchard biosecurity practices. These practices can be grouped into four categories as follows;

- i. Sourcing clean plant material;
- ii. Orchard monitoring;
- iii. Visitor hygiene; and
- iv. Tool hygiene.

Each interviewee was asked their perceived effectiveness of each biosecurity practice on a 10-point scale, in terms of mitigating the spread or impact of a future biosecurity incursion.

Growers and grower services representatives were also asked about the level of implementation for each practice on their orchard, or across their growers' orchards, and how this might have changed over time since Psa infection.

7 RESULTS AND DISCUSSION

7.1 ON-ORCHARD PRACTICE IS SLIPPING BUT THERE IS MORE TO THIS THAN COMPLACENCY ALONE

Despite KVH's efforts to increase awareness of other emerging threats to kiwifruit, on-orchard biosecurity practices in the kiwifruit industry are primarily to prevent or manage the impacts of Psa. This is clearly illustrated in the higher number of biosecurity practices implemented by growers in Containment or Exclusion Regions where Psa is in limited distribution or not present, versus Recovery Regions where Psa is widespread (Figure 3). While the data in Figure 3 were taken from a small sample size of six growers, interviews with grower services representatives verified that these trends are indicative of the 300 growers they represent (data from grower services were too difficult to quantify and include in this graph). Growers in Containment and Exclusion Regions seem to be implementing a broader range of biosecurity practices than growers in Recovery Regions. This doesn't necessarily indicate how well these practices are being implemented, and there is a wide variation in the application of practices even within the small number of growers interviewed in this study, but it does suggest they are actively mitigating risk over a greater number of pathways.

Of course there are also exceptions to such broad generalisations and growers with a high standard of biosecurity practice can be found in any region, but are more likely to be found in a Containment or Exclusion Region.

"In Containment Regions there is a higher standard of biosecurity practice, and when I visit I have to ensure that I haven't been on orchards, changed clothes etc. Seems to be standard practice in those regions²."

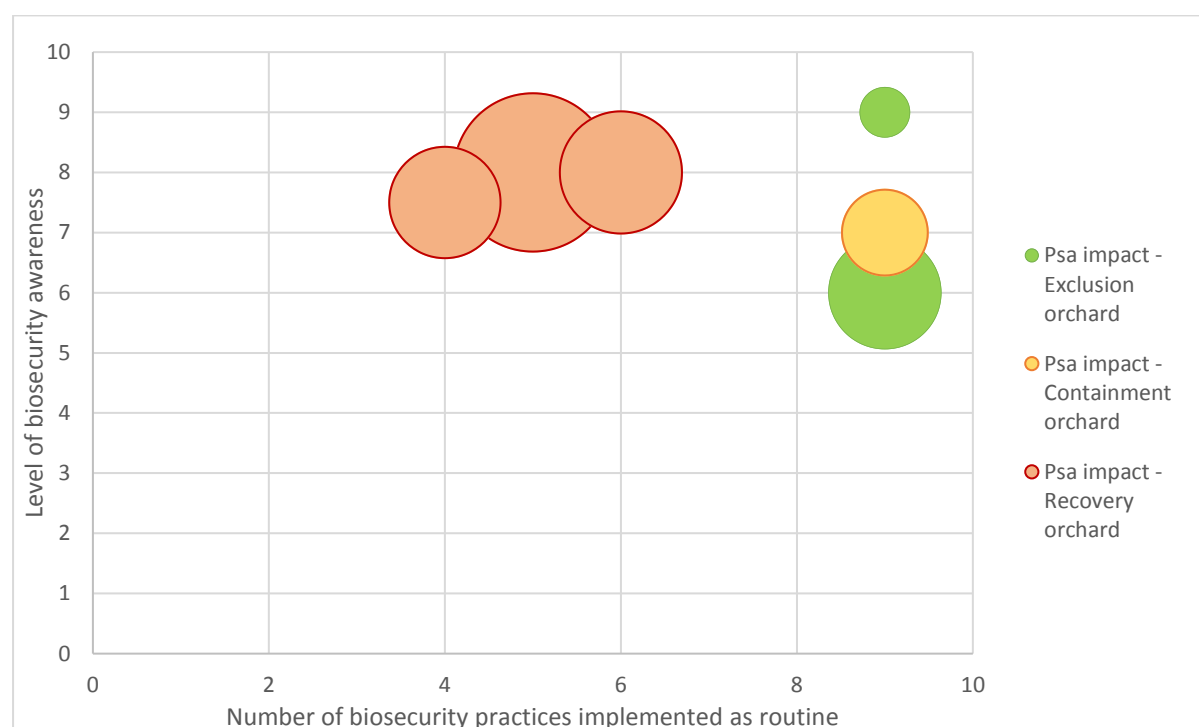


Figure 3. Comparison of the interviewed grower's; level of Psa impact, level of biosecurity awareness and the number of biosecurity practices implemented as routine practice. Colours indicate the status of the region.

² Quotes in the text from here on, including this one, are from interviewees unless noted otherwise.

In general, on-orchard biosecurity practices in the kiwifruit industry have decreased from the “height of Psa”, the period when the risk of Psa was at its greatest, which differs between regions, and between growers. For the two remaining Exclusion Regions, the height of Psa might be the present day and many growers are as vigilant as they have ever been in these regions. Whereas in most regions and the Bay of Plenty in particular, where 80 % of the industry is concentrated, the “height of Psa” was three to five years ago and on-orchard biosecurity has been slipping ever since.

Some of this can be attributed to complacency. The industry is learning to manage Psa and this is reflected in the high orchard gate returns experienced over the last couple of seasons. As a result, some growers may be breathing a sigh of relief, the immediate threat and extent of this threat has diminished and the sense of urgency has decreased. Growers can return their attention to other more pressing needs of the day. Any biosecurity practices that these growers do retain as routine are those that are practical, pragmatic and perceived to be effective in mitigating any perceived risk.

Others agree, but argue that this change in practice over time is not a result of complacency, rather it’s been about finding an appropriate balance and that the initial recommendations were excessive, our understanding of risk and effectiveness has evolved over time and the “new norm” is about right.

But, what is “the new norm”? It seems that practice varies from one orchard to the next and even more so between regions, there is a need for standardised industry best practice guidelines, not for Psa as there is a plethora of those, but rather on-orchard biosecurity guidelines that can be implemented on a routine basis to mitigate the impact of the next biosecurity threat. This point will be returned to later in this study.

It seems that the primary reason for a decline in on-orchard biosecurity practice is the “Psa-centric” paradigm of the industry, and that the perceived effectiveness of some practices are lost once the orchard has Psa, or in some cases the practices were never perceived to be effective anyway (this will be explored further). Other reasons cited for the decline in practice include:

- Smaller growers seem to be more complacent as they have less to lose and also don’t have the benefit of scale and control over third party operators that larger growers have.
- If biosecurity is not in their face all the time, then growers can start thinking about other more pressing issues and biosecurity practices can drop away. Growers who have post-harvest involvement or are on industry bodies are more likely to maintain a higher standard of biosecurity practice which is likely a result of an increased awareness of risk and biosecurity messages being raised on a more frequent basis than those without this exposure.
- Those with a long experience in horticulture can be more in tune to biosecurity, but they can also be more complacent, it depends on what their experience has taught them.
- New growers are often quite vigilant as they treat biosecurity like other business risks and want to understand it as best they can.

7.2 BIOSECURITY AWARENESS

Psa has raised biosecurity awareness in the kiwifruit industry

Having experienced a major biosecurity incursion, most growers now consider themselves somewhat “biosecurity aware”. While they admit they don’t necessarily know the details of other specific biosecurity threats to kiwifruit, most can name at least one kiwifruit pest or pathogen that is not currently present in New Zealand, fruit flies, brown marmorated stink bug and the fungal pathogen in Brazil, *Ceratocystis fimbriata*, being the three most commonly named. This indicates that some of the biosecurity communications from KVH have been successful in raising grower awareness of offshore threats, as these threats are the top pests and pathogens on KVH’s “Most Unwanted” list (KVH 2016).

The close relationship between the industry and research institutions was cited as a strength of the kiwifruit industry in understanding biosecurity threats and developing knowledge that is readily transferred to the field.

