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The issue of biosecurity in New Zealand.

A case study of the PSA epidemic on the kiwifruit industry

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Abstract

In this age of globalisation the need for increased trade across borders has also meant the increase of movement of biological material - why biosecurity has become such an important issue in the 21st century. New Zealand with its unique flora and fauna has historically had an advantage in agriculture where kiwifruit is one of the most prosperous export industries, thanks to a comprehensive biosecurity policy.

This thesis will examine the case of the devastating *Pseudomonas syringae* pv. *Actinidiae* (PSA) disease on the kiwifruit industry in New Zealand: where it came from, how it has been handled and what its source may be. Since this has revealed flaws in the biosecurity systems, it raises the question if there is a dilemma - between the vital interests of biosecurity, and that of trade. In the pursuit of an effective and profitable industry, the kiwifruit flowers are in many cases artificially pollinated, and with globalisation of trade an international market for pollen has emerged which is suspected to be a factor contributing to the PSA outbreak on orchards in New Zealand's Bay of Plenty region,

This thesis will focus around *what* response the PSA disease outbreak has triggered both in word and action, rather than to study factors as to *why* the PSA disease outbreak on New Zealand's kiwifruit industry could emerge, considering its advanced biosecurity strategies. From this, the key questions that will be addressed more in depth are as follows:

- 1) In connection with the problems PSA has caused, what have the various actors' approach been to handling the issue?
- 2) How has the government department responsible for biosecurity been the subject of scrutiny after the PSA outbreak?
- 3) What do the various actors consider to be the source of the PSA outbreak?

While the costs PSA has inflicted on kiwifruit growers is many hundreds of millions of dollars, most of the focus of the industry is on improving the biosecurity set up, which the responsible authorities have also endeavoured to do, by limiting the spread and investing in research for disease resistant varieties of kiwifruit.

Key words: *biosecurity, New Zealand, MAF, MPI, kiwifruit, PSA, disease, kiwifruit pollen.*

Table of contents:

Abstract	2
Table of contents	3
List of abbreviations	4
Chapter 1 – Presentation of thesis and its objective	5
1.1 Introduction	5
1.2 Presentation of the thesis	5
1.3 Objective and key questions to be considered in this thesis	6
1.4 Structure of the thesis	6
Chapter 2 - Biosecurity and the case of New Zealand	7
2.1 Background and a theoretical definition of biosecurity	7
2.2 Historic context of the development of New Zealand’s biosecurity policies	8
2.3 New Zealand’s present biosecurity commitments	9
2.4 The goals for New Zealand’s biosecurity becoming more politicised overemphasising economic interests	11
2.5 Previous research on the wider topic of biosecurity	11
Chapter 3 - New Zealand and the kiwi fruit industry	14
3.1 Basic facts about kiwifruit in New Zealand	14
3.2 The origins of the kiwifruit	14
3.3 The kiwifruit disease PSA and its symptoms	15
3.4 The first cases of PSA in New Zealand	16
3.5 The costs of PSA	16
Chapter 4 - Methodology	18
4.1 How I have approached the chosen topic resulting in a document study	18
4.2 Scientific approaches: inductive and positivistic	18
4.3 Rationality and Objectivity	18
4.4 Data collection process	19
4.5 The geographic demarcation of context and relevance	19
4.6 Demarcations of the various disciplines encompassed in this thesis	19
Chapter 5 –What have the various actors’ attitudes been to handling the PSA issue?	21
5.1 Introduction	21
5.2 Biosecurity measures to limit the spread of PSA	21
5.3 Zespris approach to the PSA challenge	22
5.4 How the kiwifruit growers have reacted to the PSA situation	23
5.5 Kiwifruit growers wanting to make a legal case of the PSA incursion	23
5.6 The kiwifruit growers looking ahead to other biosecurity issues	24
Chapter 6 – How has the government department responsible for biosecurity been the subject of scrutiny after the PSA outbreak?	25
6.1 Introduction	25

6.2 Immediate inquiries commissioned by the Ministry of Primary Industry concerning its biosecurity commitments, following the PSA incursion	25
6.3 Main points of the Audit	25
6.4 The scrutinising over the permitted kiwifruit pollen imports	26
6.5 MAFs details about all imported kiwifruit pollen since 2008	27
6.6 MAFs report about local New Zealand produced pollen being contaminated with imported, potentially PSA infected pollen.	27
6.7 The MAFs explanation to the first symptoms of PSA being found on an orchard next door to Kiwi Pollen Ltd–New Zealand’s only pollen importer	28
6.8 Various evaluations of the PSA risks involved with imported pollen	28
Chapter 7 - What do the various actors consider to be the source of the PSA outbreak?	31
7.1 Introduction	31
7.2 KVH’s findings over pollen as a potential path of entry for PSA	31
7.3 The Ministry of Agriculture’s findings of whether PSA could have entered via imported pollen	31
7.4 Other voices concerning the source of the PSA outbreak	33
Chapter 8 - Analysis and concluding reflections	35
8.1 Introduction	35
8.2 Analysis and discussion	35
8.3 Concluding remarks	35
8.4 Future research	36
References	37
Interviews	40
Appendix I	40

List of abbreviations:

BNZ - Biosecurity New Zealand
CAC - Codex Alimentarius Commission
FAO - Food and Agriculture Organisation of the United Nations
GMO - Genetically Modified Organisms
IAS - Invasive Alien Species
IOE - International Office of Epizootics
IPPC - International Plant Protection Convention
KVH - Kiwifruit Vine Health
LMO - Living Modified Organisms
MAF - Ministry of Agriculture and Forestry
MPI - Ministry of Primary Industries
NZD - New Zealand Dollars
NZFSA - New Zealand Food Safety Authority
OECD - Organisation for Economic Co-operation and Development
PSA - Pseudomonas syringae pv. Actinidiae
WHO - World Health Organisation

Chapter 1 – Presentation of thesis and its objective

1.1 Introduction

New Zealand, more than any other developed country in the world, is dependent on its *biosecurity* – to protect its borders from foreign biological material potentially posing a danger to national interests. However, biosecurity threats are today a problem not only to New Zealand, but are also a huge problem on a global scale. There are countless notable examples of pests and diseases that, when introduced to a new biological environment can pose serious danger not only to humans, animals and plants, but also have a great impact on economic and social wellbeing. Apart from numerous animals and pests that legally and illegally cross borders, there are also serious diseases, such as swine flu, avian influenza, foot and mouth and mad cow disease and bird flu – that all pose a serious threat to the health and well being of humans as well as animals and plants. The list can be made very long. To win the battle against such exotic invaders, countries at high risk, as well as those highly exposed, require an internationally linked and robust biosecurity system, protecting environmental, economic, cultural and social values, as well as enabling the unhindered continuation of international travel and trade. (MAF, 2007) For New Zealand, being heavily dependent on trade with the outside world, and particularly on exports from its primary industries, a well-functioning biosecurity system is of utmost importance. One of these primary industries heavily dependent on exports, is the kiwifruit industry, where as much as 95% of kiwifruit grown in the country is exported, with a 32% share in all its exports. (World Kiwifruit Review, 2010)

1.2 Presentation of the thesis

This thesis will both be describing the issues of biosecurity, by highlighting some of the problems that the kiwi fruit industry has been exposed to with the outbreak of the serious disease *Pseudomonas syringae* pv. *Actinidiae* (PSA) and the dilemma that has been exposed to the national government. With its great dependence on the agricultural sector for exports vital to the national economy, New Zealand's dependence on its natural environment cannot be underestimated, where agriculture together with the tourism sector, account for around a third of its gross domestic product, and up to half of the countries' export contributions. This is the highest degree of dependence on the natural environment among the OECD countries. (Swaffield, 2010:95) Biosecurity policy plays such a central role in its national economy, where the interests of a large number of primary industries are heavily dependent on its functioning efficiently. Just how exposed one of these exporting industries is to any biosecurity threat is realised by examining the kiwi fruit industry in New Zealand. New Zealand's agricultural sector is one of the world's most export oriented, where over 80% of livestock products, and more than 50% of its horticulture produce are export destined. As New Zealand's internal market is limited and there not being any governmental policies stabilising or buffering domestic prices, prices on farming produce in New Zealand can fluctuate greatly as they are mostly determined by global market prices, the fluctuations the value of the New Zealand dollar and shipping costs. (Melyukhina, 2011:10) Just to give an example of how important exports of agricultural products are in relation to its relatively small human population of approximately 4.5 million, consider the number of sheep in New Zealand - today around 40 million, making it one of the world's leading exporters in sheep products. (Stats NZ, 2013; Swaffield, 2010:101) Like with New Zealand's sheep industry has the highest number of sheep per capita, New Zealand also has the highest levels of kiwifruit exports per capita,

which gives a picture of how its economy has such a high dependence on the agricultural sector. From these examples it is easy to understand the devastating effects on New Zealand's economy, should one or more of its agricultural sectors become infested with disease or the unharnessed spread of invasive species. (MAF, 2011a) The outbreak of PSA (*Pseudomonas syringae* pv. *Actinidiae*) on kiwi fruit orchards in the Bay of Plenty area late in 2010, therefore was a test to the advanced biosecurity policies in place, and can serve as an interesting case to describe weaknesses in this system, by reviewing how various actors have reacted.

1.3 Objective and key questions to be considered in this thesis

The objective of this thesis is to study how the PSA disease outbreak on the New Zealand kiwifruit industry has revealed weaknesses in its advanced biosecurity strategies, with a certain focus on how the various key actors have dealt with the problem of PSA.

The three key questions will be addressed more in depth from chapter 5 to 7, and are as follows:

- 1) In connection with the problems PSA has caused, what have the various actors' approach been to handling the issue?
- 2) How has the government department responsible for biosecurity been the subject of scrutiny after the PSA outbreak?
- 3) What do the various actors consider to be the source of the PSA outbreak?

Even though this thesis is setting out to primarily look at how and why the PSA disease was able to break out, a certain attention will also be brought to the ongoing discussion about who carries the blame for the outbreak. Although this question is not a central part of this study, it will be addressed to give an overall picture of how this question is widely held as important from a liability perspective, among kiwifruit growers, politicians and the public.

1.4 Structure of the thesis

In Chapter two a background description and definition of the term biosecurity, a historic development, New Zealand's advanced set-up and the applicable governmental agencies put in charge to handle this national interest are presented. In chapter three some background will also be given about New Zealand's kiwifruit industry to understand why it is such an important primary industry that is being examined in this thesis, especially in connection with its devastating bacterial PSA disease. Chapter four will deal with the methodology where explanations of the various scientific approaches to research are developed. After this background study the empirical research is presented through three chapters each bearing the same title as the preceding three key questions to be answered in this thesis. The first of these, Chapter five deals with the immediate reaction on behalf of the various actors within the kiwifruit industry, mainly looking for ways to limit the spread of the disease. Chapter six addresses the how the devastating effects of the PSA led to a scrutinising of the government agencies responsible for New Zealand's biosecurity and the systems in place in order to prevent such an epidemic on New Zealand's kiwifruit industry, by looking into how events in the past may have developed into an outbreak. In Chapter seven the various actors give their opinion as to the likely source of PSA. Finally in Chapter eight the results of the research are presented and discussed, with concluding remarks and possible further research.

