Horticulture Innovation Australia

Final Report

A model for industry planning and preparedness for an incursion of Varroa mite

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Plant Health Australia

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MT12049

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Summary

The almond industry is heavily reliant on the mechanical movement of bees between properties to achieve effective pollination. Australia's current freedom from the Varroa mite (*Varroa destructor*) ensures bee and hive numbers are stable and are able to move within and between all regions of Australia. With a very real threat of Varroa entering Australia complacency is not an option for an industry where production levels are directly related to the availability of bees. Biosecurity planning and preparedness for a potential incursion of Varroa provides a mechanism for growers, industry stakeholders, and governments to assess current biosecurity practices, identify gaps and opportunities, and ensure the continued growth and stability of the almond industry in the event of Varroa becoming widely established in Australia.

The Varroa mite is an external parasitic mite that without intervention, including treatment programs and ongoing management, has the ability to kill entire honey bee colonies in 2-3 years. The downturn in hive numbers available for paid pollination services and reduction in feral bee numbers that would result from Varroa mite entry and establishment will create competition between growing regions and different industry groups.

Australia is the last major honey producing country in the world to not have Varroa, and the almond industry, which in 2011 had an estimated farm gate value of more than $250 million and exports totaling $100 million, has an opportunity to be better prepared and cope with the potential arrival of this pest.

This project tested the preparedness of Australia's pollination-dependent industries for Varroa mite through a national review and simulation workshop (Workshop Acari). The outcome of both activities identified the significant reliance on honey bee hive movements over large distances as a considerable risk to business continuity in the event of Varroa mite entering the country. The likely movement restrictions implemented to respond and manage the pest would result in many pollination-dependent crop producers not having access to pollination services.

Nonetheless, Australia has effective response arrangements in place under the Emergency Plant Pest Response Deed, and these were tested as part of Workshop Acari activities. Early detection and the implementation of honey bee hive movement controls were highlighted as important response options. There was also specific reference to supporting and improving the National Bee Pest Surveillance Program to ensure the likelihood of detecting Varroa mite early is increased.

Keywords

Honey bee, Varroa mite, almonds, pollination-dependent, biosecurity.

Introduction

PHA established the Varroa Continuity Strategy Management Committee (VCSMC) to support bee pollination reliant industries and beekeepers of Australia. The objectives of the Varroa strategy are to have arrangements in place that allow the honey bee industry, crop industries responsive to honey bee pollination and governments to prepare for, and respond quickly and efficiently to, the establishment of Varroa mite (*Varroa destructor*) in Australia so effects on the honey bee industry and pollination of responsive crops are minimised. Due to the almond industry's current reliance for hives during pollination, industry specific alternatives and opportunities need exploration to provide recommendations to growers and industry stakeholders to direct preparedness activities.

Varroa was first detected in Auckland, New Zealand in 2000 and between 2000 -2007 there was a 56% reduction in the number of beekeepers registered in the North Island. If Varroa enters Australia, it will progressively kill Australia's feral honey bee population and as the number of feral honey bees fall, the horticulture industry sector will be greatly affected with average losses estimated at $50 million a year. As the almond industry is 100% dependent on pollination, this loss will have a major impact on the industry. Alternatives to honey bee pollination may be available such as manual/artificial pollination, grower managed hives, and dedicated bee raising facilities. Presently these options are costly and have a high labour cost associated with them however these opportunities need further investigation to provide viable options to the industry.

Biosecurity preparedness ensures that an effective response can be mounted in the event of an incursion and there are plans in place to manage an ongoing pest presence. A clear understanding of the industry consequences and legal implications of a Varroa incursion can be achieved through targeted training and awareness programs. Contingency planning is needed to investigate regional hive availability, pollination alternatives and the regional capacity to coordinate an effective incursion response. Formalised preparedness activities will ensure biosecurity risk management plans are effective and up-to-date and supported by adequate resourcing.

Regular training and simulation programs will increase the understanding of industry roles, identify areas of improvement, and allow the almond industry to road test their emergency response systems. The identification, training and coordination of key industry personnel will create a stronger biosecurity network and will significantly enhance the almond industry's ability to respond to Varroa and meet and understand their obligations under the Emergency Plant Pest Response Deed (EPPRD).

An incursion of Varroa would potentially result in immediate movement restrictions of hive and apiary equipment by state and territory governments. The extent of these restrictions and how they would be enforced is a central theme of the VCSMC strategy, however further investigation will be needed to understand the impact these movement controls would have on the ability to continue with intra- and interregional paid pollination services for the almond industry.

In the event of an Emergency Plant Pest (EPP) Incident, owners of crops that are damaged or destroyed under an endorsed Response Plan may be eligible to receive Owner Reimbursement Costs covering direct losses. While this process is clearly defined in the EPPRD, the complexities around ownership arrangements in the almond industry need to be investigated to ensure almond businesses are appropriately covered or aware of their vulnerability.

Methodology

Industry wide review and contingency planning

An online census was undertaken for ten participating pollination-dependent industries, at the peak industry body and grower levels, to ascertain the potential impact of honey bee hive movement restrictions. The participating industries were almonds, apple and pear, avocados, cherries, melons, canned fruit, onions, prunes, summerfruit and vegetables.

The census asked questions around the following areas:

- Crops represented/grown
- Location
- Reliance on native/wild bees
- Level of reliance on paid pollination services
- Location of pollination services employed (local or interstate)
- Biosecurity practices implemented
- Research into Varroa mite preparedness
- Level of threat Varroa mite presents

Outcomes of the census were collated and compared to related activities previously undertaken (e.g. 2009 pollination report and Varroa Continuity Strategy Management Committee), with all information presented in the *Varroa mite preparedness of pollination dependent industries* report.

Owner Reimbursement Cost clarification

PHA, as custodians of the EPPRD, works with Industry Parties to develop industry-specific ORC Evidence Frameworks, which are used in the event of an EPP Incident to determine the ORC payments. Under this project, PHA worked directly with the Almond Board of Australia (ABA) to progress the draft ORC Evidence Framework for the Almond Industry and ensure the ownership arrangements in the almond industry are understood in relation to the ownership definition under the EPPRD.