While Psa has raised awareness of biosecurity in the kiwifruit industry, there is also a risk that the ability to which the industry has successfully recovered may actually encourage further complacency in the industry.

“I think we totally have a she’ll be right culture and if it turns up we will sort it out. Having got through Psa only reinforces this culture. Having dodged a bullet once we can do it again”.

“Once something is detected protocols etc. would get put in place pretty quickly just like they were for Psa. It would be very easy to get these procedures back if we needed to.”

Future biosecurity incursions are considered a significant risk

Growers believe a future biosecurity incursion is a risk to their investment, although there is some variation in the level of perceived risk. Most believe it is one of the most significant risks to their investment and some believe it is an inevitability. Others feel that the likelihood of an incursion is low but would have potentially high consequences. The general consensus is that a biosecurity incursion is a threat and someone needs to be proactively managing it, but until the threat is perceived as imminent, there will be challenges in creating a culture of proactive behaviour.

- *“See this as a risk, but not sure how significant, that would depend on the particular challenge you are talking about. Good proactive disease management is a lot better than trying to rescue it afterwards”.*
- *“Something will crop up. It’s an inevitability, whether it is a market access issue or production issue”*
- *“They (growers) are willing to have someone look out for them on their behalf, but in terms on on-orchard practice, not so much”*

Grower’s role in the biosecurity system is not widely understood

“Someone will look out for that. I am going to do what I am paid to do, which is to grow kiwifruit”.

Most of the industry see biosecurity as primarily the role of KVH and the Government, which is understandable given that these organisations have dedicated biosecurity roles. However, the role that a grower plays in the biosecurity system appears to be not well understood by many.

The subject experts, and some of those within the industry, explained that biosecurity is everyone’s responsibility.

- *“The Government has a responsibility for managing what comes across our borders while still maintaining commercial trade”.*
- *“Industry bodies have a role in readiness activities and ensuring that we are doing everything we can to keep threats out but should they arrive we have systems in place to mitigate their impact and advocating for more controls when required. Industry bodies also provide an important point of contact for growers, for advice on how to manage risks on their orchard and a central place for feedback without having to approach the government”.*
- *“Growers have a responsibility for their operation and they make the decisions about what enters that zone. They can educate their workers and ultimately the responsibility rests with them”.*

One subject expert highlighted that the rest of the industry have biosecurity responsibilities also, right across the supply chain. It’s not just about growers, there are so many people coming onto orchards, as contractors, to carry out monitoring etc., and one of the bigger challenges is how to get a level of awareness in people carrying out these activities who potentially carry the biggest risk.

A belief that biosecurity is someone else’s responsibility is another factor that would support a complacent attitude to on-orchard practice.

Only when the risk is perceived as imminent will behaviour change

“Nothing ever becomes real until it is experienced”

John Keats

Before Psa was detected in New Zealand in late 2010, the reports of impacts on Italian orchards seemed distant and many did not perceive this as an imminent threat.

When Psa was detected in Te Puke, growers in that region were quick to respond and implement recommended practices. However, some growers in other regions, where Psa was not yet present, watched on and were slower to change their own practices, again not necessarily perceiving Psa as an imminent threat.

“Every region thought that they were going to be the one that wouldn’t get hit. Until the wave hit. A bit of human nature until the wolf is knocking at the door.”

In many cases, it was only when growers visited, observed the impacts and talked to affected growers that triggered a change in behaviour. But for many growers, they believed that Psa would never affect them and we still see this in some regions today.

If some growers were reluctant to perceive Psa as an imminent threat, a pathogen decimating orchards within their own country, then changing behaviours to mitigate the impact of offshore pathogens that might never enter our orchards is always going to be a significant challenge.

Growers can learn from the experience of others; some don’t learn from their own

Growers can learn from the experience of others without being impacted directly, and we saw this with the 2015 fruit fly incursion in Auckland, where a “near miss” increased industry awareness significantly. Civil Defence Emergency Management have also seen this in the public sector, where New Zealand in general has become more prepared for earthquakes as a result of the Christchurch quakes, however the most prepared are always those who have lived through it, even if they are not

longer residing in a high risk region. The same seems to be true for biosecurity, we can learn from others, but the more real the lesson can be the greater the uptake is likely to result.

However, how well do growers learn from their own experience? That seems to depend on what lessons that experience has taught them.

Only three Recovery Region growers were interviewed which is too small of a sample to draw conclusions from, however for these growers there no correlation between the impact of Psa on their orchard and their level of biosecurity awareness, or number of biosecurity practices implemented (Figure 3). Across a larger sample size, grower services representatives were also unable to observe any correlations about the growers they represent.

One might expect that those that have been impacted the hardest would hold higher biosecurity practices going forward and some grower services reps saw evidence of this.

“Te Puna growers haven’t been hit as hard financially as Te Puke growers and as a result are more complacent. The hurt is still there in Te Puke, although they are practical about their biosecurity practices”.

Other grower services reps saw no correlation across their growers.

“I would like to think so but this hasn’t been demonstrated. People are doing what they have to do to protect their incomes”.

“Some of the worst hit orchards I have seen are not doing any more and they certainly aren’t making us jump through footbaths”

A similar level of ambivalence exists when interviewees were asked about the influence of a family history in horticulture. Some thought a history of horticulture is valuable and experience teaches the value of proactive measures. However, many thought that the new entrants to the industry are the more vigilant. In many instances experience may have demonstrated that growers can get away with complacency and implement the same practices as generations prior, but risks are greater now and the lessons of the future may be more unforgiving.

“New entrants are purchasing a business and assess biosecurity threats like they do any other risk to the business. Whereas some of those who inherit might not take the same approach, particularly if for three generations they have seen how biosecurity was managed without an incursion, then they are likely to just carry on with the same practices.”

7.3 BIOSECURITY PRACTICES

The practices that don’t make a difference are dropped

If we look at what practices have dropped off in Recovery Regions, we can see that it is primarily relating to; sourcing clean pollen, monitoring and reporting of unusual symptoms and visitor hygiene practices (asking questions to risk profile, hygiene and/or restricting access) (Figure 4). Sourcing clean budwood and rootstock, and tool hygiene are still routine practices for most growers in Recovery Regions. These general trends of practices that are being maintained versus those that are slipping away are also supported by interviews with grower services representatives.

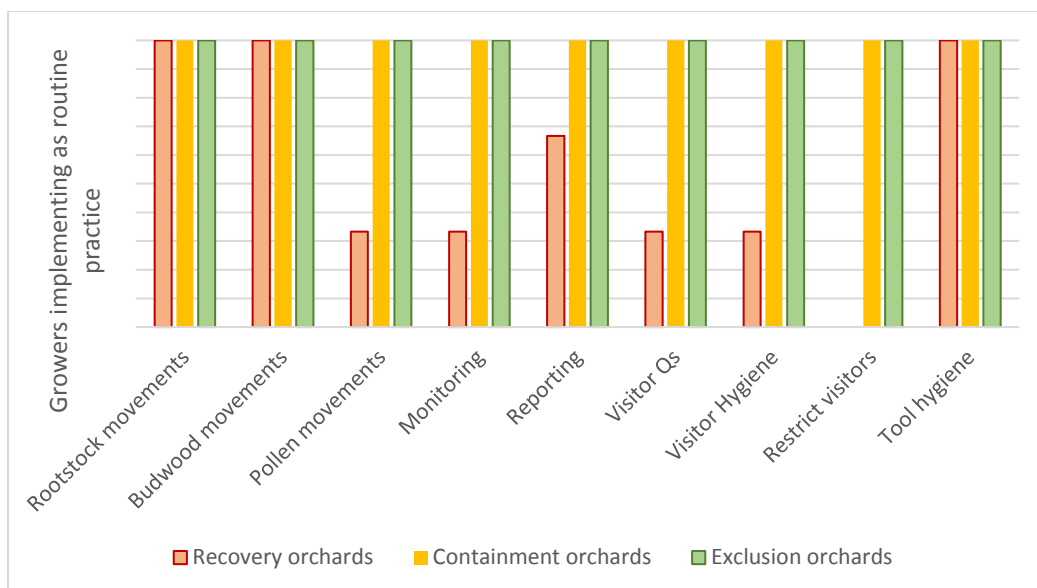


Figure 4. Biosecurity practices that growers interviewed implement as routine practice.