Chapter 2 - Biosecurity and the case of New Zealand

2.1 Background and a theoretical definition of biosecurity

In this era of globalisation, words with bio-prefixes are widely used, such as biotechnology, biosafety and biodiversity which signify just how important biological resources are in national development. According to the Food and Agriculture Organisation of the United Nations, (FAO, 2003) biosecurity can be defined as: “a strategic and integrated approach, covering policy and regulatory frameworks, to analyse and manage risks on food safety as well as environmental risk associated with the life and health of human being, animal and plant.” (Falk, Wallace & Ndoen, 2011:v) Thus, the definition of the term biosecurity gives a holistic approach in the context of other related bio-terms which are integrated within a policy of managing and analysing, not only the risks posed to food safety and human health, but also to protecting economic interests and threats to the environment. (Falk *et al*, 2011:v) The Oxford dictionary on-line www.oxforddictionaries.com gives the following meaning of the noun Biosecurity:

[/bɪəʊsəkjuəri/](http://www.oxforddictionaries.com) “procedures or measures designed to protect the population against harmful biological or biochemical substances.”

The biosecurity issue has been the subject of research and analysis from the time trade of agricultural produce started between countries well over a century ago, which led to the introduction of border quarantine control systems with the purpose of preventing new animal and plant disease or pests from exports and imports of these. In the 1950s the Plant Protection Convention (IPPC) forum was established under the FAO. The purpose of the International Convention according to Article I, paragraph 1 of IPPC is:

... securing common and effective action to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control, the contracting parties undertake to adopt the legislative, technical and administrative measures specified in this Convention and in supplementary agreements ... (Falk *et al*, 2011:27)

Further development was made under the Codex Alimentarius Commission (CAC) founded by the FAO and World Health Organisation (WHO), who deals with the procedures, recommendations and standards that can result from movement of agricultural products and food, whereas the International Office of Epizootics (IOE), supervise animal trade between countries with the objective of reducing the risk posed to life and the health of the animals in countries concerned. (Falk *et al*, 2011:vi) Where biosafety within the OECD definition encompasses also any issues related to environmental, plant, animal and human health and biodiversity refer to threats of infestations from genetically modified organisms (GMO) or Invasive Alien Species (IAS), according to FAO within the realm of biosecurity, it focuses mainly on biological threats towards agriculture and food. While adherence to the international standards, regulations, laws and policies of biosecurity in the name of humanitarianism, are often stressed upon by the global north (the developed countries) as reasons for refusing imports of biological products from the global south (developing countries), their motives are in fact often primarily anti competitive protectionism of domestic agricultural sectors. Biosecurity policymaking at the national level is usually intended or established to answer the following five threats against plant and animal (and also human and marine) health: quarantine pests and diseases, Invasive Alien Species (IAS),

bioterrorism, genetically modified organisms (GMOs) or Living Modified Organisms (LMOs) and the smuggling of genetic resources. (Falk *et al*, 2011:28)

2.2 Historic context of the development of New Zealand's biosecurity policies

While biosecurity is a relatively new phenomenon, efforts to achieve *biological control* are nothing new and have been used in agriculture back in ancient Asian and Middle East civilisations, where for example ants were used to control pests found on the phytophagous plants. The term biosecurity however has been adopted much more recently, and appeared not until the late 1980s. (Science Learn, 2012) In New Zealand it was introduced in the early 1990s, and was especially referred to since the passing of the New Zealand Biosecurity Act in 1993. However, when looking beyond these present-day rules and regulations, to find an explanation to the development of such a high level of significance and application in a national policy, compared to most other OECD nations, we have to look into New Zealand's history and its colonisation, with the subsequent problems encountered when invasive species disrupted its delicate and unique flora and fauna. The approach to managing these problems in the past during the colonisation era of New Zealand mainly focused on setting up border inspections and quarantine stations. From the 1860s, these quarantine stations were built on islands close to the major ports, so that incoming ships could unload all their passengers and animals there, until they had been properly inspected. They generally would stay there until deemed free from sickness, diseases or pests. (Teara, 2012) Although these basic principles of quarantine were very effective and in a historic context cannot be questioned from a present day perspective, there were dear lessons to be learned from the deliberate introduction of alien species to New Zealand. From the 1840s, attitudes towards importing these alien species were entirely based on whether they were regarded as useful to the settlers. Already in the 1860s, certain settlers reported problems they were experiencing with imported wild animals such as birds and rabbits eating their crops. As a countermeasure, weasels, ferrets and stoats were imported specifically to decimate the rabbit population, but the measure failed and they ate native bird species instead, such as the earth bound kiwi bird that previously had had no natural enemies. (Teara, 2012) It was not until 1896, that the original Protection of Animals act of 1867 was amended in such a way that the government had full control over all animal importation. The lessons learnt from the problems to native ecology caused by these first settlers have had far-reaching influences on the present policy to protect the current "status quo" on the environment, which still needs to be protected from further incursions. (Jay & Morad, 2006) However, the policy throughout the 19th century did centre on protecting the agricultural sector, which meant it was soon discovered that New Zealand had a competitive advantage over other agriculture exporting countries, being free from many of the common diseases and pests present in other parts of the world. (Jay & Morad, 2006) This competitive advantage in trade and economical benefits has remained a driver to New Zealand's prosperous development throughout the 20th century. While the history of New Zealand's colonisation and introduction of new species have had a great impact on the development of the need for quarantine stations at borders, it is only recently that biosecurity has been introduced as a concept encompassing not only biological control, but also economical interests, environment and national security and health. All involved parties at all levels today agree that biosecurity is very important now and for the future of New Zealand's primary industries and natural environment. Furthermore the goals are that there is a great need for improvements. To work preventative and with long term commitments, rather than as often has been the case: short sighted goals and solving problems only *after* they have occurred. While biosecurity has become more politicised in the past 20 years, with a need for more coordination

between the industry and government agencies, there is an increasing need for a scientific approach to biosecurity as well as including environmental issues and life styles, Maori culture and historical heritage besides the economical interests and agriculture. Rather than these separate interests being at the expense of each other, find ways that they can all be included and enhanced in creating future biosecurity goals.

2.3 New Zealand's present biosecurity commitments

The first time biosecurity was formally referred to in New Zealand was in the Biosecurity Act 1993, and then refined Biosecurity Strategy for New Zealand in 2003, where the definition was: "Biosecurity is the exclusion, eradication or effective management of risks posed by pests and diseases to the economy, environment and human health." Goldson, Frampton & Ridley (2008:241) further claim New Zealand's biosecurity set up was designed both to protect its primary industries critical to the national economy *and* the New Zealand way of life.

While biosecurity policies of the 20th century had been efficient in their objective to limit introduction of harmful diseases, towards the end of the 20th century these were regarded as both insufficient and inefficient. This was partly due to changes in trade, transport and travel technology, but the biosecurity policies were inadequate also due to an increasing public awareness and appreciation in the cultural values of the native flora and fauna as symbols of national identity. (Jay & Morad, 2006:6) The native New Zealand fern and the kiwi bird are frequently used as such symbols, across society in for instance commerce and also used as symbol by many sports teams. This shift in values has had an impact on how invasive species have been viewed and treated in New Zealand. With the passing of the Biosecurity Act in 1993, plants, animals and products from these could only be imported provided the right import health standard/certificates were first issued. While the 'biosecurity' term for the first time was introduced into legislation, the Act also ensured it was implemented into a regulatory framework with government at both regional and central level, ensuring increased biosecurity responsibilities for New Zealand's foreign relations, external trade and both border and pre border biosecurity control functions, where the legislation even provided the conditions for selecting a Minister of biosecurity. Although the Biosecurity Act did provide an overall policy and responsibilities throughout government institutions, the Ministry of Agriculture and Forestry were retaining more power in practical ways, due to the nature of biosecurity being more functionally included within their realm. The Ministry (MAF) were with the Biosecurity Act invested with the authority to perform quarantine inspections at seaports and airports and formulated regulations surrounding goods exports and imports. With the Biosecurity Act of 1993 its establishment and framework focused on managing biosecurity risks, and in 2004 Biosecurity New Zealand (BNZ), was set up to coordinate and lead the biosecurity system. (Teara, 2012) In 2007 BNZ merged with the Ministry of Agriculture and Forestry Quarantine Science and became MAF Biosecurity New Zealand with a staff of 1000. In order to develop a comprehensive strategy in protecting New Zealand's unique environment from the possible pests and diseases posed by the last few decades sharp increases in tourism and trade, but at the same time considering the demands of environmental, economic, social and cultural interests, have changed the way New Zealand has had to view and manage its biosecurity systems in order to meet these challenges.

In 2007, under the direction of the Minister of Biosecurity, Jim Anderton called for a new approach giving the science community clearer guidance on what research they should undertake, since the arrangements formed by the government under the "2003 Biosecurity Strategy" were now deemed as *too ad-hoc* and thus needed to be more targeted to identifiable needs. The challenges the biosecurity systems had faced in these four years were now being addressed in a 25-year action

plan, by prioritising a *more scientific approach*, where the system on a regular basis will review and identify areas of priority within research. Some of these priority areas were to increase focus on pre-border activities, trying to forecast emerging biosecurity risks and better understanding of pathways of pests and diseases into the country. Also gain a better understanding of how human behaviour can create biosecurity risks, but at the same time finding better tools for inspecting, detecting and treating these threats, and where possible to manage these risks offshore. (MAF, 2007) The goals of the Biosecurity Science Strategy for New Zealand in a 25 year period were thoroughly laid out through the MAF (2007) strategy, which purpose was to include research, science and technology to be able to both enhance and protect:

- Trade, as well as marketing New Zealand as product for tourism
- Economic growth, opportunities and prosperity
- Rewarding lifestyles, respect for cultures and value the recreation and natural environment
- The historical heritage, integrity of ecosystems and character of New Zealand landscape
- Biologically based cultural and economic Maori resources.

The call for: *“More targeted and better coordinated procedures between industry and Government will enhance the country’s biosecurity...”* were expressed in the interview (15-07-2013) with Mike Chapman, Chief Executive Officer of New Zealand Kiwifruit Growers Inc., when asked how stricter levels of biosecurity would benefit the resilience towards diseases affecting the kiwifruit industry in the long run. Charlotte Hardy, Technical Research Coordinator at Kiwi Vine Health, answered the same question: *“...tighter, higher levels of biosecurity would benefit the industry in the future to prevent other biosecurity risks impacting kiwifruit orchards. There needs to be a more coordinated approach towards looking for potential current and emerging risks that could affect the kiwifruit industry. This work should be done collaboratively between organisations such as MPI, science research institutes and KVH and Zespri.”*

Although the goals of New Zealand’s biosecurity policy for a long time have been to prevent the establishment of pests or diseases that would damage its primary industries, native flora and fauna or health, there has in recent years been a shift towards a more economically focussed mission statement of its biosecurity commitments and goals: *...to grow the economy in order to deliver greater prosperity, security and opportunities for all New Zealander’s is our key driver. New Zealand needs to lift the long-term performance of the economy and the agriculture...* (MPI, 2013)

Besides the evident action taken by authorities to improve their preparedness and readiness towards future pests and diseases in the wake of the PSA epidemic on kiwi fruit orchards in the Bay of Plenty region, the public and New Zealander’s in general are urged to be made aware of the biosecurity issue. Already in the biosecurity strategy of 2003 there was an explicit objective of the public to pass on any information to the Ministry about any suspicious observations that could lead to biosecurity incursions. Although the MPI (2013:20) also reports that the public awareness is high, partly thanks to the past decades’ 2 million dollar investment in the “Check, Clean, Dry” campaign as part of the “Biosecurity New Zealand” brand, there is still more work to be done to raise public awareness to influencing behaviour by effective communication.