To complement the direct liaison between PHA and ABA, an Australian Nut Industry Council ORC workshop was facilitated to ensure all the nut industries have a consistent understanding of the ORC process and could progress the development of the individual ORC Evidence Frameworks for each industry.

Simulation Workshop

The planning of Workshop Acari was overseen by a planning committee comprising of members from PHA, ABA, Rural Industries Research and Development Corporation, HAL, an independent pollination provider, New South Wales Department of Primary Industries, Victorian Department of Environment and Primary Industries (Vic DEPI) and the Australian Government Department of Agriculture. The planning committee developed the workshop aim, objectives, scope, activity structure and scenario. The activities and inputs were developed by PHA with technical contributions received from Vic DEPI.

The two day workshop was structured to include a variety of key note speakers and simulation activities (Table 1). For the simulation activities, participants worked together in groups of 6 to 8 people, with outcomes presented to the entire workshop for discussion. Participants worked together to compile overarching outcomes and future recommendations.

Table 1. Summary of the presentations and simulation activities delivered at Workshop Acari

Session	Day 1 – 11th June 2014	Day 2 – 12th June 2014
Morning	Presentations: • Introduction and background (Ashley Zamek) • New Zealand experience with Varroa mite (Mark Goodwin) • Complexities of Australian beekeeping (Trevor Monson)	Presentations: • Owner Reimbursement Costs (Sophie Peterson) • Impacts of Varroa mite on crop pollination (Saul Cunningham)
Afternoon	Simulation activities: • Emergency response course of action • Industry representation and involvement • Effects of a hive standstill on pollination services	Simulation activities: • Development of key messages • Drafting of communications material • Identification of top impacts • Identification of top priorities

Additional details of the methodology to plan and deliver Workshop Acari can be found in the workshop report attached to this report.

Outputs

Varroa Mite Preparedness of Pollination Dependent Industries

This report highlights individual industries dependence on honey bee pollination and evaluates the effect a Varroa mite incursion may have on short-term and long-term pollination services. The report provides eight recommendations that could be employed to mitigate the effect of a Varroa mite incursion and improve pollination dependent industries' overall preparedness.

Workshop Acari: Workshop Report

This report provides an overview of the planning, activities and outcomes of Workshop Acari. This workshop investigated preparedness and response options for the honeybee and pollination-dependent industries, primarily almonds, for a potential Varroa mite incursion in Australia utilising a simulated scenario where the pest is detected in Melbourne. The six recommendations formed as a result of workshop activities are presented.

Outcomes

Industry wide review of Varroa mite preparedness

For every year Australia remains free of Varroa mite, industries which rely on honey bee pollination together receive a benefit of $50.5 million per year. Pollination dependent industries represent over 65% of all the horticultural and agricultural crops produced in Australia. These industries require bees for pollination as they are either self-incompatible or only achieve a commercially adequate yield through honey bee pollination. The data collected from the pollination census conducted for this report clearly shows the dependence of industries on honey bees as pollinators. This makes pollination dependent industries incredibly vulnerable to honey bee pests and diseases and in particular, Varroa mite which is known to decimate wild honey bee colonies and severely impact managed hives.

The impending threat of Varroa mite on the livelihoods of pollination dependent industries and beekeepers themselves is severe and will impact on the production of horticulture in Australia. Pollination dependent industries and beekeepers need to work together to mitigate the risk of Varroa mite entering the country and develop both short and long term contingency plans to maintain effective pollination in the event of Varroa mite establishment.

Pollination dependent crop industries need to address the current gap in R&D work into alternative pollination techniques and selective breeding of crops to minimise reliance on pollination vectors. In the event of an incursion, emergency response procedures would create quarantine borders which may restrict hive movement at a regional or state level. The location and availability of hives from year to year is not consistent or guaranteed as shown in previously published reports. Although seasonal hive movements, outside of pollination services, are dictated by unpredictable floral resource availability, there is still an over-reliance by industries for basic decisions on past seasons hive availability. This variable hive availability also does not take into account the future possibility of these services not being available due to quarantine restrictions.

Workshop Acari

Workshop Acari presented current research and on-the-ground activities relating to Varroa mite preparedness, pollination service delivery and emergency response policy, together testing the ability to effectively respond to a Varroa mite incursion through discussion exercise activities. The 32 participants from government and industry investigated the emergency response operations, movement restrictions and their implications, and the communications required during an emergency response.

As a result of these activities, the key outcomes identified were:

- Restricting the movement of managed honey bee hives is an effective tool for limiting the spread of Varroa mite following its detection, but this approach can threaten production in a range of crops through the inability to access adequate hives to achieve full pollination. Key aspects in managing this risk include rapid and transparent decision making regarding the implementation and review of movement restrictions, together with clear communications to affected stakeholders.
- Australia's Varroa mite early detection surveillance program is a critical preparedness activity, benefiting the honey bee and pollination dependent industries. There is an opportunity to review the current program to identify aspects that limit its effectiveness.

- Broadening surveillance to formally engage growers and bee keepers provides an opportunity to significantly increase detection sensitivity without significant increases in required resources.
- Changes in pollination practices can limit the impact of Varroa mite on honey bees and the ability to achieve satisfactory pollination.
- Current Varroa mite preparedness activities are focused on the honey bee industry, leading to an opportunity for pollination-dependent industries to better engage and ensure collaborative approaches are implemented across the honey bee, agricultural and horticultural sectors.
- There are identified gaps to the provision of Owner Reimbursement Costs (ORCs) to all affected stakeholders in a Varroa mite response.
- Underpinning communication messages relating to Varroa mite are consistent across production sectors.

Owner Reimbursement Costs

PHA updated the ORC Evidence Framework for the Almond Industry to align with current ORC Evidence Frameworks for other industries, and added the relevant information available. PHA has provided the draft to ABA for review and completion of industry specific information. PHA will continue to work with ABA to complete the update of the document.