Similar trends can be seen in the results illustrating the perceived effectiveness of each biosecurity practice in mitigating the spread or impact of a future biosecurity incursion (which includes any forms of Psa not currently present in that orchard) (Figure 5). Interviewees were asked their opinion on 10 biosecurity practices which have been grouped into the following four categories (sourcing clean plant material, monitoring for and reporting unusual symptoms, visitor hygiene, tool hygiene).

Growers considered tool hygiene to be the most important practice and is a practice widely used by growers across all growing regions.

All groups considered visitor hygiene to be the least important of the four categories and this group of practices is the least well implemented in Recovery Regions.

There are a multitude of factors that influence why growers are implementing certain practices and not others, these are explored further below.

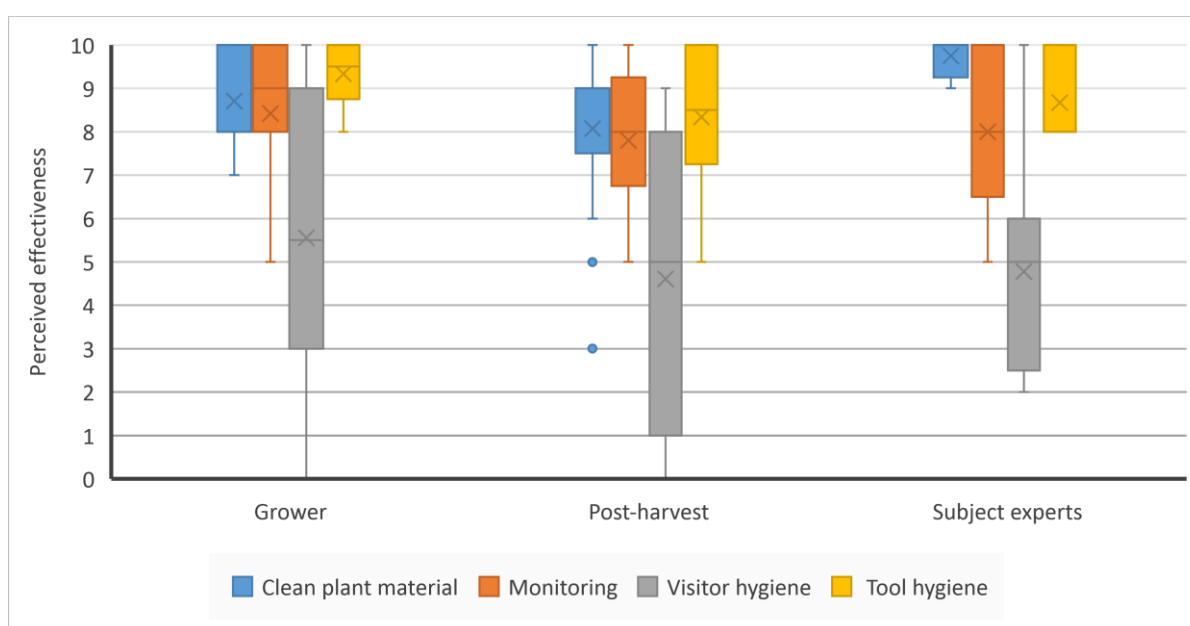


Figure 5. Perceived effectiveness of biosecurity practices in mitigating the spread or impact of a future biosecurity incursion.

Sourcing clean plant material

Plant material was considered, by the subject experts, to be the number one route for pathogen entry into orchards and therefore sourcing clean plant material as the most effective way of mitigating that risk (Figure 5).

Of the plant material pathways, rootstock was considered the greatest risk as it is able to host a wider range of pathogens, followed by budwood and pollen (Figure 6). Growers and Post-harvest also considered plant material to be a risk pathway (but not to the same extent) and there was the greatest variation in opinion around budwood and how effective sourcing clean plant material would really be for future pathogen incursions.

The key issues for plant material are explored further below.

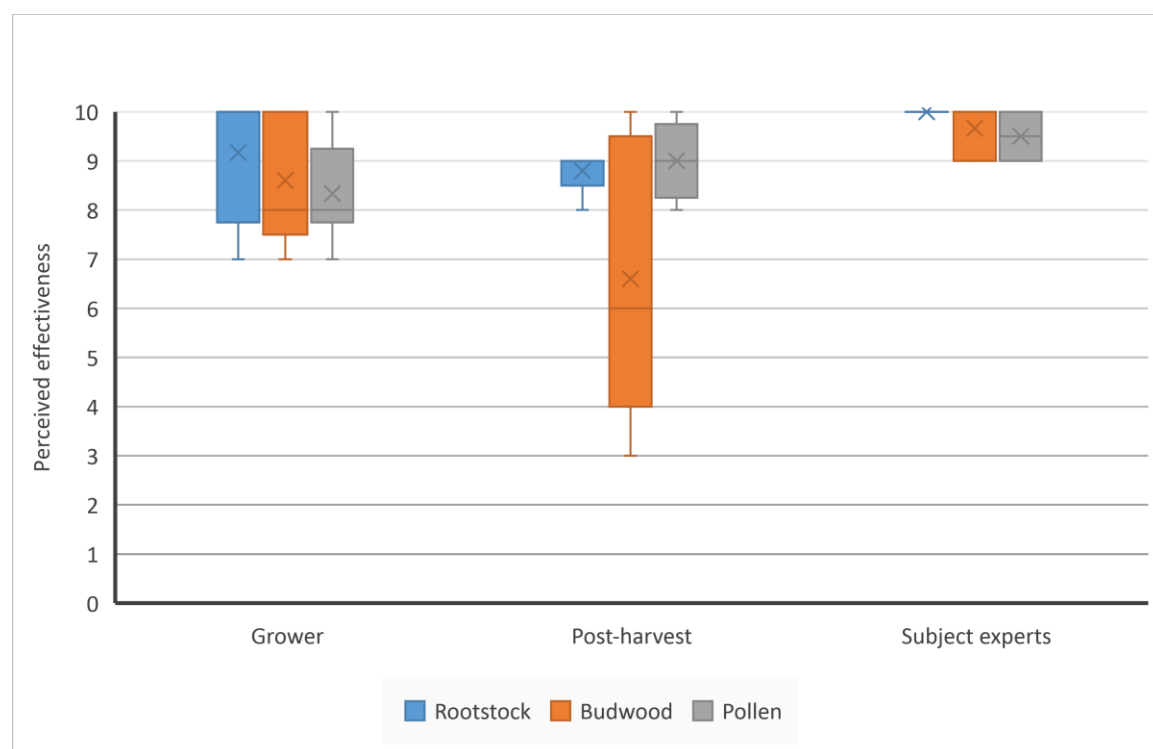


Figure 6. Perceived effectiveness of sourcing clean plant material (rootstock, budwood and pollen) in mitigating the spread or impact of future biosecurity incursions.

i. Rootstock

“A key management tool in minimising spread both within and between regions and also within an orchard. Rootstock would be the biggest risk and source of problems”.

Subject experts were unanimous in ranking rootstock as the plant material pathway with the greatest potential to introduce biosecurity threats.

It is also the pathway where KVH has put the greatest effort and has introduced biosecurity risk management requirements that all nurseries selling kiwifruit plants must meet. KVH has also introduced a higher standard of biosecurity risk management, the Kiwifruit Plant Certification Scheme (KPCS), a standard that some nurseries are already producing plants to, and will become mandatory for all nurseries beyond October 2016. The risks with the rootstock pathway have been well highlighted and are being recognised amongst growers but plant quality is still the primary driver when sourcing plants.

Growers are seeking plants that will provide a good long-term return on investment. That might mean sourcing KPCS plants, however biosecurity risk management is secondary to plant quality. Most growers are only thinking Psa when buying KPCS plants but are also managing other biosecurity risks as a secondary benefit rather than a conscious decision.