2.4 The goals for New Zealand's biosecurity becoming more politicised and overemphasising economic interests

Goldson, Frampton & Ridley (2008:241) acknowledges that the application of biosecurity within a national policy has become an increasingly politicised topic in the past 20 years in New Zealand, where the public believe that biosecurity control policy can solve complex ecological questions. However there is often a danger that the expectations exceed reality, given the complexity of the number of agencies and organisations involved within the field and the fact that the drafted legislation is feasible and harmonises with agreements, also internationally. Goldson *et al* (2008:243) Biosecurity in the context of New Zealand has been defined as “protection from the risks posed by organisms to the economy, environment and people’s health through exclusion, eradication and control.” (Jay *et al*, 2003:121)

Jay & Morad (2006) argue that “The institutional arrangements created by the legislation of the Biosecurity Act of 1993 allowed for faster and more efficient conduct of trade, but not effective control of environmental pests.” This over emphasis on trade and the economic aspects of biosecurity as a way to promote and protect New Zealand’s primary industry sectors at the outset of the act allowed the protection of pest to horticulture; agriculture and forestry take presidency over and at the expense of protection towards pests to the environment. Although most New Zealanders live in cities, a majority of them have relatives or friends living on farms, and so there is a strong support and widespread understanding for the country’s dependence on its primary industries. However, from the 1970s onwards an increasing concern for environmental issues have been given more political support, where threats such as pests to the natural environment have come to play a greater role in shaping the biosecurity policies. (Jay & Morad, 2006) In the past few decades as New Zealand’s natural environment has been promoted as source of increased tourism, this has in current biosecurity legislation given it the same importance of protection from pests and diseases, as has the primary industries.

The dilemma or concern of biosecurity policy has been, weighing in both the fact that “the world has become smaller” – through the last few decades rapid improvements, and further reliance on communication and information technology, along with advancement of transportation technology, resulting in the inevitable increase of movement of people between countries - leading to a lesser extent of protectionism of the national markets under World Trade Organisations (WTO) related free trade systems. But on the other hand, prioritising the interests of increased movement of passengers and goods have brought negative consequences of spread of diseases and pests, and thus giving biosecurity policies a lower priority since the two interests stand in opposition to each other. (Falk *et al*, 2011:25) Threats to New Zealand’s biosecurity have emerged as a consequence of its increased economic dependence on travel and trade, with the unintentional bio invasions of foreign biological matter. While the prosperity of primary industries such as the kiwifruit industry depends on globalisation, the dilemma that presents itself is how this in the process can prevent an entirely effective biosecurity policy.

2.5 Previous research on the wider topic of biosecurity

Rodoni (2008), addresses how important especially plant biosecurity is today with a globally rapidly increasing human population, where the still unknown viral diseases that may appear in any of the agricultural food product sectors potentially able to cause a quarantine block, will have a

serious effects on a steady food supply. What drives plant biosecurity forward is globalisation where the challenges are an increase in the international movement of human and plant products, as well as the number of discovered viruses and emergency plant pests that are increasing exponentially. This is partly due to improved diagnostic technologies, however the aims of plant biosecurity is to prevent virus epidemics from emerging in the first place, rather than the responding and adapting to epidemics once they have already occurred. By definition adaptation to an epidemic of emergency plant pests will result in additional costs in connection to virus containment and control. As this thesis will reveal, the policy of New Zealand's biosecurity set up is working in a preventative way to minimise any potential threats to its national interests.

Jay, Morad & Bell (2003) in "Biosecurity, a policy dilemma for New Zealand".highlight how the conflicting objectives of biosecurity in New Zealand that have gradually evolved from a protection from pests, to handling the complexities globalisation with increased trade and travel, and its impacts on native biosecurity and socio economic wellbeing. With the exploring of these aspects of biosecurity this paper has given valuable input towards the dilemma that has presented itself, and as such represents an important contributing factor within the causes categories of the key questions. In this paper Jay *et al* (2003) also draws attention to the fact that New Zealand with its high dependence on travel and trade has placed a growing challenge on its biosecurity systems. New Zealand, being an island nation its biological isolation means it experiences both advantages and disadvantages, where its agriculture industry has kept relatively free from diseases and pests that have caused considerable trouble elsewhere. However, the consequences of the introduction of exotic species has meant a catastrophic loss to New Zealand's native biodiversity.

Although the goals of New Zealand's biosecurity policy for a long time has been aiming at preventing the establishment of pests or diseases that would damage its primary industries, native flora and fauna or health, there has in recent years been a shift towards a more economically focussed mission statement of its biosecurity commitments and goals. The dilemma or concern of biosecurity policy has thus been, weighing in both the fact that "the world has become smaller" – through the last few decades rapid improvements, and further reliance on communication and information technology, along with advancement of transportation technology, resulting in the inevitable increase of movement of people between countries. But on the other hand, prioritising the interests of increased movement of passengers and goods have brought negative consequences of spread of diseases and pests, and thus giving biosecurity policies a lower priority since the two interests stand in opposition to each other. (Falk *et al*, 2011:25) From this we derive that threats to New Zealand's biosecurity have emerged *as a consequence* of its increased economic dependence on travel and trade, with the unintentional bio invasions of foreign biological material. While the prosperity of primary industries such as the kiwifruit industry depends on globalisation, the dilemma that presents itself is how this in the process can prevent an entirely effective biosecurity policy: Borders open for trade are also open to biosecurity threats - and *this* is a dilemma that has to be taken seriously when analysing how lessons can be learnt from the case of the PSA disease on New Zealand's kiwifruit industry, to find a better approach.

In figure 1, Hulme (2009:12) makes the striking correlation between just how much more island nations (black spots), such as New Zealand, are exposed to biological invasions compared to continent nations (white spots), and illustrates how an increase in gross domestic product is proportional to the increase of alien plant richness, where it is evident just how much more exposed island nations are to biological invasions.

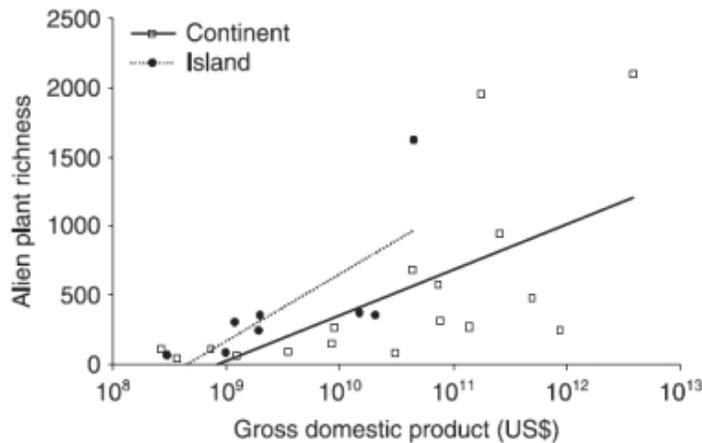


Fig 1. Relationship between gross domestic product (US\$) and alien plant richness for selected island and continental regions of the world. Source: Hulme (2009)

As Hulme (2008:404) points out in ‘Grasping the routes of biological invasions’, there are numerous ways alien species can enter a new region and what globalisation has done is to ensure that the diversity of pathways will both become dynamic and also increase over time.

Although most organisms introduced to a new environment fail to survive - a significant enough number do, and naturalise in the new host environment, where they pose a considerable threat not only to native biodiversity, but also to economic wellbeing and human health. In line with this, Jay *et al* (2003:127) makes the point that; “Unfortunately, protection for primary production does not always coincide with ecological protection of native species and ecosystems, and the New Zealand record of effective control of potentially dangerous invasives is heavily weighted in favour of primary production.”

The dilemma with such an overemphasis on prioritising the economic interests of the primary industries, is that it has been at expense of the interests of preserving native biodiversity. Though the interest of preserving biodiversity has been incorporated into the objectives of the biosecurity framework, it is only in the recent few decades that environmentalists has expressed that this policy should come under further review process. (Jay *et al*, 2003)

Chapter 3 - New Zealand and the kiwi fruit industry

3.1 Basic facts about kiwifruit in New Zealand

Kiwifruit is New Zealand’s largest export industry in the horticultural sector. Within this sector of intense plant cultivation the global marketing structure is unique, where the kiwifruit industry and the New Zealand market is dominated by a single cooperatively owned and controlled limited liability company, Zespri Limited. Zespri was founded in 1997 and has since grown globally from 61 million sold trays of kiwi fruit to 116 million today, with revenue reaching NZ\$ 1.62 billion. (Zespri, 2012) According to Melyukhina, (2011:57) “99% of exports are channelled to overseas markets through Zespri, an investor-owned company controlled by the growers”. New Zealand’s global market share of kiwifruit is today more than a fifth of the total kiwifruit market, being the third largest kiwifruit grower in the World, see fig. 2. (Shadbolt, 2009) Today, almost all of New Zealand’s kiwifruit is growing in the western strip of land of the Bay of Plenty, in the Te Puke region, with its rich deep volcanic soil, all year round natural rainfall, high sunshine hours, just the right temperatures avoiding critical frost thus enhancing its growth cycle. (Kiwi360, 2013)

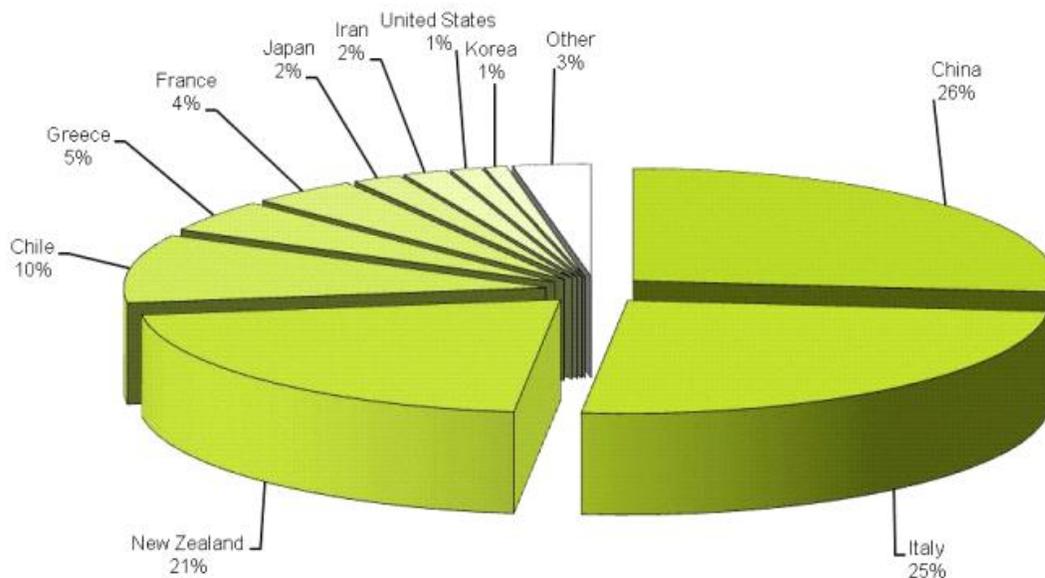


Fig.2: New Zealand is the third largest Kiwifruit grower in the World, with more than 1/5 of the global market share. Source: <http://www.zespri.com/about-zespri/faqs.html>