Evaluation and Discussion

Delivery against intended project outcomes

Activities under this project were targeted to three key intended outcomes:

1. Documentation of the preparedness of pollination-dependent industries for Varroa mite was achieved in the *Varroa mite preparedness of pollination dependent industries* report. Through literature review and a survey of pollination-dependent crop producers, this report outlines the state of preparedness and the likely impact of Varroa mite in eight spate industries, together with a combined national analysis.
2. Testing of the emergency response operations and the resultant impacts on pollination-dependent industries was achieved through Workshop Acari. The discussion activities undertaken during Workshop Acari covered emergency response operations, movement restrictions and impacts, and communication to growers during an emergency response. In addition, a number of key note presentations highlighted specific aspects of the emergency response, pollination service delivery and management of Varroa mite.
3. Clarification of the underpinning details of Owner Reimbursement Costs and their implementation was achieved through a presentation at Workshop Acari and through direct liaison between PHA and ABA. Following these discussions, the ORC Evidence Framework for the Almond Industry has been updated by PHA to include current details, and has been submitted to ABA for Industry Party review and update.

Evaluation of Workshop Acari

Workshop Acari activities were evaluated through a participant questionnaire completed at the conclusion of workshop activities. The responses to the questionnaire (Table 2 and Table 3) demonstrate that the workshop was beneficial and met its aim and objectives.

Table 2. Collation of the quantifiable responses to the participant questionnaire for Workshop Acari

	Number of responses			
Question	**Yes**	**No**	**Not sure**	**N/A**
Prior to the workshop, was Varroa mite a concern to you?	25	1	1	0
As a result of the workshop, would you say you have a greater awareness of what pollination-dependent industries can do to minimise the impacts of a Varroa mite incursion?	25	0	2	0
As a result of this workshop, do you think pollination-dependent industries should work with the honey bee industry to limit the impact of a Varroa mite incursion?	27	0	0	0
Do you think this will be pursued?	18	0	9	0
Do you believe that pollination-dependent industries have a role in honey bee biosecurity?	27	0	0	0

	Number of responses			
Question	**Yes**	**No**	**Not sure**	**N/A**
Do you believe pollination-dependent industries need to develop Varroa mite contingency plans to limit the impact of an incursion?	27	0	0	0
As a result of this workshop, do you have a greater understanding on the current research being undertaken on Varroa mite management?	15	9	3	1
As a result of this workshop, do you have a greater understanding on the current research being undertaken on alternative pollination techniques?	10	11	5	1
Are you comfortable with the future recommendations identified through the workshop?	19	3	5	0
Do you feel that this workshop has improved your understanding of the measures that you and all pollination-dependent industries could put in place to reduce the impact of a Varroa mite incursion?	22	0	3	2

Table 3. Top participant responses to the free text questions on the feedback questionnaire

Question	**Top responses**
Based on the workshop, what are the impacts that a Varroa mite incursion could have on almond production?	• Loss of pollination, leading to lower production, yield and income • Increased costs of pollination • Competition for hives • Loss or market confidence
What would be the most important measure to put in place to limit these impacts?	• Increase in resources towards surveillance • Contingency planning activities • Education and training for all pollination-dependent industries
In your opinion, what is the highest priority action to come out of this workshop?	• Surveillance methods for Varroa mite to New Zealand to be tested for their sensitivity • Develop an almond-specific contingency plan for Varroa mite
What were the best aspects of the workshop?	• Group discussions and interactions • Increased understanding of the impact of Varroa mite on pollination-dependent industries • A chance to hear from all aspects of the industry (beekeepers, growers and government) and expertise available

Change practice

No analysis of apiarist or pollination-dependent crop producer operations was undertaken as part of this project. As a result, any changes to on farm practices as recommended in the preparedness report or Workshop Acari could not be identified. In addition, many of the recommendations and project outcomes relate to practices that would only be implemented as part of an emergency response to Varroa mite, or as part of a management practice should an eradication attempt not be successful.

On the other hand, a review of the National Bee Pest Surveillance Program was highlighted in multiple aspects of this project, and included in the recommendations shown in the next section. Together with other drivers active within the honey bee biosecurity space, this has resulted in the review being undertaken, with the intent of broadening the contributions to the program to include pollination-dependent industries that benefit from the programs existence.

Key learnings

Workshop Acari and the Industry wide review of Varroa mite preparedness each identified a number of key learnings, which are presented in the relevant reports. Nonetheless, there are a number of key learnings that were consistently identified across all activities of the project, which were:

1. Closer working relationship on biosecurity between honey bee and pollination-dependent industries required.
2. Maintain and improve National Bee Pest Surveillance Program.
3. The level and distance of hive movements for pollination service delivery presents a significant risk to pollination-dependent industries should movement restrictions be placed on honey bee hives as part of an emergency response to Varroa mite.

Recommendations

Industry wide review of Varroa mite preparedness

The industry wide review of Varroa mite preparedness generated eight recommendations. Additional context to each of these recommendations is included in the *Varroa Mite Preparedness of Pollination Dependent Industries* report.

1. Encourage floral and nectar resources
2. Manage own hives
3. Growers use specialized pollination contracts
4. Chemical registration for Varroa mite chemical controls
5. Continue commitment to the National Be Pest Surveillance Program
6. Encourage compulsory beekeeper registration
7. Increased R&D into pollination programs and alternative pollination techniques
8. Closer working relationship with the pollination dependent industries and the honey bee industry to include business planning and contingency planning

Workshop Acari

As a result of the activities undertaken at Workshop Acari, six recommendations were generated. Additional context to each of these recommendations is included in the *Workshop Acari: Workshop Report*.

1. All beneficiaries of the National Bee Pest Surveillance Program to contribute to the implementation of the program
2. Undertake a review of the National Bee Pest Surveillance Program to ensure its resources are being implemented effectively
3. Document Varroa mite response options from the almond industry perspective
4. Prioritise Varroa mite preparedness research funding to address identified gaps
5. Develop a training plan for Affected Parties in a Varroa mite response
6. Finalise the ORC Evidence Framework for the Almond Industry

Intellectual Property/Commercialisation

No commercial IP generated.

Appendices

Plant Health Australia (2013) *Varroa mite preparedness of pollination dependent industries*. Plant Health Australia, Canberra, ACT.

Plant Health Australia (2015) *Workshop Acari: Workshop Report*. Plant Health Australia, Canberra, ACT.