One of the challenges with sourcing clean plant material is aligning nursery supply with the peaks and troughs of industry demand. This was evidenced in the apple industry in the early 2000s where industry demands were fluctuating so much that in some years there were an oversupply of plants, and then in the following year there were shortages resulting in growers doing whatever they could to get hold of plants. Similar challenges are experienced in the kiwifruit industry and nurseries are increasingly growing-to-order to avoid being caught with an oversupply. Should the kiwifruit industry be caught with a severe plant shortage, then the demand for plants could result in practices that would undermine efforts from initiatives such as the KPCS, and present a potential risk to the industry.

ii. *Budwood*

Most growers, in any region, routinely try to source the cleanest possible budwood they can. Unlike rootstock there is no official biosecurity certification scheme in place for budwood so growers normally source from either Zespri (who do have some controls and are considered the most trusted source), a trusted supplier they always use, or from their own orchards. However, most growers are primarily concerned about Psa when getting budwood and not any other biosecurity risks. However, industry practice is to select from healthy plants and that is seen as practical.

"Thinking other than Psa, I don't think we would consciously go to a budwood provider and ask them have you got Verticillium wilt?"

This thinking reflected the mixed views on the perceived effectiveness of sourcing clean budwood in mitigating risk. Thoughts tended to focus on how would a budwood scheme that mitigates risk and is still practical actually work in practice?

"I don't know if it's a real concern to be honest – bringing in new biosecurity risks. I don't know if it ranks all that highly. One issue is identifying it, I mean if there was a virus in budwood and it looked healthy would you even know it was there? Like you wouldn't use a withered shoot or bud, so you do choose healthy looking material but if it did have a virus you would never know. I suggest this is a low priority as far as growers are concerned".

"Doesn't make any difference. The "clean" budwood you get from out of region might carry another pathogen that is undiscovered. Sourcing from local region is the safest bet"

The subject experts ranked it right up there with rootstock as one of the most significant pathways for introducing pathogens, but perhaps had a narrower range of pathogens that could be transported by this material. The subject experts also acknowledged the practical controls associated with this pathway, but believed that if they could be overcome, sourcing clean budwood would be a highly effective way of mitigating the spread and impact of future biosecurity incursions.

"Budwood is so easily moved it creates challenges to build into a farm biosecurity plan. Probably a less effective practice given its ease of transferability however it is still right up there. Good practices would be highly effective."

iii. *Pollen*

Pollen is widely recognised as a high risk pathway, right up there with budwood and rootstock, yet in Recovery Regions growers are much less likely to try and source clean pollen than they are for the other plant material types.

The production gains achieved through supplementing pollination artificially have seen the demand for pollen increase significantly over the past few years. Some growers do take steps to ensure any pollen used is the cleanest possible, such as harvesting their own pollen from trusted male blocks, and milling as a separate batch which involves cleaning the mill between runs. This can be a significant challenge particularly for the smaller grower, or one who does not have a block of males even if they are willing to pay a premium for clean pollen. With the high demand for pollen most growers are willing to use whatever they can get despite not knowing the source and the potential risks involved.

“Growers were really concerned about pollen, now no one asks where the pollen is from any more. Ironical given the risk that pollen presents”

“I don’t have many options when getting pollen, it’s one of the biggest risks I face because I need to use it, and it definitely improves production. But I know it comes from anywhere and everywhere and it’s a melting point for pathogens if they are out there and there is not much happening to manage that risk. To me it’s our Achilles heel at the moment.”

Monitoring and reporting of unusual symptoms

i. *Regular orchard monitoring*

At the “height of Psa” monitoring is a designated activity with a high attention to detail, conducted on a regular basis, depending on the perceived level of risk. In Containment and Exclusion Regions this practice continues. In Recovery Regions, this practice is rarely conducted as a designated activity rather it is conducted as part of another activity, usually cutting out Psa-infected canes.

Some say this is an improvement as growers are more engaged now as a result of Psa and taking a much more hands on approach to orchard management. Psa has raised their biosecurity awareness and they are always looking out for unusual symptoms.

Others believe this is not an improvement;

“Less likely to pick a new biosecurity incursion but as not paying attention, compared to monitoring for Psa when they were looking for those. Just doing a job now. Alertness not there.”

ii. *Reporting of unusual symptoms*

Recommended practice is to report any unusual symptoms to post-harvest, KVH or MPI. At the “height of Psa” this is routine as growers are on edge and ready to take immediate action. In Recovery Regions it would be fair to say that reporting of really unusual symptoms would be considered routine, but it is now a much narrower band of symptom that is considered “unusual”. Leaf spotting is a symptom that many plant pathogens induce in kiwifruit, this would not be reported. The odd dying vine is normally not reported and considered to be *Armillaria* or *Phytophthora*, and is cut out with growers then keeping an eye on neighbouring vines to ensure they don’t develop the same symptoms.

“So I would say it is routine, but I think if we had an industry standard, saying right everyone do this – that would be better.”

Orchard visitors

People are most likely to introduce a pathogen to an orchard when they have come from another orchard. Asking visitors if that have been on another orchard is an important part of the process to assess risk and whether this warrants further intervention such as hygiene practices or restricting access to parts or all of the orchard.

This process is very rarely done in Recovery Regions but is still very strong in Containment and Exclusion Regions. From a PsA-centric view, visitors do not present a risk. However, even the question phase is not routine and visitors are not given even a cursory risk assessment. International visitors are also not asked and subject to hygiene practices in most instances, and these might present an elevated risk of bringing in a new pest or pathogen.

Those growers that do implement this practice state that the question process creates a thinking process and is very effective in creating the attitude, that the operation is facing a challenge and there are certain responsibilities to mitigate that risk.

“Staff and visitors all have to come through that gate. Reminds you that there is a need to do something. Spraying wheels or whatever may not be effective in itself, but is very effective in creating the right attitude”.

Restricting visitor access was a measure frequently used at the “height of PsA”, and is still employed by some growers where the risk is deemed unacceptable. The more common approach is for high risk visitors to undertake hygiene measures and most growers are comfortable that this reduces the risk to an acceptable level. One interviewee made the following comment on why he never restricts visitor access;

“The pluses of letting people on outweigh the negatives. Disseminating knowledge is the most effective. It’s far more effective to have people on with appropriate hygiene. However, for isolated orchards this is different and there is greater advantage (in restricting access).”

Tool hygiene

Sterilising pruning and girdling tools with an effective sanitiser has become widely integrated into routine practice across the industry and a majority of growers would be doing this at some frequency. However, the frequency that this sanitising occurs varies widely for pruning tools from between vines at one extreme to between orchards at the other. Girdling tools seems to be widely accepted as a greater risk and most growers sterilise these tools between plants.

Cleaning pruning tools seems to be a classic example of practices declining from the “height of PsA” to settling at a “new norm”. At the height of PsA, more growers sterilise tools between vines. This still occurs on many Containment and Exclusion orchards and on the more vigilant Recovery orchards. The “new norm” varies significantly between growers and contractors but “break frequency” (putting tools in buckets of sanitiser at smoko and lunch breaks), would be the most common in Recovery Regions. There are reports of this practice slipping also and tools being left on orchards rather than being placed in the buckets as required. Some growers seem to be unable to influence the practices of their contractors and are frustrated that sterilisation is only occurring at a break frequency or less and have been told that increasing this frequency to between rows would be too hard. The bigger growers have a better chance of staying on top of it but it is a real challenge.

Growers rated tool hygiene as the single most effective measure of preventing the impact of future biosecurity incursion and it is also the most widely implemented (voluntary) biosecurity measure. This

is because growers understand the “Why”, and the following story could be largely responsible for that, as many interviewees recounted it in some form;

“There is anecdotal evidence of spread down rows where hygiene hasn’t been applied, we haven’t seen this at our place but we have certainly heard about it. Implementing this practice is very important.”

There is a need for clear guidelines on what is an effective and practical sterilising frequency to minimise biosecurity risk.

8 THE BARRIERS TO IMPLEMENTING BIOSECURITY PRACTICE

Cost, hassle, lack of perceived effectiveness, ability to get contractors to follow instructions were all cited as barriers to implementing biosecurity practice. However, this study has revealed that these can be overcome if we start with effectively communicating the “why”.

8.1 INFORMATION OVERLOAD

Interviewees reported an oversaturation of information in the industry. Growers are receiving information from Zespri, Horticulture New Zealand, New Zealand Kiwifruit Growers Inc., KVH and their post-harvest company, not to mention the multitude of organisations that might be trying to sell them a product or service. Some growers become overwhelmed with the volume of information and consider it too hard. Consolidating information in fewer, simple to read best practice guidelines will assist the industry overcome this barrier.