3.2 The origins of the kiwifruit

The kiwifruit vine, a native plant of the Yangtze valley of China, used to be known as the Chinese gooseberry, and the first seeds brought to New Zealand in 1904. Since then, 150 different varieties have been identified. The original fruit that came to New Zealand from China was very small. However, the industry developed it into a larger commercial size by selective breeding. Hayward, the variety most commonly grown today, with its oval shape, is what we are used to seeing in the supermarket. Hayward Wright, a New Zealander, by selective breeding developed the variety

bearing his name, using separate male and female plants. (Kiwi360, 2013) The main difference to other varieties of kiwifruit, which would last up to five months in cold storage, is that the Hayward variety would last up to nine months in cold storage. Cold storage at temp between 0 and +1 Celsius, as close to freezing as possible, slows the ripening down, they finish the ripening when they come out of the cold storage and onto the supermarket shelves. Since the minimum storage time of six months is required to survive the long transport to the worldwide markets, the Hayward variety has proven to be most successful to supply the export markets. New Zealand's kiwifruits are harvested in the late autumn season in April – May and which means the fruit lasts until late December. 75 % of New Zealand's kiwifruit production consists of Hayward's and 25% of the Zespri gold variety as it is popularly known, for its yellow sweet flesh, but also known as the Hort 16A. The name was given it at the Horticulture research centre, row 16, bay A. (Kiwi360, 2013)

3.3 The kiwifruit disease PSA and its symptoms

Pseudomonas Syringae pv. *Actinidiae* (PSA) is a bacterial disease causing serious effects to kiwifruit vines. The first visible appearances of PSA on the kiwi vine consist of brown leaf spots and withered curling edges on otherwise green leaves (see fig. 3), and in some severe cases the trunks of infected vines also develop cankers, open sores, oozing of white or orange sap. As the bacteria invades and hinders vascular tissues, it often blocks new shoots from developing or cause them to wither and in worst case resulting in the entire plant dying. No danger is posed to humans, animals or other plants through consumption of kiwi fruit from PSA infected vines, as only the growth of the plant itself can be seriously affected. (Science Learn, 2012) The symptoms of PSA are generally found in the spring and autumn seasons when climate conditions are most favourable, with cool temperatures and high humidity due to persistent rainfall. The Psa bacteria is temperature sensitive and most active between 10 – 20 degrees Celsius where it is limited by temperatures exceeding 25 degrees. The disease most commonly spreads via the kiwi flower pollen windborne and also via strong winds and heavy rainfall. It is also likely that it can spread even via footwear, tools, vehicles and animals. The bacteria enters and infects the kiwi fruit plant via natural openings and wounds. (Biosecurity, 2012)



Fig. 3: PSA infected kiwifruit plant, showing the most easily identifiable symptom of brown spots on leaves
Source: <http://www.bayofplentytimes.co.nz/news/psa-inquiry/1442664/>

The first documented discovery of PSA on kiwi fruit farms was in the Italian Latino district back in 1992, though damaging effects were not fully felt there until 2007. Also Chile, Portugal, South Korea and France have recently been affected, while, according to reports the disease has affected orchards in China for quite some time. (Greer & Saunders, 2012:2)

3.4 The first cases of PSA in New Zealand

The first confirmed case of PSA infected kiwi fruit orchards in New Zealand, was in the Te Puke region on the 5th of November 2010. The direct effects of the PSA incursion on New Zealand's kiwifruit industry has had a devastating effect and will be felt by orchardists in the Bay of Plenty areas economy for many years to come. (The Orchardist, 2012) An industry wide response was immediately organised with the initial intent to contain and to eradicate the disease, but when the task was deemed impossible, the objective for the industry has shifted to minimising damages to the industry by seeking and identifying recovery strategies. Throughout the year of 2011 PSA rapidly spread throughout the Bay of Plenty, and has since the initial outbreak spread to 75%, or 773 orchards in the region. (MAF, 2011a) However it is worth noting that the Hort 16A gold variety was the variety hardest hit by the PSA disease, compared to the Hayward green variety. See examples in fig. 4 & 5.



Fig.4 & 5: Psa has devastated Dave Marshall's Zespri Gold crop, while his ENZA Gold crop on the same orchard is growing well. Source: <http://www.fruitnet.com/produceplus/article/16717/psa-continues-to-spread-in-new-zealand>

3.5 The costs of PSA

An exact figure is hard to give on the cost PSA has caused, but direct costs to the loss of harvest is estimated at NZD (New Zealand Dollars) 410 million over a five year period from the time of discovery in 2010, without taking into consideration secondary effects or the considerable wealth lost on individual basis. (Moore & Loan, 2012) It is expected that the PSA within a ten year period will cost the kiwi fruit industry at least NZD 500 million, however, these costs only cover the immediate net returns from the industry according to Greer & Saunders (2012). In their report "The Costs of PSA to the New Zealand Kiwifruit Industry and the Wider Community" which was commissioned by the Kiwi Vine Health, like the name suggests, sets out to give an overall picture of the economic impacts the PSA disease has caused. This report has contributed to valuable wider background material to the thesis as to how serious this problem has been and still is, which partly justifies why this topic deserves further research.

In the monthly industry magazine *Coast & Country* (2012b) Mike Chapman, Chief Executive of New Zealand Kiwifruit Growers Incorporated, puts the total cost caused to the kiwifruit industry by PSA much higher. According to his simple calculation the figure including potential capital loss is so far at least NZD 2.1 billion. The financial loss caused by PSA is in fact an aggregation of, primarily all the individual orchardist's reduced production levels, but also the additional costs of managing and controlling PSA. This figure also includes the additional pack house costs, redundancies of staff, and not least mentioning the dramatic reduction in capital values of land, property and equipment in the affected areas. Estimates from Lincoln University show that the kiwifruit industry in the Bay of Plenty will lose between 360 and 470 equivalent full time jobs every year between 2012 and 2016. The loss of income to the industry combined with the loss of jobs is a particularly significant economic crisis to the region as a whole, not only the kiwifruit industry. Before the PSA crisis the kiwifruit industry would generate a cash flow of NZD 2 billion per annum into the Bay of Plenty region accounting for around 20% of the regions GDP every year. Besides monetary costs, the PSA disease has affected whole families and in some way or another involved everyone in the kiwifruit industry. (Coast & Country, 2012b) However, thanks to the efforts of KVH, with a more positive outlook for future growth within the kiwifruit industry. (MAF, 2011b:31) This establishing of a completely new agency was the result of the fact that the industry as a whole immediately responded in order to minimise damage, find a way back to full recovery and for future growth of the industry to be made possible. (Greer & Saunders, 2012:vii)

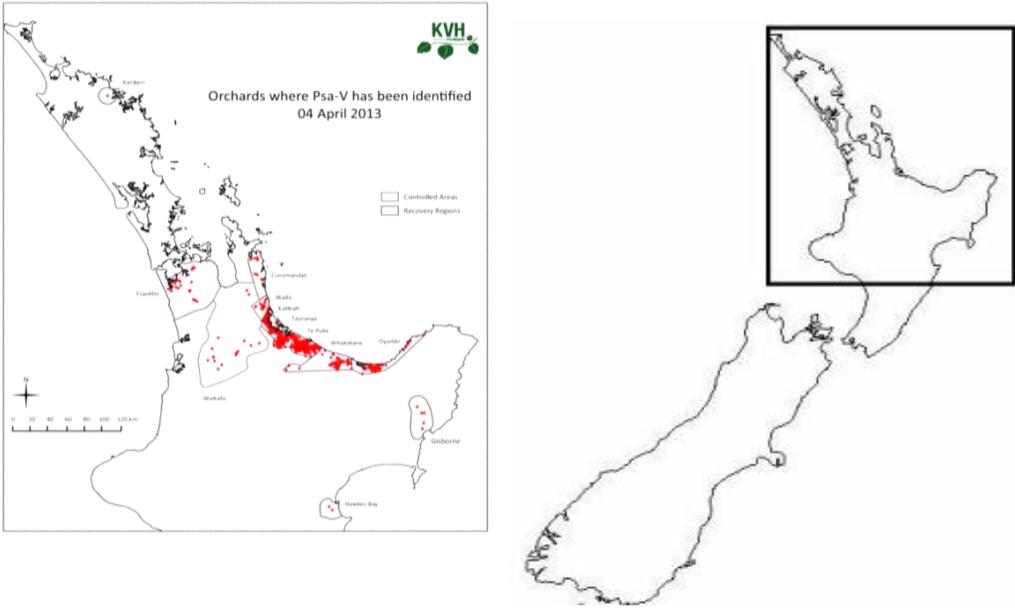


Fig. 6: Concentration of spots indicating the distribution of infected orchards in the Bay of Plenty on New Zealand's north island (Fig. 7). Source: KVH.co.nz

Chapter 4 - Methodology

4.1 How I have approached the chosen topic resulting in a document study

What has been done in writing this thesis basically was to make a study of a series of documents. When examining these documents the crucial point was to find out if they could answer any of my key research questions, *how* and *if* they were relevant to the direction I intended to bring this thesis. At the outset of selecting the research topic for this thesis, I have used the discipline: *New Zealand's biosecurity policy* as a foundation, and then applied this to *the kiwifruit industry*, where the focal point of these two national interests led to the third area of interest, that much of this thesis is revolving around, namely *the outbreak of PSA on kiwifruit orchards*, soon three years ago, which makes it a contemporary subject of research.

4.2 Scientific approaches: inductive and positivistic

When writing this thesis an effort has been made to distinguish between the two ways to draw scientific conclusions: inductive, based on empirical facts, and deduction being based on logic. To draw general inductive conclusions being based on empirical facts means they have to be done from a number of given and *repeated conditions*. Through induction one reaches more or less the same verifiable likelihoods on several occasions, though not always one hundred per cent accurate. (Thurén, 2007:22) Deduction on the other hand, is to draw general conclusions based on *logical presumptions*. A logical conclusion is drawn, but is only valid if logically coherent. Thus, the deduction validity has nothing to do with the truthfulness of the basic conditions. (Thurén, 2007:28) In this thesis an inductive approach has been used to draw conclusions, where these results are primarily based on the document study. Further, this thesis is supported by a positivistic approach being one of two main fields within scientific theory. The way we gather knowledge according to positivism is either via our senses, or via our logical reasoning. (Thurén, 2007:16) The things we observe with our senses represent the things that are empiric, which means that not all things we see and hear are necessarily truth: everything has to be scrutinised to distinguish truth from falsehood. Logic on the other hand works differently where it represents things we can deduce purely based on our intellect. (Gren & Hallin, 2003:18)

4.3 Rationality and Objectivity

This thesis will attempt to be based on the scientific viewpoint where rationality means a decision only becomes rational when it is related to its objective: ones values and which perceptions knowledge is based on. Being rational is thus based on choosing the means most likely fulfilling the desired goals. Likewise, the opposite being to act irrationally means acting against better knowledge and one's own interests. Since different individual goals and moral preferences are very different, what is rational for one person will be irrational for another. Based on this analysis of the rationality concept, it appears to be very subjective and dependant on context, what can be considered as rational from a scientific perspective. (Thurén, 2007:93) Within science objectivity means that the one making research must not let personal viewpoints influence the research, that has to be neutral and avoid political or social standings influence the research at hand, since scientists as a collective group determine the scientific status of a matter. (Gren & Hallin, 2003:42) In the light of the scientific viewpoints of rationality and objectivity, this thesis will attempt to get

the best possible balance between these two, though a certain degree of bias is always inevitable.