Plant Health
AUSTRALIA

Varroa Mite Preparedness of Pollination Dependent Industries

Prepared by Plant Health Australia

December 2013

HAL
Horticulture Australia

Australian Government
Rural Industries Research and Development Corporation
RIRDC

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Executive Summary

For every year Australia remains free of Varroa mite, industries which rely on honey bee pollination together receive a benefit of $50.5 million per year. Pollination dependent industries represent over 65% of all the horticultural and agricultural crops produced in Australia. These industries require bees for pollination as they are either self-incompatible or only achieve a commercially adequate yield through honey bee pollination. The data collected from the pollination census conducted for this report clearly shows the dependence of industries on honey bees as pollinators. This makes pollination dependent industries incredibly vulnerable to honey bee pests and diseases and in particular, Varroa mite which is known to decimate wild honey bee colonies and severely impact managed hives.

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Pollination dependent crop industries need to address the current gap in R&D work into alternative pollination techniques and selective breeding of crops to minimise reliance on pollination vectors. In the event of an incursion, emergency response procedures would create quarantine borders which may restrict hive movement at a regional or state level. The location and availability of hives from year to year is not consistent or guaranteed as shown in previously published reports. Although seasonal hive movements, outside of pollination services, are dictated by unpredictable floral resource availability, there is still an over-reliance by industries for basic decisions on past seasons hive availability. This variable hive availability also does not take into account the future possibility of these services not being available due to quarantine restrictions.

This report highlights individual industries dependence on honey bee pollination and evaluates the effect a Varroa mite incursion may have on short-term and long-term pollination services. The report provides eight recommendations that could be employed to mitigate the effect of a Varroa mite incursion and improve pollination dependent industries' overall preparedness.

Introduction

Managed honey bees[1] are found Australia-wide with approximately 673,000 registered hives in Australia managed by 10,500 beekeepers (Plant Health Australia 2012a). The Australian honey bee industry produces between 20,000-30,000 tonnes of honey annually making Australia the ninth largest producer of honey in the world, exporting about a third to over 38 countries (Kneebone 2010). The Australian honey bee industry has an overall estimated gross value of production of $90 million a year which includes the production of honey, beeswax, queen bees and paid pollination services (RIRDC 2012). However this figure severely understates the importance of honey bees to the agricultural industry as a whole.

The worlds agricultural industries are based on the production of agricultural produce from the reproduction of plants which in most cases relies on the fertilisation of an ovule by pollen known as the act of pollination (RIRDC 2010). The complexities of crop pollination vary from:

1. Self-pollination: where a flower produces pollen and fertilises itself or other flowers on the same plant. Some self-fertile plants may still need an vector to move pollen from the anthers to the stigma (RIRDC 2010).
2. Self-incompatible or self-infertile: where the plant has a mechanism that prevents self-pollination and requires the use of vectors for the transfer of pollen. Examples of self-incompatibility are when male and female flowers are on different parts of the plant, on a different plant entirely or when female and male flowers occur at different times on the same plant (Goodwin 2012).

Pollination by insect vectors is essential to fruit production and can account for up to 50% increases in fruit set (Abrol 1993). Bee pollination comes from sources such as wild honey bees[2], commercially reared honey bees and native bees[3] (Cunningham et al. 2002). Over 65% of horticultural and agricultural crops introduced to Australia since European settlement require bees for pollination (Gordon and Davis 2003) as they are either self-incompatible or only achieve a commercially adequate yield through pollination vectors (RIRDC 2009a). Honey bees forage for nectar and pollen for food and as a direct result of their activities pollinate plants resulting in increased seed or fruit set, improved storage qualities and shape of some fruit, and a more even maturation of some crops (Plant Health Australia 2013a). In temperate-zone agriculture and horticulture it is widely assumed that all pollination by animal vectors is done by honey bees with contributions made from other fauna only minimally recorded (Cunningham et al. 2002). The pollination market in Australia currently involves 481 commercial pollination businesses supplying 220,000 hives (Commonwealth of Australia 2011) across Australia.

In Australia, significant pollination of crops occurs from the large population of wild honey bees that are found throughout Australia. This means that pollination of crops often occurs without any deliberate intervention from, and at no cost to, the grower. This incidental pollination means the level of awareness about the importance of pollination by bees for pollination dependent crops is lower than might be expected given its importance (RIRDC 2010). Studies have shown that the transfer of pollen by honey bees can increase yields in some crops by 150% (Mcgregor and Bean 2009) in comparison to the yield obtained without the use of pollination vectors.

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[1] Honey bees in this report refer to European honey bees (*Apis mellifera*)

[2] Wild honey bees in this report refers to European honey bees that are not managed by a beekeeper and live wild in the environment

[3] Native bees in this report refers to bee species found naturally in Australia, not of the *Apis* genera

Australia's relative freedom from many of the debilitating pests and diseases that affect honey bees in other countries has allowed for plant producers to become reliant on incidental pollination or only require minimal use of commercial pollination companies. Australia's climate and geography provides an ideal environment for honey bees as the native floral nectar resources available (such as Eucalypts) produce large quantities of nectar and pollen. As a consequence, Australia has a large population of wild honey bees that provide significant free pollination services to Australian agriculture and horticulture.

However Australia's biosecurity is constantly threatened from increased trade, travel and changes in the environment which increase the chances of a honey bee pest or disease entering the country. One of the biggest threats to the Australian honey bee industry is the Varroa mite (*Varroa destructor*[4]) which over the last 50 years has spread to every major beekeeping area in the world except Australia, making it the most serious pest ever of the honey bee (Anderson 2006). Varroa mites are an external parasite that feed on the haemolymph of drone, workers, larvae, pupae and adult bees (Plant Health Australia 2012b). The Varroa mite weakens bees, shortens their lives, or causes death from virus infections that otherwise would cause little harm. Unless urgent action is taken, infested colonies will slowly decline until all honey bees are dead (RIRDC 2010).

The effect of Varroa mite in other countries has seen wild honey bee colonies and managed colonies drastically decline (Cunningham et al. 2002). In the US and Europe, Varroa mite killed 95-100% of unmanaged or wild honey bees within three to four years of infestation (Commonwealth of Australia 2011). While efforts are being made to prevent an incursion into Australia, it is generally accepted that Varroa mite will eventually become established in Australia (RIRDC 2010). Varroa mite is expected to progressively kill 95-100% of Australia's wild honey bee population, greatly reducing the free pollination service they provide. The effect on commercial beekeepers will be the costs associated with implementing control measures, increased labour requirements, and the need to replace infected colonies (RIRDC 2010). The effect on pollination dependent industries will be the loss of incidental pollination and increases in the direct costs of pollination services and/or the possibility of insufficient number of hives being available (Gordon and Davis 2003).