“If we come back and there is a solid protocol we will be better off. As Psa draws back into routine practice we need to put a stake in the ground to determine which practices we retain for other biosecurity threats.”

Interviewees also touched on the need for more community engagement to make sure we understand all the channels for getting advice to people who we want to carry out risk management activities, and making sure we have all those people on board. By creating champions with key staff at post-harvest, influential growers, and key leaders among the contractors we can deliver consistent messages from influential people about what is important. And then turn these into habits.

“They don’t need any more documents or emails, they just bin or delete these. But you pick them up at a roadshow, and you have a captive audience.”

“I have often wondered if we need a buddy system where we have proactive growers ringing the more complacent ones. I think growers would be open to doing this if they only had to ring one or two people, and the recipient would probably be quite receptive to the message coming from another grower. You send an email and you do wonder if the message gets through.”

8.2 CONTRACTORS

Kiwifruit, like most horticultural industries, has a relatively low labour requirement on a day-to-day basis, punctuated by short periods of intensive activity such as harvest and pruning. These activities are often performed by a “gang” of contractors, who travel between orchards carrying out specific activities either directly for the grower or for a post-harvest orchard manager.

Getting contractors to follow on-orchard biosecurity practices was commonly referred to as a significant barrier to implementing biosecurity practice.

“Contractors definitely. And it is really about getting agreed standards across the industry that they all operate to. I think something is needed there. And we have to overcome language barriers to achieve that. And I guess we have to ask if there is anything industry can do to make practices easier, such as innovation to improve sterilisation spread, or something contract gangs could have to make things easier.”

However other interviewees pointed out that during the “height of PsA” contractors did implement best biosecurity practice so the industry has proven that this is a barrier that can be overcome.

“The contractors will adjust their practices accordingly, although growers need to understand that if they want contractors to do additional work they will need to adjust their rate accordingly also.”

“If you select the right contractor and enforce the rules you will be fine.”

8.3 COST OF IMPLEMENTING PRACTICES

Most interviewees said that cost on its own is not a significant barrier to implementing biosecurity practice, but combined with other factors such as hassle and lack of perceived effectiveness, it can become too much and result in complacent behaviour.

For contractors, cost may be a more significant barrier, particularly if growers and orchard managers are not willing to pay a premium to cover time and resources associated with additional biosecurity practices. For example, it is best practice not to prune when the canopy is wet as this increases the likelihood of pathogens entering wounds. Contractors that follow best practice and act in the grower’s best interest by waiting for the canopy to dry, put themselves at a disadvantage unless this practice is rewarded or regulated. Contractors have to be cost competitive, and as long as financial incentives operating that aren’t aligned with biosecurity it’s challenging to get everyone to operate to a high standard.

This could be overcome if there was a universal standard that all contractors were operating to.

8.4 UNDERSTANDING THE “WHY”

“It’s all of the above. If there is no perceived risk, then it’s just an added cost and hassle and they will take short cuts until the event happens”.

“Messaging is better than it has been, but failure to implement some of the discussed practices reflects lack of perceived value. Other barriers can be overcome.”

“The missing ingredient is that people have to understand the WHY.”

The single largest barrier seems to be a lack of understanding of;

- i. specific risks;
- ii. how recommended practices are effective in mitigating those risks.

If we can achieve these two objectives, practices will have a high perceived effectiveness and any other barriers such as cost, hassle or getting contractors to follow instructions may be overcome. This was demonstrated at “the height of PsA” where the industry showed a remarkable ability to overcome barriers and achieve what was required.

i. Understand the risk

"There is definitely an awareness out there but it is getting it at a grower level in a form that is meaningful for them."

Understanding the risk does not mean being able to name biosecurity threats, although that is a start, it is about understanding how these threats could directly impact growers. Impacts need to be conveyed in terms that growers easily relate to such as production losses, or loss of markets and what this means in economic term such as impacts to their Orchard Gate Return (OGR), messages will be more easily picked up.

"You have to put in real terms, i.e. China won't take your fruit which is 25% of your supply, which is then going to reduce your tray price as a result of oversupply. So there's the pain. Then sell them the situation and the potential risk."

ii. Understand how practices mitigate this risk

Once aware of the risk and how it might impact them, growers need to understand how the recommended practices mitigate that risk.

"The biggest barrier to implementation is the gap between the threats and why they are doing these practices to mitigate the risk. If all growers knew about how pathogens spread through the environment, then they could make smart decisions to manage these risks and it's not just a documentation exercise."

This understanding helps empower the grower and let them make their own decisions about what practices are required on their orchard within a set of guidelines. A prescriptive list with no understanding of why they are doing these practices is not effective.

I think it's about simplifying the science and communicating how organisms spread and how the measures mitigate risk.

Tool hygiene is one practice that is widely supported by growers. This may be because growers understand the direct relationship between risk and how the practice mitigates that risk. They have also seen first-hand or heard about what happens when wounds are created with contaminated tools which reinforces their understanding of the relationship between the risk and the practice.

8.5 THERE IS VALUE IN A COORDINATED APPROACH WITH OTHER INDUSTRIES

In many regions kiwifruit is in close proximity to other horticultural crops. Some kiwifruit growers grow other crops, and some post-harvest organisations pack other crops. Therefore, most interviewees thought it was logical to have consistent biosecurity messages across horticultural sectors, provided we didn't lose focus of the threats that are important to kiwifruit.

Consistent messaging would make things easier for those who grow multiple crops and increase uptake of the recommended practices.

"Critical! Put this as a 10 with exclamation marks from me. It's something we don't do enough of. We try and go through phases only to slip away again. We need a process to hold this together. For example, if a new fungus pops up in the citrus industry, there should be strong links so that other industries are aware of this. Not just for biosecurity but links for other areas we have in common also such as pollination. Where need to do more here and it's a big area".

While interviewees were keen to have a coordinated approach to biosecurity messaging with other industries, they didn't want to see any new bodies or organisations established to achieve this. The

most effective approach might be to develop coordinated and consistent messages with other sectors, and then deliver those through the current industry channels, particularly the existing relationships with growers, the people who are out there every day.

Messages also need to stay relevant to that specific sector and provide the detail to create awareness of specific risks relevant to them. If messages become too generic across sectors, the detail will be lost and they will become meaningless.

8.6 OTHER OPPORTUNITIES TO IMPROVE UPTAKE OF BIOSECURITY PRACTICE

“Opportunities: almost endless but I would propose two;

- I. Getting biosecurity as a standing item in board meetings –commitment from the top to match the operational endeavours in the business*
- II. Being well-informed as an industry so we can make biosecurity an everyday discussion in our community; knowing about Brown marmorated stink bug and Spotted wing drosophila not just fruit fly; knowing what the causal factors of biosecurity risk are in the community so we can educate for improvement”*

“Constant education. Look at drink driving. We all understand this but only seem to respond to shock and horror campaigns. May be we need more shock and horror stories about what Psu will do. This is still a disease that can be hugely damaging. I believe that G14 flower drop is contributed to by Psu”.

8.7 WHAT CAN WE LEARN FROM CIVIL DEFENCE EMERGENCY MANAGEMENT?

Civil Defence are tasked with preparing the general public for events that may never occur so complacency must be a huge challenge for them in dealing with the general public.

An interview with Bay of Plenty Civil Defence Emergency Management (BOP CDEMG) reinforced many of the key messages highlighted in this study and offered advice for overcoming barriers causing complacency.

About Civil Defence Emergency Management

BOP CDEMG was set up about a year ago to deliver all the Civil Defence services for all seven councils in the Bay of Plenty region.

The aim of the BOP CDEMG is to:

- Coordinate all planning activities related to hazard and emergency management;
- Encourage cooperation and joint action within the region;
- Determine the aspirations of our community; and
- Examine the risks that hazards may pose to the goals, and prioritise each hazard

Essentially emergency preparedness is about increasing community resilience and decreasing community vulnerability so that we are better prepared to respond and also recover to any events should they occur. BOP CDEMG list all out hazards and plants and animal pest threats are one of the top hazards to our region and therefore they have a role in working with biosecurity agencies in those sort of events. BOP CDEMG work across four arms to achieve the aims stated above;

- Reduction – Working to prevent or minimise the risks of an event happening.
- Readiness – Ensuring that we are ready for events and that communities know how to respond should an event occur.
- Response – Making sure that systems are in place to manage a response.
- Recovery – Long term, how do we get back to a new normal?