4.4 Data collection process

Most of this thesis is based on the compilation of secondary data, that has primarily been collected from relevant reports, audits and papers found on for instance on the data base Science Direct, but also through industry relevant press and magazines, as well as government agencies websites on the topic of biosecurity. Since the PSA disease is so recent most relevant literature is only available in electronic form. The key questions posed at the outset have been used as a guide while browsing through the source material, and when applied to each of these has aided to keep the thesis to the main topic and answer these questions. A lot of the reports and documents this thesis is based on are issued from governmental sources, why I was expecting and did find a certain degree of bias, and due to the sensitive nature of some of my key questions that placed the burden of proof on governmental agencies, which is why I searched for as many independent sources as possible. In order to gain up-to-date information and to add some relevant and contemporary support to the findings in this thesis, the choice was also made to conduct qualitative interviews comprising five questions (see appendix I), addressed to relevant authorities, academics, leading actors in the kiwifruit industry, who are likely to have vital knowledge on the subject. In addition to interviews conducted via email correspondences, while visiting the Bay of Plenty region as a tourist, a visit was made to Kiwi360 - a theme park of a kiwifruit orchard, where an interview was conducted on site to get first hand feed-back from a representative of the growers directly involved in the industry.

This thesis, like many scientific projects where the researcher may choose to collect data through more than one method, the results of the data collection may be analysed independently of each other, but also to be compared to one another. The method of triangulation is thus about discovering convergences in the combination of these reliable sets of data. Like in this thesis, such research methods that the triangulation technique is based on, could for example involve both participant observation and surveys, where the observations made through research are checked against the responses from the structured interviews. When the two sets of data converge, the researcher can be convinced they both reflect the same picture of reality. (Nightingale, 2009:490)

4.5 The geographic demarcation of context and relevance

The chosen subject of research has a specific geographic context as such, due to its geographically specified location in New Zealand, with a certain focus on the Bay of Plenty region, and empirically demarked in the field of *kiwifruit* – with its highly regional concentration of growing, and on a theoretical level the more geographically nationalised phenomena of *biosecurity* and *the PSA disease*: which is why this subject of research at hand most appropriately falls under the discipline of human geography category, due to its close connection to socio-economic factors.

4.6 Demarcations of the various disciplines encompassed in this thesis

A demarcation of the context of this thesis has been done in order to give clearer answers to the key questions posed at the outset, and is limited to basic concept of the biosecurity as a measure of “national security” in relation to a “national economic interest” of one of its primary industries.

The thesis thus centres on the focal point of two of these national interests and which new challenges present themselves on a national scale, when the existing equilibrium is ruptured. Likewise, with the collection of empirical data for this thesis a great deal of effort has been needed to limit the scope of the research field amidst the abundant material found on the topic of the PSA epidemic on New Zealand's kiwifruit industry. However, by keeping the original objective and key questions posed at the outset of this thesis, at the forefront, and using them as a guide through the research and applying them to the documents the thesis has been based on, has been a vital aid and means of demarcation of the empirical research that has been conducted.

Chapter 5 – What have the various actors’ approach been to handling the PSA issue?

5.1 Introduction

Friday the 5th of November 2010 is a day that every kiwifruit grower in New Zealand will always remember, which was when the *Pseudomonas Syringae* pv. *Actinidiae* (PSA) disease was first identified in New Zealand. The direct effects of the PSA incursion on New Zealand’s kiwifruit industry has had a devastating effect and will be felt by orchardists in the Bay of Plenty areas economy for many years to come. (The Orchardist, 2012)

5.2 Biosecurity measures to limit the spread of PSA



Fig.8: All kiwifruit orchards in the Bay of Plenty have warning signs about the risks of spreading the PSA bacteria

As a response to the PSA disease the Kiwifruit Vine Health (KVH) was set up, which is an independent organisation covering the whole industry as a direct response to the outbreak of PSA disease. The kiwifruit industry strategy to the disease has thus developed with this KVH set up,

from an eradication approach (which proved impossible to implement), to a control- and containment approach. The development of a coordinated pest control was hereby also achieved. "...KVVH's mission to minimise the impact of PSA on the New Zealand kiwifruit industry and to lead the strategic and operational preparedness for other potential biosecurity risks on behalf of the of the kiwifruit industry." The Technical Research Coordinator at KVVH, Charlotte Hardy, responded in the interview on 09-05-2013 to the question what KVVH is doing to limit the spread of PSA, that their organisation does not have a role in biosecurity policy in New Zealand on a national scale, due to their confinement to the kiwifruit industry, but have mainly focused on monitoring plant and equipment movement between kiwifruit growing areas affected by PSA and those kiwifruit growing areas that don't yet have the disease. Hardy highlighted that in the coming months a PSA National Pest Management Plan will be implemented by KVVH, which will give their organisation a mandate to better help growers manage the bacterial disease on orchards, particularly in circumstances where no active management is being undertaken by orchard owners [such as when infected orchards are abandoned by their owners]. This plan is currently before the Agriculture Minister in Parliament. Another mandate of KVVH going forward will be that of assessing and analyzing potential pest and pathogen risks to the kiwifruit industry. PSA is just one disease affecting growers, and this second mandate of the organization will be important in the future to prevent further incursions of other pests and diseases. (Hardy, 2013)

Senior Research Officer Glen Greer of Lincoln University in the 09-05-2013 interview question what preventative steps should be taken now that PSA is present: "Tighter border control processes *will* reduce the risk of other disease incursions but the industry itself will need to be responsible for increasing resilience. This could be achieved by means of international screening for new pest issues and working to ensure that resources such as genetic material, prophylactic programmes, protection programmes are developed in advance of the arrival of a new threat."

5.3 Zespri approach to the PSA challenge

According to the Zespri (2011/12) annual financial report it appears that in recent years it has not been the advent of PSA disease on kiwifruit orchards in New Zealand that presented the greatest challenge, but the 2008 global financial crisis that resulted in a tougher market and the single major challenge to sales.

...Every level of the kiwifruit industry has been affected and we are all currently working to survive in the new operating reality imposed by Psa. Proportionally, the highest cost burden is carried at orchard level, whether it is from lost production, increased operating costs to protect an orchard from Psa, or significantly devalued assets. While the impact of Psa has been every bit as severe as we feared, it is important to balance our collective sense of crisis by focusing on some of the positive aspects of the situation... Ironically, as the industry focused on falling volumes and asset values as a consequence of Psa, ZESPRI had its hands full selling a record volume crop in a challenging market environment. Global revenue increased by 7.2 percent, from \$1.51 billion to \$1.62 billion in 2011/12...

As global market leader Zespri launched its most ambitious strategy which is to increase the global kiwifruit consumption that currently stands at less than one percent. Considering the previous mentioned figures of Zespri's continuous market growth of a 7.2% annual increase in sales presented in the last financial report, it appears that Zespri has gone relatively scar free through the PSA epidemic, which is could suggest that PSA cannot be considered as a real problem to Zespri, as one of the global market leading distribution and sales entities, due to their unaffected corporate profits.

5.4 How the kiwifruit growers have reacted to the PSA situation

Since the climatic and environmental conditions differ from those countries where PSA is prevalent, there was a certain degree of confidence among growers in New Zealand, that in time they will be able to recover from the problems of PSA. Furthermore Melyukhina (2011:10) states regarding New Zealand's farmers:

The spirit of free entrepreneurship seems to be strong and pervasive in the farming community today. Farmers regard self-reliance as a key principle of operating business and are proud of their independence from government protection. Many farmers also consider that risk is a normal part of business and provides not only threats but also opportunities.

Although there is a prevailing positive attitude among farmers despite many trials, there was a lot of frustration, anger and criticism towards the government and ministry in the wake of the PSA outbreak in New Zealand, by kiwifruit growers who felt betrayed after it became known that importation of pollen had taken place. In the interview on the 11-07-2013 with tour guide Simon Elton at Kiwi360, he gave an overall picture of how he thought the government has handled the PSA issue towards the kiwifruit growers. He argued that the government let them down by neither having the pollen shipment from China properly tested, nor informing the industry about it – That a cover up had taken place. Most growers did not actually realize that some of the pollen they had bought might have been mixed with some from overseas. "It wasn't known at the time amongst growers that anyone was importing pollen," Russell West stated, whose orchard in Te Puke was the first to be infected with PSA back in November 2010. "If people had known that, they would have re-thought the issue and the risks." (Science Alert, 2012) Chief Executive Officer for New Zealand Kiwifruit Growers Incorporated, Mike Chapman, was asked if there was anything more that should have been done to prevent PSA from entering, and his candid answer was that it would be: "...Inevitable that a bacteria would spread worldwide – we may have kept it out longer, we may not have." (Chapman, 2013)

5.5 Kiwifruit growers wanting to make a legal case of the PSA incursion

Kiwifruit grower Rob Thode and many other growers are convinced it is the MAF who is to blame. "MAF has said we will probably never know how it got here - that's their way of saying 'you can't get us legally on negligence', but . . . we're finding more and more stuff that condemns them," Thode said. (Stuff, 2013) However, not all kiwifruit growers are in favour of suing the MAF/MPI. Mike Chapman, CEO of Kiwifruit Growers Inc, had been given legal advice to his organisation that any civil case would be long and costly with a low chance of success. He does not believe there was any definitive proof of how the disease got here. "You've got to prove how it got here, not just have a suspicion." (stuff.co.nz, 2013) In Coast & Country (2012a) Mike Chapman on the topic of how Psa got to New Zealand, gives the answer: "We don't know. Perhaps we never will know... we know what didn't happen at the border. It *doesn't say how* Psa got NZ, but it does *show* how Psa *might* have got to NZ." However, about the pollen imported into New Zealand his view is clear and stern in his criticism regarding the fact that the industry leaders and organisations were not consulted about pollen imports and knew nothing about them.

5.6 The kiwifruit growers looking ahead to other biosecurity issues

Mike Chapman further comments the matter that PSA *is* the key focus for kiwifruit growers right now, but that it does not mean that as an organisation or as an industry, that other biosecurity threats to the horticulture industry in general or kiwifruit in particular, should be forgotten. Late last year the kiwifruit industry decided that KVH should take on a wider biosecurity role. As an industry, New Zealand's Kiwifruit growers Incorporated have as a goal to be one step ahead of the next pest or disease that may affects New Zealand's kiwifruit vines. The immediate focus for the biosecurity commitments within the industry is the monitoring of pests and diseases with the goal of avoiding further incursions. Together with Hort NZ, New Zealand's Kiwifruit growers Incorporated have been part of and taking the lead in the pan-industry drafting team that has created a draft deed to put this new arrangement in place. Particular concern has been placed on ensuring that what is developed is workable, and will give the industry an input into the whole biosecurity system. Therefore a need for dialogue between these parties is essential, to have a direct say in how the pre-border and the border is managed. It is also suggested that importers and tourists also need to pay their way, since it is not fair or reasonable, to expect the agricultural and horticultural industries to pay for inadequate pre-border and border protection and to give the importers and tourists a free ride. All are urged to do their part for a sustainable biosecurity system for the future. (Orchardist, 2013)

Chapter 6 – How has the government department responsible for biosecurity been the subject of scrutiny after the PSA outbreak?

6.1 Introduction

As previously mentioned in this thesis, the outbreak of kiwifruit PSA on one of New Zealand's primary industries has been taken very seriously by all parties, not least the Ministry of Primary Industries and its predecessor the Ministry of Agriculture. This chapter will also look into why they had to scrutinise themselves after the PSA incursion.