[4] Another closely related exotic species of Varroa mite is *Varroa jacobsoni* which is often discussed together with *Varroa destructor.* However this report only focuses on *Varroa destructor* K and J haplotype

Project background and method

In 2009, Plant Health Australia (PHA) and the Australian Government Department of Agriculture conducted a survey of beekeepers throughout Australia to determine the movement of commercial hives and the type of crops pollinated through their services. The results of the survey were summarised into the report "Collection of data and information about pollination dependent agricultural industries and the pollination providers" (herein 2009 pollination report). The overall findings of this report indicated that the routine long distances that hives are transported mean that rapid detection of incursions are critical in order to prevent the spread of Varroa mite past the possibility of eradication (Plant Health Australia 2009).

In 2011 PHA established the Varroa Continuity Strategy Management Committee (VCSMC) funded by the Australian Government Department of Agriculture to support honey bee pollination dependent industries and the beekeepers of Australia. The VCSMC looked closely into the intra- and inter-state movement restrictions that may result due to an incursion of Varroa mite. In the event of a Varroa mite incursion, governments would introduce a restricted area and a control area around the identified infected premises. Within the restricted area all managed apiaries would be quarantined and movement out of the restricted area will be prohibited. The control area would be a larger declared area around the restricted area(s) and initially may be as large as a state or territory (Commonwealth of Australia 2011).

However, further investigation is needed to understand the impact these movement controls would have on the ability to continue with intra- and inter- regional paid pollination services. Increased industry specific planning and preparedness for a potential incursion of Varroa mite will provide a mechanism for growers, industry stakeholders and governments to assess current biosecurity practises, identify gaps and opportunities, and ensure the continued growth and stability of pollination dependent industries.

In 2013, PHA was further commissioned by Rural Industries Research and Development Corporation (RIRDC) and Horticulture Australia (HAL) to explore how the impact of honey bee movement restrictions potentially implemented as a result of Varroa mite incursion would affect pollination dependent industries[5]. Combining these findings with those from the 2009 pollination report will enable for an effective analysis of the potential impacts that state and regional quarantine responses may have on hive movements and the availability of pollination services. This project also aims to understand the reliance of pollination dependent industries on native bees, wild honey bees and managed honey bees for pollination as well as the alternatives to bee pollination that are available.

Information was collected from peak industry body representatives and growers from 10 participating industries through an online census. The peak industry bodies targeted were: Almond Board of Australia, Apple and Pear Australia, Avocados Australia Ltd, Cherry Growers Australia Inc., Australian Melon Association, Canned Fruit Industry Council of Australia, The Australian Prune Industry Association, Summerfruit Australia, AUSVEG Limited and Onions Australia. The links to the census were emailed to peak industry body representatives who were encouraged to forward it on to their members. There were two censuses available – one for the peak industry body (Appendix 1) and another tailored for growers (Appendix 2).

The completion of one census per peak industry body was all that was required to represent the industry's views. The grower census was to give an "on the ground" perspective and therefore required a large number of responses from as many growers

[5] This report only covers the pollination dependent industries that funded this project through HAL and RIRDC

as possible. However, response numbers received per industry were varied with some industries receiving no responses (Figure 1). This sporadic level of data meant that all interpretation undertaken in this report can only give an indication of the views of a particular industry and only represents a snap shot in time.

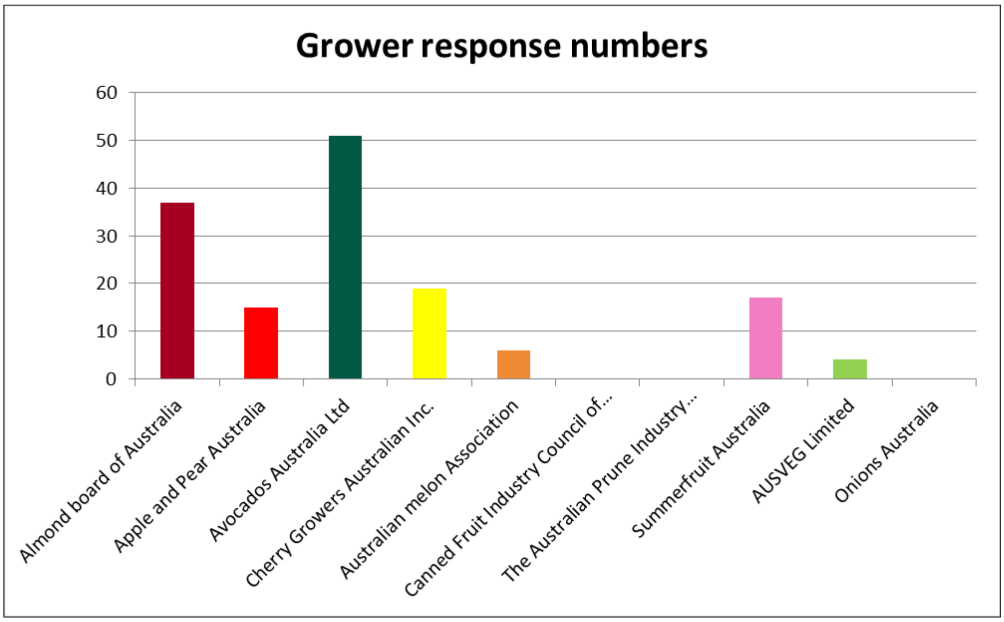

Figure 1: The individual industry level of responses to the grower pollination census