Not only do the aims and work streams of BOP CDEMG correlate closely with kiwifruit biosecurity, but kiwifruit biosecurity threats also fall within BOP CDEMG scope, as well as the natural hazards that are more commonly associated with this organisation. Therefore, this interview provided some insight that is highly relevant and established a platform for further knowledge sharing and potential future collaboration between BOP CD EMG and KVH.

Some key learnings from this interview are summarised below.

1. **When people understand true risk that correlates into preparedness.**
2. **It is important to manage people's expectations.** People need to have a realistic expectation of the support services that might be available, and how much responsibility they are going to need to take on to manage their family and others. By having this conversation and clarifying what people expect from the Government or organisations such as the Civil Defence, or KVH, helps put everyone on the same page.
3. **Need to be clear on what we expect from people in preparedness.** Often this is quite simple and people may be more prepared than they realise, they just might not be doing this overtly and in a planned manner. Need to be able to consider the practical implications of what we are asking and that we have given the advice deep consideration and it's actually meaningful.
4. **Demonstrate the value of preparedness.** There is always that balance in spending for something that we might never see the benefit of. So we take the approach of demonstrating the value, which might be over a ten-year time frame. This makes it easier for the decision makers to make an informed decision.
5. **There are flow-on effects from events to other regions, but these drop off quickly.** After the Christchurch earthquakes people here understood a similar thing could happen, but that drops off pretty quickly compared to those that have experienced it. There is nothing like experiencing the real thing. It is difficult to maintain that momentum and after a while people get sick of hearing about Christchurch. Local people are more likely to talk about Edgecumbe than Christchurch, despite that being 30 years ago, because they experienced it.
6. **Increasing community connectedness builds resilience and is a good approach to preparedness.** The stronger a community is, with those bonds in place between neighbours, the stronger they are to manage a response. So the first step is supporting community activities, and second is to work with the leaders in those communities to develop community response plans, to map out what resources they have and a plan of action should an event occur.

The other component is mapping out community's vulnerabilities as communities can be vulnerable for a range of reasons, i.e. lack of money or resources or geographically living in a high risk area. We then set a programme around reducing these vulnerabilities where possible.

The driver for this change in approach is that we have seen our current approach wasn't working and delivering the message effectively. The guys in Wellington have done a great job with this community driven approach so we have taken a few lessons from them. Overseas research has also shown that where communities are strong, they are able to withstand shocks much better.

It's about finding those leaders and advocates and they become your champions, as people take up messages a lot more when they come from someone they know and respect.

7. Lack of understanding perceived risk is the biggest barrier to preparedness.

“If you can get perceived risk across, everything else falls inline. That’s your number one. Your cost, effectiveness and hassle factors come down to being able to demonstrate that value of what you are asking them to do. If they see value, and direct relationship to the perceived risk then they are happy to spend money, deal with the hassle etc.”

“In most other aspects of life we talk about the economics of cost and value, but we don’t seem to do it enough in this space. If you could demonstrate to growers the cost of an incursion vs the cost of what you are asking them to do and the value in that activity in mitigating the risk, then you should have a high uptake.”

- 8. For communication you can’t beat face-to face meetings.** When it comes to understanding risk and the actions you want people to take you can’t beat face to face meetings and conversations. And that’s where the champions come into their own. If you have key people in the community that these people talk to a lot, if these guys are communicating your message for you, they will be doing it ten times more effectively than you will ever be able to do. P listen to them.
- 9. Invest in your champions.** The more you invest in these people the more they will engage, take ownership and value what they are doing.

9 CONCLUSIONS

The current state

Psa has increased biosecurity awareness in the kiwifruit industry, and is reinforced by recent fruit fly incursions and biosecurity communications by industry bodies. Kiwifruit growers believe that a future biosecurity incursion is a significant risk to their investment in kiwifruit, if not the greatest risk. Yet on most orchards, biosecurity practices have slipped from where they were several years ago.

There are several reasons for this apparent paradox.

Only practices that are seen to make a difference have been retained by many growers in Recovery Regions. Some growers believe the initial protocols implemented for Psa are now excessive for the current environment and the decline in practice is not a result of “complacency” but rather a “new norm” appropriate for the current level of risk. However, by “risk” most growers are thinking only about Psa.

There is a Psa-centric paradigm in the industry. Psa is seen as the concern of growers and the wider industry and other biosecurity threats are the responsibility of KVH and MPI. Most growers believe they are doing what is necessary to manage “risk” (of Psa). However, this falls below what most subject experts would recommend as a minimum standard to reduce the impacts of a future biosecurity incursion. The role growers can play in mitigating the impact of future biosecurity incursions does not seem to be well understood by many. If every grower maintained a baseline of minimum on-orchard practice, even in the absence of an imminent threat, the industry would be more likely to limit the spread of a pest or pathogen before it is detected. For many pests and pathogens, these actions could determine whether eradication is a possibility or not which could have significant financial implications for growers and the wider industry over the long term. A biosecurity threat that is not eradicated, creates a challenge that needs to be managed year after year. Impacts to the grower may include loss of orchard productivity and land value, increase in operating costs, market access implications and in some cases, all of the above. Biosecurity practices provide the industry with a form of insurance against a significant business risk.

On-orchard practices can reduce the impact of a future biosecurity incursion, but they also demonstrate that our internal risk pathways are well managed. This is important to underpin the changes that the kiwifruit industry is encouraging, or requiring other sectors to undertake, to mitigate risk to our industry (such as nurseries, bee keepers, transporters and ports of entry).

However, the industry is doing many things well and has an excellent platform to build on. Psa has increased grower engagement in orchard practices and orchard productivity is at an all-time high. There is confidence that the industry can overcome future biosecurity challenges like it did for Psa (although this confidence may also encourage complacent behaviour). Achieving general awareness of biosecurity and the understanding that biosecurity threats are a significant risk to growers' investment in kiwifruit is a significant step. This needs to be built upon and converted into on-orchard practices to mitigate these risks.

What is required and how do we achieve this?

Subject experts, from biosecurity and Civil Defence, were unanimous in stating that the single greatest barrier to uptake of recommended practice is a lack of understanding of risk, and how specific measures mitigate this risk. This is a fundamental first step that must be achieved for subsequent barriers to be overcome.

Communications informing the industry of potential biosecurity threats should continue to ensure a level of awareness across the industry. Attempts should be made to make these messages as real as possible for growers with impacts described in terms that growers can easily relate to, such as orchard productivity and value, and impacts on trade with images or videos available to illustrate impacts.

Industry guidelines are required to provide a consistent view of what best practice is for biosecurity threats other than Psa. These guidelines would be to maintain a baseline for business as usual in absence of an imminent threat or response. Should risk be elevated, such as during a response, then practices can be increased accordingly to mitigate this risk.

These biosecurity guidelines should only retain practices that make a difference, with clear explanations how each practice mitigates risk. There is no point recommending practices that have little effectiveness in mitigating risk. Guidelines need to set minimum requirements to ensure there are no commercial disincentives for those implementing best practice, particularly for contractors.

Guidelines also need to be made simple, to understand and to implement. The more that can be done to facilitate the implementation process, the more likely uptake of recommended practice will be. Awareness creates intention to implement, but it is the provision of a plan to assist with implementation that is effective in creating action.

However, a paper document alone will not achieve the paradigm shift necessary for mass uptake of these guidelines across the industry. People are not passive recipients of information but are complex beings that can respond with a number of actions or feelings, and therefore adoption is not an event, but a process characterised by the following stages.

1. Knowledge - awareness of the risk and recommended practice.
2. Persuasion – forming a view on the recommended practice
3. Decision - engaging in activities that will lead to a choice to either adopt or reject the practice.
4. Implementation - putting the practice to use, or rejection.
5. Confirmation - seeking reinforcement of the decision by observation of its impact.