6.2 Immediate inquiries commissioned by the Ministry of Primary Industry concerning its biosecurity commitments, following the PSA incursion

Immediately after the kiwifruit PSA outbreak was identified, the MPI first conducted an internal PSA tracing report (MAF, 2010b), then *an audit* of the MPI was done by the Auditor-General, and later the MPI also commissioned the independent Saphere report. (Moore & Loan, 2012) Although the possible pathways by which PSA could have entered New Zealand, in the reports they are perceived as coming from a wide range of possible sources. The reports do not specify a single likely pathway, but do identify *people movements* and *pollen* as the most likely pathways. However, the reports suggest that PSA arrived in New Zealand from China rather than Italy. The purpose of the audit that was commissioned was to identify the future needs and to make suggestions for improvements for *how* the MPI has been taking the lead in providing biosecurity since its new set up in April 2012. But in order to review its effectiveness in the wake of the scrutiny the Ministry had been submitted to recently, the MPI authorised the Office of the Auditor General of Wellington, to carry out a performance audit on themselves, with the objective of investigating how effective its biosecurity systems has been working in responding to, and preparing for *biosecurity incursions* – namely the arrival of foreign organisms and pests in New Zealand - which was made public in February 2013. This audit had the purpose of investigating how effectively the biosecurity systems had worked in preparing for and responding to foreign pests and diseases arriving in New Zealand. Since this audit report was scrutinising all recent biosecurity incursions, where PSA was just one of many examples, it gave a very overall picture of the contemporary biosecurity policy setup, which made it valuable for a wider biosecurity understanding in this thesis, as well as its very specific advice about how the PSA problem can be handled better in the future.

6.3 Main points of the Audit

Although the report could conclude that the MPI and its predecessor organisation (MAF) having responsibility for biosecurity issues by and large have had success, dealing with up to 40 biosecurity incursions in a year, although no border control being 100% efficient. However, the audit did conclude that the MPI during the past years had been “...under prepared for potential incursions from some high-risk organisms. Responding to incursions has taken precedence over preparing for the potential arrival of other pests and diseases.” Although the report stated that some serious weaknesses still remain and that there is still a lot to do, the audits recommendations for the future were “...improvements to biosecurity preparedness and response that will need to be

implemented if MPI is to bring about the changes required...” The most serious criticism from the audit were the lack of completed plans to the response of incursions from some potential high risk organisms, for instance the plan for dealing with an outbreak of foot and mouth disease is inadequate. “...the previous track record of delivering sustained improvements is not good.” (MPI, 2013) Concerning the first identified occurrence of PSA on kiwifruit orchards in New Zealand, the Office of the Auditor General identified that in the response to PSA, findings suggesting that laboratory capacity sometimes being a bottleneck that should be better prepared for. Many kiwifruit producers experienced the length of time taken being too long, in determining whether their orchard was infected with PSA or not. Since one of the first steps to take in an incursion is to determine how far a pest or disease has spread, so that the subsequent response can be targeted in order to be effective, it is vital that the complete laboratory process is undertaken with minimal delays. The Audit found that in total it took an average of 10 days to sample plant material, test it, and report back to the orchard. And without quicker testing they found that it was very difficult to measure exactly how widespread PSA was at any given time. Thus the Audit identified the imminent need for quicker testing procedures and the necessity for extra laboratory capacity to be made available on short notice. (MPI, 2013:25) Moore & Loans (2012:10) suggestions to the Ministry of Primary Industries basically were that: “MPI needs to improve the transparency of when organic matter is being imported into New Zealand for the first time. “

6.4 The scrutinising over the permitted kiwifruit pollen imports

Soon after the outbreak of PSA in late 2010, closer examination was needed due to the fact that pollen had been imported to kiwifruit growers in New Zealand to assist fertilising of kiwifruit flowers as mentioned in 3.3. Firstly, the fact that the MAF at the time even permitted kiwifruit pollen to be imported was especially remarkable, after the recent outbreak of PSA which was perceived as rather troublesome, considering the biosecurity risks not fully understood, and will be further addressed in 7.8. And secondly, that the company who was importing the pollen, (Kiwi Pollen Ltd) were potentially misleading its customers about where some of its pollen was from. Kiwi Pollen Ltd, were thus suspected of being in breach of the Fair Trading Act, which prohibits misleading or false claims about the place of origin of goods. In September and October of 2010, Kiwi Pollen Ltd imported pollen from Chile, while giving its customers the impression that all of its kiwifruit pollen was from New Zealand. the General Manager of Competition Kate Morrison, together with the Commerce Commission (the agency set up to promote and regulate fair business competition), said that, although most of Kiwi Pollen’s product was sourced from New Zealand during that time, Kiwi Pollen Ltd did not properly inform its customers when it was also selling them imported pollen. “Our investigation showed that kiwifruit growers consider the country of origin of pollen to be very important,” Ms Morrison. (Commerce commission, 2012) In considering what action to take against Kiwi Pollen Ltd, the Commerce Commission looked at the possible harm they caused customers and competitors. In particular looking into allegations that imported pollen could be a potential source of the PSA outbreak: “We have examined information from numerous sources and have found there is no conclusive evidence to show that the imported pollen *sold* by Kiwi Pollen Ltd caused the Psa outbreak in New Zealand,” Ms Morrison said. For this reason a warning was issued to Kiwi Pollen Ltd, rather than prosecute, as no harm had been done. However, while there is no evidence suggesting that the particular imported pollen *that was sold* to growers was the pathway of PSA, due to the narrow time frame of less than a month between those particular import shipments taking place and the first visible signs of PSA symptoms, it does not mean imported pollen was not the source, which will be addressed later on.

6.5 MAFs details about all imported kiwifruit pollen since 2008

According to MAF (2011), since 2008 a total of six consignments of commercial kiwifruit pollen have been imported to a single importer, in New Zealand, Kiwi Pollen. However, before approving the import license to Kiwi Pollen, the Moore & Loan, (2012:42) concludes that the MAF should first have consulted various actors in the kiwifruit industry, who would have voiced their concerns since they were aware of the Italian PSA outbreak that occurred years earlier. MAF however considered that importing kiwifruit pollen to be a negligible risk and that there was no need to undertake a formal risk analysis, even so approval was given to import of new biological material despite there being a recently published scientific paper on the risks associated with pollen imports. Of the six shipments of imported kiwifruit pollen, four were milled pollen from Chile, received between the 15th of December 2008 and the 6th of June 2010. Under the MAF import health standard (155.02.06), these consignments were given biosecurity clearance upon arrival to New Zealand, despite concerns from the kiwifruit industry that this Chilean kiwifruit pollen was originally from Italy, since there is a strong market demand for pollen from Italy, where PSA is known to be present in a large number of orchards, as previously mentioned in this thesis. Of these four shipments two were re-exported again, but the other two that were given biosecurity clearance on the 1st of December 2009 and 3rd of May 2010 respectively, were reported as used on orchards for pollination of kiwifruit flowers during the 2010 growing season. (MAF, 2011:16) Further the report interestingly does also disclose that: “Based on procedures and timing there is potential for small amounts of cross contamination between New Zealand sourced pollen and Chilean pollen.” The two kiwifruit pollen shipments from China that were received on the 24th of June 2009 and the 6th of June 2010 were according to the MAF very small in quantity, only 15 grams, where the first of these was reported to be tested and left unused or *discarded* due to low viability of the pollen. However the...“disposal process was described but not able to be independently verified.” ...this possibly suggests that the shipment was not discarded while in MAFs possession, but performed by the importer, Kiwi Pollen Ltd, and *perhaps* not according to appropriate protocol? The only information provided about the second shipment, was that it was damaged during border inspection, and that it subsequently was: “Unlikely to be the source of the 2010 outbreak as initial symptoms observed before pollen application”. However, the MAF (2011:16) report does admit that the information about the Chinese pollen appears to be reliable, and that “...it has tested strongly positive for Psa...”

6.6 MAFs report about local New Zealand produced pollen being contaminated with imported, potentially PSA infected pollen.

According to the PSA tracing report (MAF, 2011), since the imported pollen was used for the first time in the 2010 season, it is unlikely to be the source of the direct infection of PSA. However, it cannot be ruled out that previous imported pollen shipments can have been used either mixed with New Zealand grown pollen or by accidental contamination with local pollen. On the 13th and 16th of October 2010, artificial pollination was used on the orchard where symptoms of PSA were first discovered on the 23rd of October on kiwifruit plants. Initially it was believed that only New Zealand grown pollen had been used, but with the lack of independent evidence to whether local or imported pollen was used, suggests that one cannot rule out the possibility of imported or contaminated locally produced pollen having been used. Since many uncertainties remain whether

PSA even can be transmitted via pollen, and if so what quantities are needed, whether or not any of the New Zealand packaged pollen was contaminated and the fact that neither Chile or China have any official reports of PSA outbreaks in their orchards, it is difficult to determine if kiwifruit pollen is a likely pathway. (MAF, 2011:17)

6.7 The MAFs explanation to the first symptoms of PSA being found on an orchard next door to Kiwi Pollen Ltd – New Zealand’s only pollen importer.

When examining the evidence from an objective standpoint, where there is a known, specific site from which the first initial symptoms of PSA were discovered - which happens to be geographically and chronologically very close to the location of a pollen importer with documented imports of kiwi fruit pollen, of which can not be ruled out whether they carried PSA or not, it is easy to conclude that the circumstantial evidence are overwhelming in connection with the accusation of the subject MAF approved shipment was in fact the source of PSA. However, the MAF in their *Psa – Pathway tracing report*, without 100% proof of the accusation simply conclude:

“There was an obvious coincidence that the property directly adjacent to the initial notification site has strong business ties with a major kiwifruit pollen producer. That producer [Kiwi Pollen Ltd] was also the only pollen company to import pollen into New Zealand... This led to a need to investigate the potential for pollen as the pathway for stimulation of a Psa outbreak in New Zealand... (MAF, 2011:15)

So, while the MAF are referring to the surrounding events supposedly leading up to the PSA outbreak, as simply 'coincidence', interestingly, they do not deny that pollen is a possible source, since the same report states:

...[T]here is [...] preliminary evidence that the application of infected pollen will result in infection in a plant.” (MAF, 2011:15)

In the interview on the 09-05-2013 with Senior Research Officer Glen Greer of Lincoln University, she also highlights the kiwifruit vines being susceptible to wind-borne diseases, where kiwifruit in the past has been a relatively disease-free crop in New Zealand before PSA, and the plant hygiene practices in the industry (sanitising equipment, limiting the transport of plant material, restricting traffic between orchards, etc.) were generally considerably less stringent than in other horticultural industries. This complacency is thought to have contributed to the spread of the disease. According to Greer there also appeared to have been several failures in respect to the border processes that were in place and the border processes with respect to pollen were not adequate. While this is largely a “policy responsibility” the industry must also accept that it was not proactive in this area either.