Industry analysis

Almonds

Represented by Almond Board of Australia

Varroa impact rating: HIGH

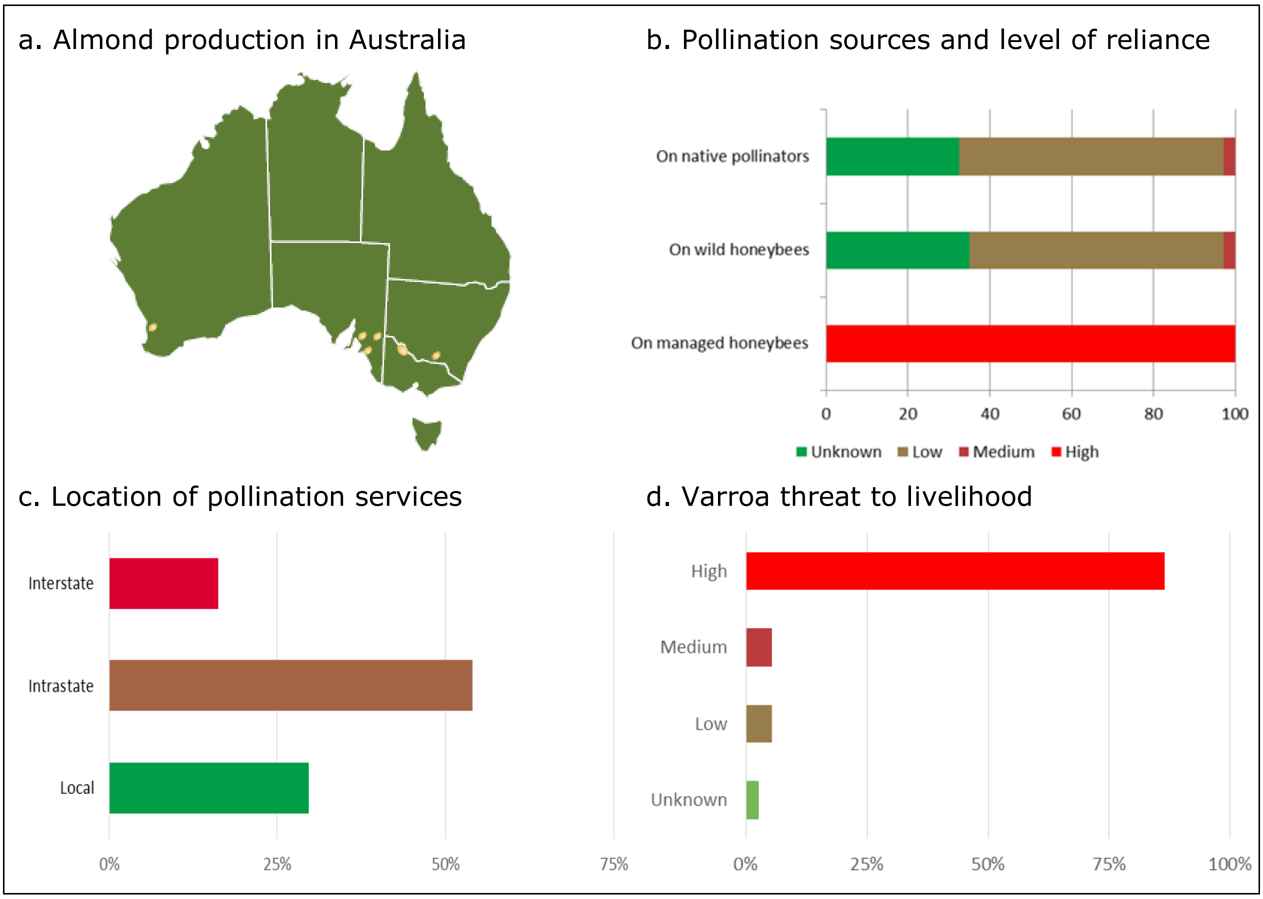

Figure 2 (a-d): Snapshot of the pollination dependence of the almond industry (data from 37 growers)

The Australian almond industry is located in South Australia, Victoria, Western Australia and New South Wales (Figure 2a). The majority (60%) of almond orchards in Australia are located in Robinvale, Victoria. A total of 30,259 hectares of land is dedicated to the cultivation of almonds with an estimated farm gate value of more than $250 million (Plant Health Australia 2012a). It is forecast that the Australian almond industry will increase its share of current global production from 3% to 6% surpassing Spain, to become the world's second largest almond producer in the next few years (Cunningham 2012a). The majority of commercial almond cultivars in Australia are self-incompatible and typically require the joint planting of at least two inter-compatible and simultaneously blooming cultivars as well as the presence of insects to transfer pollen (RIRDC 2008a). Currently the strategy employed by the industry is to mix early and late flowering cultivars to ensure overlap with the premium variety (Cunningham 2011).

The pollination requirements of almond growers are provided for solely by paid pollination services (Figure 2b). The location of hired hives varied, however the majority (80%) of the hives used by the growers who responded to this census were sourced from within the state that the growers are located (Figure 2c). This census result is contradictory to industry anecdotal evidence that suggests that a large proportion of hives used for almond pollination are sourced out of state. The growers who responded to the census believe the access of hives within their own state means that if border restrictions were put in place, they would still have access to sufficient pollination services to successfully pollinate their crops. A minority of almond growers (16%) would have problems in sourcing pollination services as they are located close to state borders and use inter-state pollination companies because of their location. Currently, almond producers pay an average of $65 per hive for pollination services; however responses regarding pollination costs varied from $6 per hive to $80 per hive. The average stocking rate for almond growers was 5.7 hives/ha which is slightly less than documented current practise of 7.5 hives/ha (Cunningham 2012a). Overall almond growers feel that the current costs of pollination services are already putting a strain on the viability of the industry.

The demand for honey bees by almond growers is at its peak in August with requirements estimated at over 23,000 hives (Plant Health Australia 2009). An important aspect to consider when determining the availability of hives for almond pollination is the location of hives in July. Throughout the year pollination providers will transport hives to source nectar and pollen before fulfilling pollination contracts to ensure bees are healthy and robust enough to be effective pollinators. In the 2009 pollination report, beekeepers indicated the location of the majority of hives in July 2008/2009 was determined by a Spotted gum (*Corymbia maculata*) flowering event near Batemans Bay NSW (Figure 3). This map was developed from the responses to the 2009 pollination report and is not representative of the entire industry; however it gives an idea of the location of hives at this time.