Awareness of risk and the practice is only the first step in the adoption process. Growers need to be supported through the remaining steps. Support must continue past implementation to provide reinforcement of their decision to implement by communicating risk and providing confirmation that their practices are mitigating risk.

The “diffusion of innovations theory” also tells us that the adoption of a new idea or practice follows a pattern and those associated with different phases of the adoption process respond to different cues. Providing information might create uptake among the “innovators” and “early adopters” but is likely to be largely ineffective with the remaining 84% of the population who receive information differently. For most of the population, implementation requires support and guidance, testimony from trusted sources such as their peers or opinion leaders, observation that the practices are effective and feedback to reinforce their decision to implement once they have done so.

To facilitate the necessary behavioural change, the industry should establish a working group of biosecurity champions and opinion leaders. Involvement of this group in the development of biosecurity guidelines will ensure they are practical, fit for purpose and have the support and ownership of the industry from an early stage.

Industry champions also provide a respected resource to communicate key messages and provide on-going support to growers. When programme champions play an active role in the development of an innovation, spread and implementation is likely to be more effective. Care needs to be taken when selecting biosecurity champions to ensure they have sufficient influence across a range of areas. Experts can be selected who influence through opinion and status, but the greatest success is likely to be achieved through peer opinion leaders. To achieve high uptake, these leaders need to tap into a range of networks across the industry. To be most effective they need to be of similar backgrounds and socio-economic groups as orchardists and be considered as a respected peer and a trusted source of information.

This approach of using industry champions has been used in the kiwifruit industry previously in several forms such as the KVH Regional Coordinator network which was implemented for the Psa response and is still in place today. Reviewing how effective these previous experiences have been in getting industry uptake of messages will provide insight into how this should be adopted to achieve uptake for on-orchard biosecurity practices going forward.

This study identified that there is value in a coordinated approach with other industries, to have consistent biosecurity messages across the horticultural sector where appropriate. This may be an appropriate point to introduce this coordinated approach, to learn from others’ experiences and knowledge but retain a specific focus on the kiwifruit industry.

Overall, it comes back to starting with effectively communicating an understanding of risk, and how specific measures mitigate this risk. This understanding, and the flexibility and empowerment to make decisions about the level of protection required for their operation within certain guidelines, could be a path towards better biosecurity outcomes.

10 RECOMMENDATIONS

This study provides a platform for further work and recommends the follow actions be undertaken by the kiwifruit industry:

1. Biosecurity awareness material needs to be made “real” for growers, in terms they relate to such as potential impact to orchard productivity, trade, and orchard value.
2. Industry biosecurity guidelines are required, to indicate the level of practice required for business-as-usual operation in absence of an imminent biosecurity threat or response. These guidelines would provide consistency across the industry, remove commercial disincentives that currently exist, and thereby improve the industry’s ability to withstand a future biosecurity incursion.
3. Guidelines should clearly explain the purpose of a recommended practice and how this mitigates risk.
4. Recommended practices should be practical and easy to implement. Industry bodies should facilitate this process.
5. A network of industry champions and opinion leaders should be created to assist in the development, communication, implementation and on-going support of the biosecurity practices.
6. Care must be taken when selecting industry champions and opinion leaders to ensure selection of individuals with appropriate influence into a diverse range of industry networks.
7. There is value in a coordinated approach with other industries and they should be involved in the development of biosecurity guidelines to provide consistent messages across the horticultural sector.

11 ACKNOWLEDGEMENTS

This study is to fulfil the requirements of the Kellogg Rural Leadership Programme and has been completed with funding by Kiwifruit Vine Health (KVH), for whom the author is an employee.

Thank you to KVH for supporting this project and to my colleagues for your advice and input. Thank you to all interview participants, for your time and contributions particularly during harvest season when time is at its most precious.

And finally thank you Patrick Aldwell, Anne Hindson and Desley Tucker for the hard work you put into the Kellogg programme to make it the exceptional experience that it is.

12 REFERENCES

- Birnie, Douglas, and Anna Livesey. 2014. *Lessons learned from the response to Psu-V*. Wellington: Sapere Research Group.
- Das, K, and R Lashkari. 2015. "Risk readiness and resiliency planning for a supply chain." *International Journal of Production Research* 53 (22): 6725-6771. doi:10.1080/00207543.2015.1057624.
- European Commission. 2007. "A new Animal Health Strategy for the European Union (2007-2013) where "Prevention is better than cure"." doi:ec.europa.eu/food/animals/health/strategy2007-2013/index_en.htm.
- Everett, K, M Manning, and A Blouin. 2014. "Brief Literature Review - Diagnostic Procedures for Kiwifruit diseases." A Plant & Food Research report prepared for Kiwifruit Vine Health. Contract No 30769.
- GIA. 2016. *Government Industry Agreements for Readiness and Response*. Accessed May 20, 2016. <http://www.gia.org.nz/About-GIA/What-is-GIA>.
- Greenhalgh, Trisha, Glenn Robert, and Paul Bate. 2008. *Diffusion of Innovations in Health Service Organisations*. Chichester, GB: BMJ Book. Accessed May 29, 2016. ProQuest ebrary.
- Greer, G, and C Saunders. 2012. *The costs of Psu-V to the New Zealand Kiwifruit industry and the wider community*. Lincoln University.
- Halliday, Angela. 2016. "New Zealand Horticultural Grower's Priorities." Report for the Kellogg Rural Leadership Programme.
- Kelly, Steven. 2012. *Literature review on the diffusion of innovations and best practice for technology transfer. Health Analysis and Information for Action (HAIFA)*. Porirua: Environmental Science and Research Limited.
- KPMG. 2015. "KPMG Agribusiness Agenda 2015, Volume 1 - Growing Value." Accessed May 2016. <https://home.kpmg.com/nz/en/home/insights/2015/06/agribusiness-agenda-2015-growing-value.html>.
- Kuster, Karin, Marie-Eve Cousin, Thomas Jemmi, Gertraud Schupbach-Regula, and Ioannis Magouras. 2015. "Expert opinion on the perceived effectiveness and importance of on-farm biosecurity measures for cattle and swine farms in Switzerland." *PLoS One* 10 (12). doi:10.1371/journal.pone.0144533.
- KVH. 2016. *Kiwifruit Vine Health*. 18 May. <http://www.kvh.org.nz/statistics>.
- . 2016. "Kiwifruit's Most Unwanted." *Kiwifruit Vine Health*. January. http://www.kvh.org.nz/emerging_risks.
- Leventhal, H, R Singer, and S Jones. 1965. "Effects of fear and specificity of recommendation upon attitudes and behaviour." *Journal of Personality and Social Psychology* 20-29.
- Mills, Peter, Katharina Dehen-Schmutz, Brian Ilbery, Mike Jeger, Glyn Jones, Ruth Little, Alan MacLeod, et al. 2011. "Integrating natural and social science perspectives on plant disease risk, management and policy formulation." *Philosophical transactions of the Royal Society* 2035-2044.

- Paek, Hye-Jin, Karen Hilyard, Vicki Freimuth, J K Barge, and Michele Mindlin. 2010. "Theory-based approaches to understanding public emergency preparedness: implications for effective health and risk communication." *Journal of Health Communication* 15:4: 428-444. doi:10.1080/10810731003753083.
- Ryan, B, and N Gross. 1943. "The diffusion of hybrid seed corn in two Iowa communities." *Rural Sociology* 8: 15-24.
- Sinek, Simon. 2009. *Simon Sinek: How great leaders inspire action*. September. Accessed May 10, 2016.
https://www.ted.com/talks/simon_sinek_how_great_leaders_inspire_action/transcript?language=en.
- Slovic, P, M Finucane, E Peters, and D MacGregor. 2004. "Risk as analysis and risk as feelings; some thoughts about affect, reason, risk and rationality." *Risk Analysis* 311-322.

13 APPENDICES – INTERVIEW QUESTIONS

Appendix 1: Interview Questions for Growers

Introduction covering the purpose of interview, confidentiality etc.

Background information

1. Total size of operation (Ha)
2. Region and Psa status of region (Exclusion, Containment, Recovery)
3. Organic or conventional production?
4. Orchard Psa status and date of first infection
5. Experience with horticulture or primary industries? Personally and family – i.e. multiple generations?