6.8 Various evaluations of the PSA risks involved with imported kiwifruit pollen

While the MAF (2011a) report on one hand have assessed that the overall biosecurity risks involved with imported kiwifruit pollen as being low, it also assess that based on current information there is an uncertainty to its potential risks and therefore cannot rule it out as a potential pathway. Interestingly the “Progress Update PSA Management Action Plan” (MPI, 2012) amended the previous permissive legislation regarding kiwifruit pollen imports, to banning them completely: “The Importation of Pollen section (2.2.3) has also been amended; currently no pollen can be imported for propagation.” This suggests that the ministry have taken seriously the findings and have banned all imports of pollen. So why did MAF allow imported pollen in the first place

considering the not entirely known biosecurity risks? The simple answer is that they did not know of the dangers. However, the agency Plant & Food were in May 2010 aware that PSA could be detected on kiwifruit pollen from infected orchards, but failed to warn the MAF since they were unaware that pollen imports were taking place. Further, according to Moore & Loan, (2012:37) where this information is disclosed, confirms that this was the case. Already on the 23rd of November 2006 Kiwi Pollen Ltd made a request with the MAF for an import permit for kiwifruit pollen, with an email to the MAF requesting to import frozen male kiwifruit pollen from Italy and China. Internal correspondence within the MAF, before replying to Kiwi Pollen Ltd concluded: there were no pests or diseases known to be associated with kiwifruit pollen, so consequently, on the 8th of December 2006 the MAF replied to Kiwi Pollen that: “hand collected, unopened male flower buds of kiwifruit may be collected, milled and imported...” The MAF thus perceived that kiwifruit pollen was not a biosecurity hazard to the kiwifruit industry in New Zealand, which was basis on research conducted at Auckland University, suggesting that kiwifruit pollen cannot transmit PSA:

“...MAF allowed Kiwi Pollen Ltd to import pollen from Chile and China because it was under the erroneous impression - based on flawed advice from the University of Auckland - that pollen could not transmit Psa. In fact it can.” (Stuff.co.nz, 2013)

On the interview question; *what factors led to the possibility of the PSA outbreak taking place*, Professor Ian Warrington of Massey University in the interview on the 14-05-2013, acknowledges that it is a complex set of factors and ranging across a number of different issues. However, included in the main factors are: a lack of recognition of the importance of this bacterial disease already established in other countries such as Italy, no industry risk-management plan and no scoping to understand how the disease might be transmitted into New Zealand, in particular the ignorance about vectors such as pollen. There is also lack of depth in the New Zealand scientific population with regard to plant pathology in general – there had been far too much focus on only molecular biology over the past 20 years. Also, the prevailing mono culture in New Zealand is a considerable problem, in spite of warnings that the narrow genetic bases to the industry were a huge vulnerability. A narrow geographic zone for the kiwifruit industry in New Zealand has also proved to be a huge risk, in spite of them being warned that the lack of diversity in growing regions (spatially and climatically) would make the industry vulnerable to diseases such as PSA. There is also a considerable arrogance in the industry – “we know it all” and no harm can come to them! A lack of skill sets in the New Zealand biosecurity sector and a lack of political positioning of the industry. The lack of political ownership of the export income and employment generated by the sector, both directly by growers, but also through service industries like packaging, supplies, transport. The downsizing of staff in the biosecurity sector was another potentially contributing factor to the PSA outbreak. There should have been an integrated and more comprehensive response to the knowledge that this disease was a potential and serious threat to New Zealand, before it actually arrived here, which should have involved the New Zealand Government, biosecurity staff, industry leaders and scientists.

The MAF initially stated that there was no evidence to prove that PSA in pollen could actually infect healthy kiwifruit vines, but later it went out to warn growers that pollen could carry the bacteria and made the suggestion for those using artificial pollination, that the pollen should be collected from their own orchard presenting a lower risk. (Science Alert, 2012)

Moore & Loans (2012) report reveals MAFs lack of information interchange with the industry and other countries regarding the threat of PSA: “In May 2010, Australia reacted to the Italian Psa outbreak by initiating a first-principles assessment of the risks posed Psa and by requiring all pollen

imports to be tested for Psa... The evidence also demonstrates a lack of basic information sharing between staff at MAF and Plant & Food Research. [...] never informed MAF of research they had undertaken in Italy that showed that live Psa could be detected on kiwifruit pollen from infected orchards.” (Moore & Loan, 2012:9)

According to Science Alert (2012) the imports of kiwifruit pollen were not on a routine basis tested for disease at the border. However, MAF pollen had been imported from China for laboratory testing purposes, and it was Chilean pollen which was applied to crops. Moore & Loan, (2012:8) States: “MAF should also have consulted industry prior to allowing the first consignment of pollen to enter the country.” It is the kiwifruit pollen supplier, of whose pollen growers apply the process of artificial pollination, who usually decides whether their pollen for commercial use will be sourced locally or from overseas. Several factors determine this decision, for instance the availability and the cost, where it is imported pollen is cheaper. (Moore & Loan, 2012:33) However the main reason for pollen imports to take place, based on interviews with MAF staff and industry stakeholders confirms that before the outbreak of PSA in Italy in 2006-2007, PSA was not considered to pose a significant threat to New Zealand’s kiwifruit industry. (Moore & Loan, 2012:28) In the interview on the 11-07-2013 with tour guide Simon Elton of Kiwi360, he was asked how he thinks the government has taken responsibility - *if* it was their fault for letting PSA into the country, supposedly via kiwifruit pollen, which he is convinced about, and that it alone should have led to prosecution. ... and that there must have been a bit of a cover up and that the government let the industry down.

Chapter 7 - What do the various actors consider to be the source of the PSA outbreak?

7.1 Introduction

In many cases it has been evident how a disease or pest has come into New Zealand, but unfortunately this was not the case with PSA, according to the *PSA Tracing Report*. (MAF, 2011a) Often there are wide ranges of possible ways in which a disease may have entered.

7.2 Kiwi Vine Health's findings over pollen as a potential path of entry for PSA

According to the KVH (2012) report, MPI (former MAF) collected samples of pollen from a large number of orchards it was planning to test for PSA. The results from KVH study based on the aid of the MPI and the pollen company it is working with to determine how to best proceed with testing, has confirmed that PSA *can* survive commercial milling. The process of milling of unopened male kiwifruit flowers is done to avoid contamination of the pollen, which then can be extracted. The testing covered in that research had detected PSA DNA in green kiwifruit pollen that was used in artificial pollination. However, the report does make a note about these research results not confirming whether the PSA disease can be transmitted when used for artificial pollination in the field (KVH, 2012)

7.3 The Ministry of Agriculture's findings of whether PSA could have entered via imported pollen

While the "Psa – Pathway tracing report" (MAF, 2011a) gives a comprehensive background picture of how, when and from where PSA might have arrived and how it spread and established in New Zealand, it is primarily a technical document. Though this report was an internal investigation by the Ministry of Agriculture and Forestry scrutinising itself, a certain degree of bias was expected and was also found. But because of its technical nature, a precise and scientific approach to presenting all the analysed possible sources and pathways of PSA, which is why referring to this reports suggested action to be taken, adds vital contribution to this thesis.

Since the PSA tracing report (MAF, 2011) sets out to investigate all potential pathways for the likelihood of PSA entering New Zealand and spreading to kiwifruit orchards, such as via kiwifruit -pollen, -budwood, -seeds, -fruit, -plant material, -orchard equipment, we will here only be looking into the likelihood of pollen as a source, for evident reasons found in this part of the thesis due to the scrutiny the pollen imports has been subject to.

However, just like with all the other potential pathways of PSA into New Zealand, the report likewise does not find it likely that the use of imported pollen could have been the source of the initial incursion and the spread of PSA, due to the time frame not being consistent between reported use of imported pollen, and the first symptoms of the outbreak of PSA. Uncertainties whether pollen potentially contaminated with PSA could survive after milling, shipment and storage, suggest that it is unlikely to be the source, combined with previous findings is why the PSA tracing report (MAF, 2011:5) does not find it likely that PSA entered via commercially used pollen. Furthermore, on the same line to reasoning Vanneste *et al*, (2011) concludes: "This is the first report of Psa being associated with pollen. There is currently no evidence that artificial pollination

leads to increased infection or that pollen has been responsible for the introduction of Psa in a previously Psa-free area.“

According to the *PSA Tracing Report*, (MAF, 2011a) it assesses three possible aspects, or criteria that have to be fulfilled in order to determine the likelihood of a potential pathway to the actual one. Location: Does the location in which the pest or disease was first detected have a geographically feasible link to the location of the suspected pathway entry? Timeline: Does the date of the disease first being detected indicate a likely pathway back to particular events in accordance with the incubation period for that particular disease? Plausibility: Are there scientific evidence suggesting that disease even can be transmitted via the suspected pathway? By applying these three tools in analysing each potential pathway will enable the assessment of their varied biosecurity risks, and these results can then be compared to others in order to rule them in or out. (MAF, 2011a)

The report further mentions that PSA most likely came into New Zealand, according to the MAF laboratory findings, at the most 18 months before the first visible symptoms were observed on kiwifruit orchards in October 2010. Furthermore, the most probable pathway of entry is said to have been a single point of entry, geographically close to the place where the infected kiwifruit vines were first detected. As to the source country of the PSA infection, the report is unwilling to point out any country, either European where an outbreak of PSA has been documented, or other countries where it is present but has not yet been confirmed. The spread pattern from the orchard in Te Puke where the symptoms of PSA were first detected in October 2010, indicates that the disease arose from one single location point, from which it by natural means, such as rain and wind spread to kiwifruit orchards throughout the region. However, the spreading could also have been accelerated by unintentional movement of infected plant material, kiwifruit cuttings, or bacterial contaminated orchard equipment or contamination from footwear and clothes. (MAF, 2011a)

The PSA tracing report (MAF, 2011) also acknowledges the possible dangers of both backyard enthusiasts wishing to develop kiwifruit for non-commercial gain as well as air passengers arriving in New Zealand failing to declare goods of high biosecurity risk, like kiwifruit. In 2005-2006 such goods were seized from 0.4 % of arriving passengers. Although x-ray machines and sniffer dogs are used to detect such undeclared goods, there is always a certain level of goods that comes through undetected. (MAF, 2011:24) Such pathways for illegal importation of kiwifruit pollen could be either for personal plant breeding or for commercial purpose. In the MAF (2011:29) report it states:

“...At this stage and without further scientific evidence we conclude that pollen is a possible entry pathway.” “...This is frustrating for industry and MAF as it reduces our ability to target specific activities to prevent further spread or further introduction through similar pathways. This is not unusual however and it is rare to be able to confidently identify the introduction pathway of a new pest or disease particularly when its biology is not well known.” (MAF, 2011:29)

However small these other pathways may be, they are an increasing threat that has to be taken seriously by the Ministry being vigilant to new and unexplored pathways. With the effects of globalisations increase in trade and travel in the 21st century, it is of utmost importance that research is conducted around these threats, as it is possible that the next biosecurity incursion enters unscreened luggage or cargo.