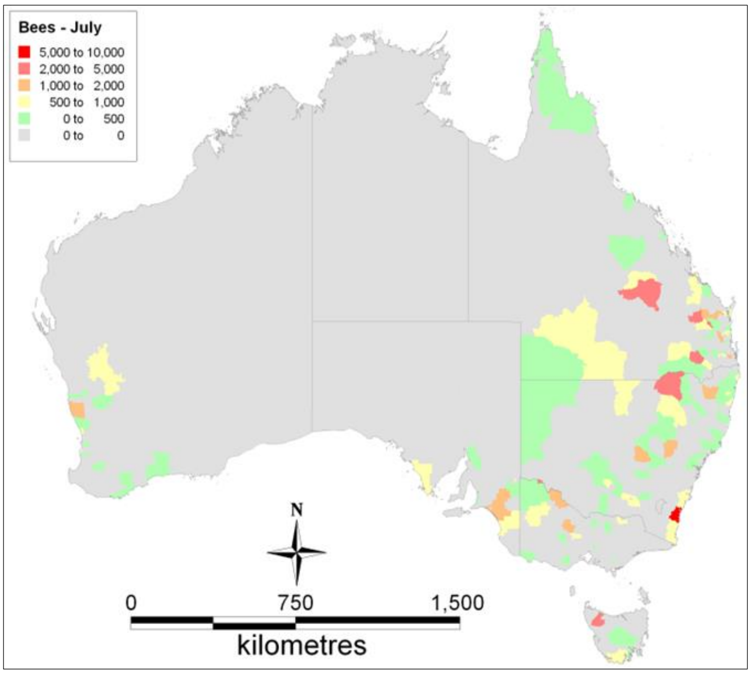

Figure 3: Location of hives July (2008/2009) (Plant Health Australia 2009)

If quarantine restrictions were implemented when hives were located as depicted in Figure 3, a large amount of hives would have been unable to enter Victoria to provide the required almond pollination service to the Robinvale area. However, care needs to be taken when relying on this information to develop contingency plans. The location and availability of flora varies yearly and with seasonal conditions which can dictate flowering events sometimes 18 months in advance. Therefore even with this information (representing a snapshot in time), there is no definitive way to determine future flowering events that beekeepers will utilise prior to fulfilling almond contracts or if they will choose to overwinter their hives instead. These reactive decisions bee keepers make to align their hives with flowering events therefore determines where hives will be located prior to moving into almond growing areas. For example, in July, the top five native floral resources utilised by beekeepers are banksia, ironbark, spotted gum, tea tree and white box (Plant Health Australia 2009). Trying to use this information to hypothesise beekeeper location in July is complicated as the location of these floral resources is varied as seen in Figure 4 and hive movement to these areas depends on flowering events (dependent on seasonal conditions) and the suitability of these events for honey production. There is also secrecy among beekeepers as to where they plan to move their hives for floral resources, as having a monopoly on a flowering event can be very important in determining the economic viability of a beekeeper's business.

In the event of a Varroa incursion, where the availability of wild honey bees and paid pollination services may be decreased, almond growers would be severely affected as 95% of growers have no alternative pollination techniques they could quickly employ. The greatest impact of a Varroa mite incursion would be the ongoing increases to the cost of paid pollination services. The threat of Varroa mite is rated high (Figure 2d) however 92% of growers make no specific biosecurity requests of their pollination service providers to mitigate risks to honey bee health. Almond growers believe that the beekeepers are responsible for ensuring the biosecurity of their own bees. Only one almond grower requires beekeepers to sign a specialised contract that states that all hives have arrived pest and disease free, meeting a minimum strength standard and are inspected by a 3rd party upon delivery. This identifies a gap in industry best practise as growers do not know what condition the bees are in when they receive them and this could affect their ability to effectively pollinate their crops.

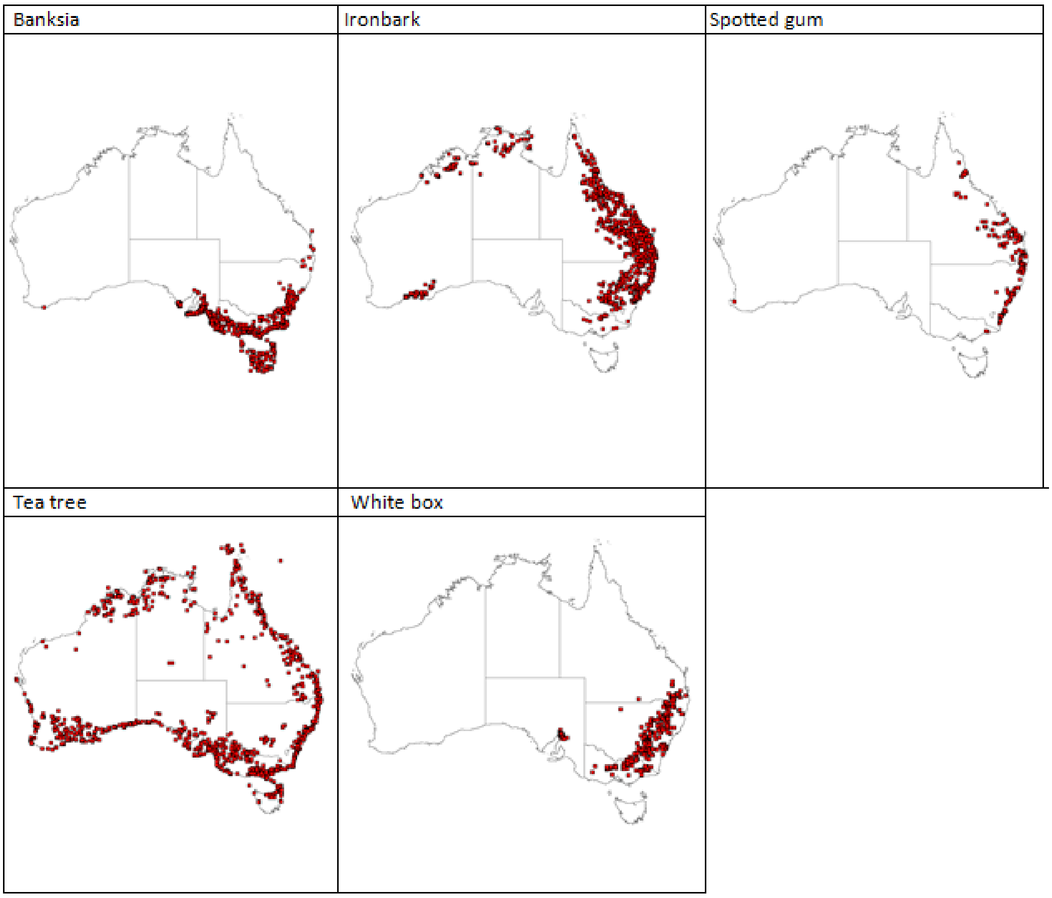

Figure 4: Location of the top 5 native floral resources for beekeepers

Alternative pollination techniques for almonds together with improving hive management and cross pollination methods are Research and Development priorities for the Almond Board of Australia. Recent projects have found that hive placement is more important than honey bee density with fruit set efficiency increasing when hives are arranged in small placements relatively close together rather than large placements far apart (Cunningham 2012b). High bee density has been associated with poor fruit set which indicates that flooding orchards with large quantities of honey bees is not an effective mechanism to increase almond yield (Cunningham 2012c). Research is also currently being conducted into self-compatible almond varieties that would not require vector assisted pollination, however currently these varieties are not yet commercial (Cunningham 2011). A Varroa incursion simulation for the almond industry planned for 2014 will provide further insight into the development of a contingency framework for the industry.