Exposure to incursion impacts

6. In any industry - what biosecurity incursions have you observed the impacts of first hand?
7. Of these how many impacted you or your family directly?
8. How significant has Psa or any other biosecurity incursion been for you on a scale of 1-10 (with 1 being very minor and 10 being catastrophic).
9. Do you consider the possibility of future biosecurity incursions to be a significant risk to your investment in kiwifruit?

Biosecurity awareness

10. Whose responsibility is biosecurity?
11. How “biosecurity aware” do you consider yourself to be (1-10, with 10 being extremely aware)?
12. Are you aware of Streptomycin and copper resistant strains of Psa have been detected?
13. Does the presence of these strains change your approach to biosecurity?
14. Can you name any potential biosecurity threats to kiwifruit?
15. If not show photos and see if they can name any of those (Most unwanted)

Biosecurity practices

For each of the following practices indicate

- If this is a routine practice that is always implemented in your operation;*
- If this is a practice you used to implement prior to getting Psa, but no longer do*
- Perceived effectiveness of each measure in reducing the spread or impact of future biosecurity incursions (1-10 with 10 being most effective)*

Measure	Routine practice	No longer implemented	Perceived effectiveness
16. Source cleanest possible plant material <ol style="list-style-type: none">a. Rootstock (KPCS)b. Budwoodc. Pollen			
17. Do you regularly monitor your orchard for unusual symptoms?			

18. If you do observe unusual symptoms do you report these to either MPI, KVH or your post-harvest operator?			
19. Do you ask visitors questions about orchards they may have recently visited?			
20. Do visitors have to undertake any hygiene practices (shoes, clothing, hand sanitiser)			
21. Do you restrict visitor access to your orchard in any way?			
22. Pruning tool hygiene - do you sterilise tools using an effective sanitiser?			
23. If so with what frequency- Between vines/bays/rows/blocks/ orchards/ no set frequency?			

24. For the practices above can you indicate what the barrier is to implementing biosecurity practices (perceived effectiveness, cost, hassle, reliance of contractors, other?)

25. What are the opportunities to improve the uptake of biosecurity practices so that the industry is better prepared for future incursions?

26. Do you think there is value in a coordinated approach with other industries?

Appendix 2: Interview Questions for post-harvest grower services

Introduction covering the purpose of interview, confidentiality etc.

Background information

1. Number of growers as customers
2. Number of years as a grower services rep
3. What regions are your growers located?
4. Do you believe there that growers become more complacent about biosecurity with time since Psa infection?
5. Is there a difference in biosecurity attitudes between organic and conventional growers?
6. Are growers who have come from a family history of horticulture more or less complacent in biosecurity practice?

Exposure to incursion impacts

7. Are growers that have been significantly impacted by Psa or other biosecurity incursions likely to implement a higher standard of biosecurity practice going forward?
8. Do growers consider the possibility of future biosecurity incursions to be a significant risk to their kiwifruit investment?

Biosecurity awareness

9. Do you think the average grower takes some responsibility for biosecurity or believes this is solely the responsibility of someone else, such as the Govt or KVH?
10. How “biosecurity aware” do you consider your growers to be from 1-10 with 10 be extremely aware? (provide a range and average for your growers)
11. Do you think all your growers would be aware of the existence of Streptomycin and copper resistant strains of Psa?
12. Does the presence of these strains change their approach to biosecurity?
13. Do you think they would be aware of any other biosecurity threats to kiwifruit?

Biosecurity practices

For each of the following practices indicate on average, for your growers;

- If this is a routine practice that is always implemented in their operations;*
- If this is a practice they used to implement prior to getting Psa, but no longer do*
- Your perceived effectiveness of each measure in reducing the spread or impact of future biosecurity incursions (1-10 with 10 being most effective)*

Measure	Routine practice	No longer implemented	Perceived effectiveness
14. Source cleanest possible plant material d. Rootstock (KPCS) e. Budwood f. Pollen			
15. Do you regularly monitor your orchard for unusual symptoms?			

16. If you do observe unusual symptoms do you report these to either MPI, KVH or your post-harvest operator?			
17. Do you ask visitors questions about orchards they may have recently visited?			
18. Do visitors have to undertake any hygiene practices (shoes, clothing, hand sanitiser)			
19. Do you restrict visitor access to your orchard in any way?			
20. Pruning tool hygiene - do you sterilise tools using an effective sanitiser?			
21. If so with what frequency- Between vines/bays/rows/blocks/ orchards/ no set frequency?			

22. What do you think are the significant barriers to implementing biosecurity practices (perceived effectiveness, cost, hassle, reliance of contractors, other?)
23. What are the opportunities to improve the uptake of biosecurity practices so that the industry is better prepared for future incursions?
24. Do you think there is value in a coordinated approach with other industries?

Appendix 3: Interview Questions for Subject Experts - Biosecurity

Introduction covering the purpose of interview, confidentiality etc.

1. Background and overview of relevant experience in horticulture or biosecurity
2. Do you believe that kiwifruit growers become more complacent about biosecurity with time since Psa infection?
3. Another way to put this is perhaps growers aren't complacent, but that we have just landed in the right place with practices. What are your thoughts on that?
4. Do growers need to be directly impacted by an incursion, or at least observe the impacts first-hand to become more biosecurity aware?
5. Are growers who come from a family history of horticulture more or less complacent in biosecurity practice?
6. Whose responsibility is biosecurity?
7. How do the biosecurity practices of the kiwifruit industry compare to other industries that you have worked with?

Biosecurity practices

For each of the following practices what is your perceived effectiveness of each measure in reducing the spread or impact of future biosecurity incursions (1-10 with 10 being most effective)?

8. Source cleanest possible plant material
 - g. Rootstock (KPCS)
 - h. Budwood
 - i. Pollen
9. Regular monitoring on the orchard for unusual symptoms
10. Reporting of any unusual symptoms to an appropriate organisation, whether that is MPI, KVH or post-harvest?
11. Questioning visitors about orchards they may have recently visited?
12. Visitor hygiene practices (shoes, clothing, hand sanitiser)
13. Restricting visitor access to orchards?
14. Pruning tool hygiene - sterilise tools using an effective sanitiser? If so with what frequency- Between vines/bays/rows/blocks/ orchards/ no set frequency
15. For the practices above can you indicate what the barrier is to implementing biosecurity practices (perceived effectiveness, cost, hassle, reliance of contractors, other?)
16. What are the opportunities to improve the uptake of biosecurity practices so that the industry is better prepared for future incursions?
17. Do you think there is value in a coordinated approach with other horticultural industries to get consistent biosecurity messaging?
18. Any further comments?

Appendix 4: Interview Questions for Subject Experts – Emergency Preparedness

Introduction covering the purpose of interview, confidentiality etc.

1. Please briefly explain what your role involves
2. Do you face an issue with complacency from the general public in emergency management preparedness?
3. How significant do you believe the association is between awareness of risk and levels of preparedness? You would expect a direct correlation between awareness of risk and preparedness, is that necessarily the case?
4. Events like the Christchurch earthquakes presumably improve preparedness in the Christchurch region, however have they also improved preparedness across NZ as a whole? Do people need to experience a disaster first hand in order to be more prepared?
How do you maintain that momentum?
5. Is there an attitude, that in developed societies especially, people have an expectation that they will be looked after should something happen, and they don't have a personal responsibility in emergency preparedness themselves?
6. Describe in general terms how you approach improving preparedness of the general public for an emergency.
7. Do you have any statistics to indicate the level of preparedness in the Bay of Plenty or wider NZ?
8. Do you believe that people believe that they are more prepared than they really are? i.e. emergency kits out of date, not maintained etc?
9. Is language a significant barrier to preparedness?
10. Which of the following are the most significant barriers to preparedness (rank in order of importance);
 - a. Perceived risk
 - b. Perceived effectiveness of any supplies
 - c. Belief that in a response someone will look after them (Govt, CD, family etc)
 - d. Hassle
 - e. Cost of supplies
 - f. Other
11. How do you quantify the value of preparing for events?
12. How effective are your communication channels? What works and what doesn't? (mainstream media – news, papers, magazines, social media, community meetings etc)