7.4 Other voices concerning the source of the PSA outbreak

In Science Alert (2012) biochemist Associate Professor Russell Poulter at Otago University states that there is evidence that the PSA disease originated from China. Although New Zealand in recent years imported 2 kilograms of kiwifruit pollen from China and 77 kilograms from Chile, where PSA has been confirmed, scientists using DNA testing have been looking at the possibility of the Chinese infection coming via Chile: “Having provided the tools, through sequencing, to recognize the different strains, we now want to determine the pathway by which the Psa came into the New Zealand,” Professor Poulter said in a statement. Poulter also states that the particular DNA strain of the PSA bacteria present in New Zealand does not originate from Europe and that it was unlikely to have come in via quarantined channels but that finding the pathway is important. The New Zealand strain of PSA was found to be significantly different from the one found in the Italian kiwifruit vines, which is why Poulter and his laboratory team have concluded that Italy cannot possibly have been the source of the PSA incursion in New Zealand. “Through a process of elimination, Chinese pollen appears to be the likely source of New Zealand’s outbreak,” Poulter also said in a statement. “China is the original source of both the Italian and New Zealand outbreaks. More recently, Psa has been confirmed in Chile and work has begun on sequencing these strains. Preliminary data suggests that the Chilean strain also originates from China.” (Science Alert, 2012)

In “A Review of Import Requirements and Border Processes in Light of the Entry of Psa into New Zealand”, Moore & Loan (2012) undertook an independent review of the Ministry of Agriculture and Forestry’s import requirements and the border processes in place *prior* to the outbreak of PSA. It was requested by the government, and performed by the Sapere Research Group, one of the largest expert consulting firms in Australasia, in among many things providing independent investigations of public services. The specific examination of the existing import requirements and border processes of high risk kiwi plant materials in connection with the PSA incursion, for the first time shed new light on the identified shortcomings and failings of the Ministry. Due to the independent findings of this review it held high scientific credibility and relevance, which is why I chose to refer to it in this thesis, since it makes clear connections between contributing factors to the problem, to suggested action. According to Moore & Loan (2012) it will probably not be possible to determine with 100% accuracy the exact pathway for how the PSA may have entered New Zealand, but do point the fact that it may have been as a result of an inadequate border requirement for high risk goods, failure from border security to implement the applicable import restrictions, unauthorised imports of biological material or due to movement of persons between PSA infected areas and kiwi fruit farms in New Zealand. Further the Moore & Loan report (2012) quite plainly concluded: “The import requirements for kiwifruit pollen were inadequate.” In the interview on the 09-05-2013 with Charlotte Hardy, Technical Research Coordinator at Kiwifruit Vine Health, about what she believes is the likely source of PSA, she refers to the information at <http://www.biosecurity.govt.nz/pests/kiwifruit-vine-disease> which does not pinpoint a single pathway of entry into the country, but highlights pollen and people movements as being *the most likely pathways*. Drawing attention to the independent review undertaken by Sapere Research Limited, (Moore & Loan, 2012) this one also highlights that imported pollen is likely the pathway for entry of PSA into New Zealand. Research undertaken by Italian scientists as well as Otago University and Plant and Food Research in New Zealand have all shown with independent molecular analysis, that the bacterial strains of PSA in New Zealand have their origins in, *and* are related to strains of the PSA bacteria in China.

Russell Poulter, biochemist at University of Otago, whose work proved the DNA link between New Zealand's bacterial strain of PSA to the Chinese one, says the pollen anthers are tiny and that there would have been at least a billion in that shipment unpacked by Kiwi Pollen. If one in a thousand carried PSA that means there are a million infective particles being unpacked. Poulter is convinced that the shipment was the pathway of PSA to New Zealand, although extremely difficult to prove with certainty. Comparing it to a criminal case where you are looking at forensic DNA: a victim has a certain DNA, and that DNA matches the accused perfectly. Does that prove it was the accused? "It's not absolute proof, but [...] beyond reasonable doubt."

In Tony Hall's article on Stuff.co.nz on the 31st of March 2013, he compares the orchard in Te Puke where PSA was first detected in November 2010, as a CSI crime scene. And straight across the road from this farm is the factory belonging to Kiwi Pollen, who back in 2009 imported 4.5 kilograms of pollen on anthers of kiwifruit flowers from China. The pollen came from Shaanxi province, where PSA is endemic to the kiwifruit orchards. In the light of this compelling evidence, the Ministry of Primary Industries, (MPI) the successor department of the Ministry of Agriculture and Forestry (MAF), admits that the 2009 shipment is only one of a number of potential "pathways". It is believed that it is highly unlikely that the MPI would ever admit that the shipment was the source of PSA. And the reason being that their fingerprints are all over that shipment they allowed it in without any restrictions or quarantine requirements. If this was confirmed to be the "pathway" it may very well lead to MPI department being liable to a huge compensation bill. However, according to the overwhelming evidence found, they *do* support the claims - through DNA testing performed at Otago University - that the New Zealand strain of the PSA disease is *identical* to the one found in Shaanxi province. The 4.5 kilograms of pollen anthers were packed in 5 kilograms of ice to keep them chilled, which scientists believe could actually have kept the PSA disease alive during shipment. Kiwi Pollen Ltd then tried to extract the pollen from the anthers but since this was not possible all the material was disposed of in the general waste. A shipment of Chinese pollen, also by Kiwi Pollen Ltd was seized by the MAF before it was delivered and used, and this one tested positive for PSA. It has been established that if PSA arrived in June, 2009, it was the right amount of time for symptoms to start appearing in November, 2010. Which is consistent with the MAF (2011a) report mentioning that PSA most likely came into New Zealand, according to laboratory findings, at the most 18 months before the first visible symptoms were observed on kiwifruit orchards in October 2010.

In the interview on the 09-05-2013 with Senior Research Officer Glen Greer of Lincoln University, on the question which were the main factors causing the outbreak of PSA, she expressed that there are any number of hypotheses about how PSA entered New Zealand, most of which involve pollen imports, and the means of entry has not yet been determined, and it is quite probable that this will never be determined. Many growers believe that pollen imports were to blame because the owner of an orchard very close to the first orchard to be diagnosed is affiliated with a major pollen producer, Kiwi Pollen Ltd. Failings in the biosecurity system are also widely considered to be to blame. Personally Greer considered that both MAF (now MPI) and the industry were insufficiently vigilant about the disease given its prevalence overseas, particularly in Italy. Both MPI and the industry should have been involved in reviewing the import restrictions relating to pollen and plant materials and in strengthening these where required in the light of the new level of risk. The industry should have anticipated its eventual introduction and been working on resistant cultivars and management plans well before 2010.

Chapter 8 - Analysis and concluding reflections

8.1 Introduction

The objective of this thesis was to study New Zealand's biosecurity policies and how these correspond to national interests, but also how the PSA disease outbreak on the New Zealand kiwifruit industry has revealed weaknesses in its advanced biosecurity strategies, with a certain focus on how the various key actors have dealt with the problem of PSA. The thesis has set out to try to answer why the government departments handling the issue of biosecurity have come under close examination, and attempted to reflect what some key actors consider to be the pathway of the PSA outbreak, but also analyse how the various key actors have dealt with the problem.

8.2 Analysis and discussion

Without a doubt the PSA disease has had a severe effect not only on the kiwifruit orchards in the Bay of Plenty, but also to the regional economy as a whole. Financial losses are easier to measure than the effects it has had on families and their livelihoods which are more incomprehensible. While sales of kiwifruit have been maintained throughout the PSA epidemic, the brunt of the increased costs caused, have been borne by the growers themselves. However, the kiwifruit growers have adopted as best they can to the situation. They have implemented necessary changes to their growing practices, but also changed the varieties they grow since the industry has developed more disease tolerant varieties of kiwifruit.

PSA has been a wake-up call to the vulnerability of an industry that has taken many things for granted. The setup of Kiwi Vine Health was a step taken to manage and move on from the problems PSA has caused, but also to prevent new diseases to the kiwifruit industry. A lot of the scrutiny that the MPI and its predecessor MAF has come under lately have been due to the PSA incursion on the kiwifruit industry. The independent reviews, as well as those conducted internally by the Ministry, have all drawn attention to the importation of kiwifruit flower pollen as one of the likely sources of the PSA incursion, although they all agree that it is hard to prove this beyond all reasonable doubt. Since it is hard to prove with 100% certainty how PSA entered New Zealand due to the complex set of factors involved, MAF and its successor MPI appear to take advantage of this situation to dismiss any claims suggesting their liability to the PSA incursion, but at the same time not ruling out that it was one potential pathway. Many believe that the PSA outbreak could have been prevented in the first place, or at least reduced the risks considerably with stricter import controls, particularly on pollen and with a much greater level of awareness about PSA. However, the ministry has taken seriously most of the criticism and suggestions for improvements of New Zealand's biosecurity.

8.3 Concluding remarks

While many kiwifruit growers feel that they were let down by the government that failed to protect one of its primary industries from PSA, and the mixed feelings of criticism, anger and frustration for the lack of information about the importation of pollen, there is still a sense of positivism among growers to find a way forward and coping with PSA. Though many growers want to pursue

a course of liability on account of the Ministry for “allowing” PSA into New Zealand, others have adopted acceptance to the fact that bacteria is often able to one way or another spread worldwide as an inevitable part of globalisation. However, increased resources being spent on research for a sustainable biosecurity is thought to meet the challenges and threats of the future, but at the same time promoting the economic interests of New Zealand’s primary industries such as agriculture. It appears that there is a general awareness of the particular seriousness of PSA, not only to New Zealand’s kiwifruit industry, but also as it puts the MPI and its predecessor MAF under scrutiny, as it is widely believed the PSA bacteria came in through the pollen shipments from China or Chile that was approved by the Ministry. However, many have made claims that the Ministry should have known better and been more aware of the risks with the biosecurity setup prior to the PSA incursion, to be more vigilant about its presence in Italy and the devastating effects it has had there. Or at least they claim they should have followed Australia’s example of banning imports of kiwifruit pollen all together. Though a lot of focus has been spent on PSA and how it got here, it is important not to forget other possible pests and diseases in the future that may have a severe effect on New Zealand’s kiwifruit industry, where biosecurity continues to play an ever important role.

8.4 Future research

In the interview on the 14-05-2013 with Professor Ian Warrington of Massey Univeristy, he expresses that New Zealand has to reflect that the economy is almost entirely based on biological exports. That no other economy in the world is so vulnerable to diseases and pests that can impact on key exports. However, the fact that all of the exporting sectors rely on introduced plants and animals (sheep, cattle, apples, blueberries etc) is exactly why *they are* all so vulnerable to pests and diseases, that have caused such major problems in other countries (eg foot and mouth in cattle). It is therefore *critical* that New Zealand has one of the best biosecurity systems in the world - second to none. *The current service does not have that status*, says Warrington. There needs to be better surveillance, better predictive models of the consequences of incursions, greater scientific efforts to fully understand all the relevant factors concerning for instance: the host species, the properties of the diseases themselves and climate interactions, enhanced training, better education and less reliance on molecular biology being the "silver bullet" or a "cure for all problems".

With the biosecurity "lessons" learned from the case of PSA, not only in New Zealand but also on a world wide scope, there is a lot of material available to study further how a biosecurity system for the 21st century must be set up to handle the challenges that is presented through the effects of globalisation.

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Live interview:

11-07-2013 with Simon Elton, tour guide at the theme park Kiwi360 at Pukenga kiwifruit orchard in Te Puke, Bay of Plenty, New Zealand

Structured interviews over email:

09-05-2013. Charlotte Hardy, Technical Research Coordinator at Kiwifruit Vine Health Inc. (KVH), Wellington, New Zealand

09-05-2013. Glen Greer, Senior Research Officer of Lincoln University, Lincoln, New Zealand

14-05-2013. Professor Ian Warrington, Massey Univeristy, Palmerston North, New Zealand: expert on the horticultural industry of New Zealand,

15-07-2013. Mike Chapman, Chief Executive at New Zealand Kiwifruit Growers Incorporated, Mount Maunganui, New Zealand

Appendix I: email interview questions

- 1. What main factors do you consider are the cause of the outbreak of Psa-V?*
- 2. How do you think the Psa-V outbreak could have been prevented in the first place?*
- 3. Do you consider that there are specific procedures in the kiwifruit growing process that make it highly susceptible to diseases such as Psa-V?*
- 4. Do you believe NZ biosecurity policy has in any way contributed to Psa-V infection in the kiwifruit industry, and if so in what ways?*
- 5. Do you think lower or higher levels of biosecurity would benefit the resilience towards diseases affecting the kiwifruit industry in the long run? And if so in what ways?*