Apples and Pears

Represented by Apple and Pear Australia

Varroa impact rating: HIGH

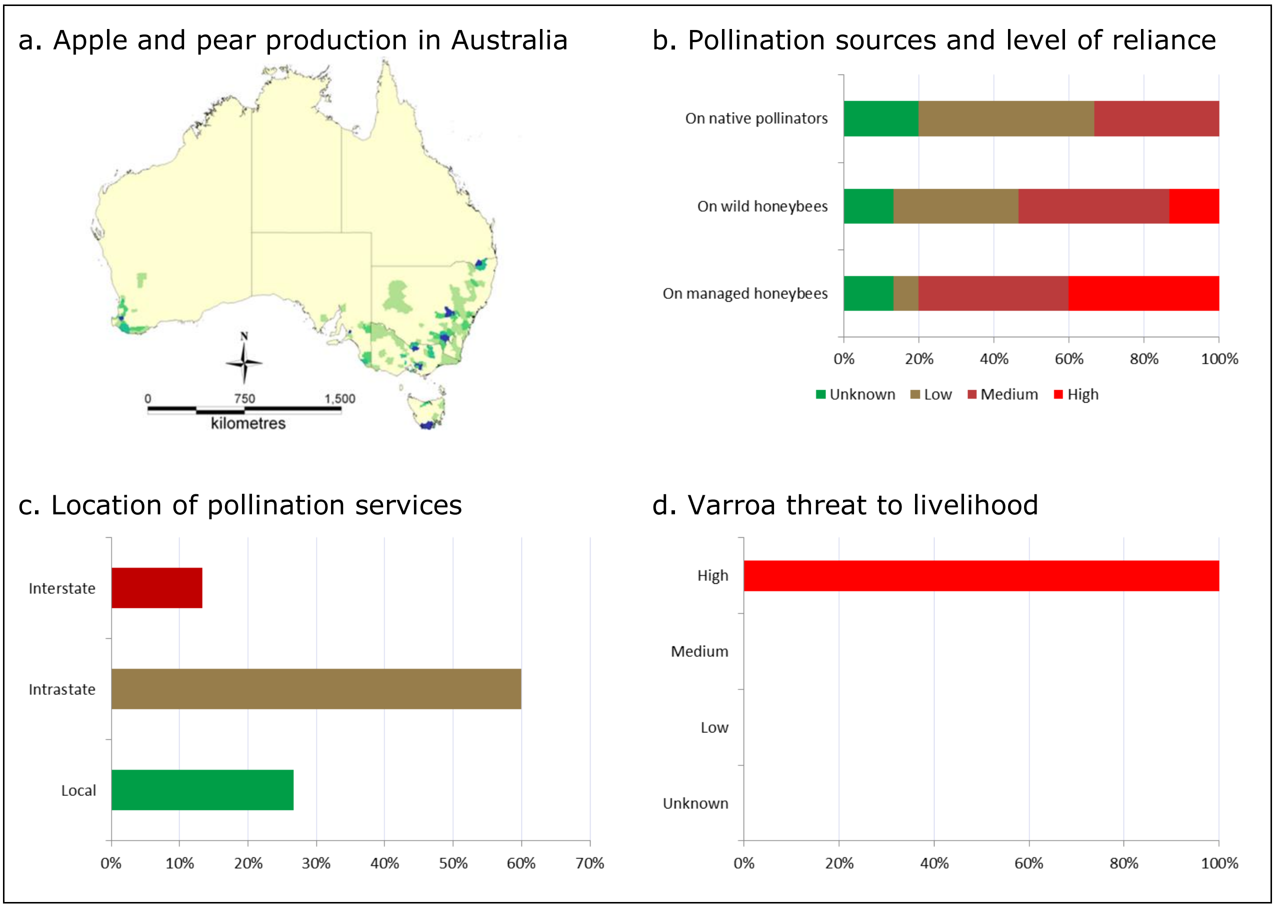

Figure 5 (a-d): Snapshot of the pollination dependence of the apple and pear industry (data from 15 growers)

The apple and pear industry is Australia's largest fruit industry valued at over $770 million (Plant Health Australia 2012a). The Australian apple industry is mostly aimed at the domestic market with around 90% of production consumed in Australia. However the export market is growing with major export markets including United Kingdom, Malaysia, India, Singapore and Sri Lanka (RIRDC 2008b). Australia produces approximately 140,000 tonnes of pears per year with the majority of production concentrated in Victoria (RIRDC 2009b). The major production areas for apple and pears in Australia are based in Queensland, New South Wales and southern Victoria with small production areas in the Adelaide Hills and Perth (Figure 5a) (Plant Health Australia 2010). Both apples and pears are considered self-infertile and require cross-pollination with another variety for the fruit to set (RIRDC 2008b). Honey bees as pollinators are known to be selective in the flowers they visit, as they choose flowers which best meet their energetic requirements (Abrol 1993). Apples are considered to be a highly attractive floral resource to honey bees however pears are not considered as attractive due to the low volume of nectar in pear flowers in conjunction with low sugar concentration (RIRDC 2009b). Due to pears being less favourable to honey bees, pear growers require greater hive density to ensure sufficient pollination and are charged higher rates due to honey losses.

There is a strong requirement of paid pollination services for apple and pear production (Figure 5b) with a small amount of pollination services believed to be completed by wild honey bees. Conversely, the peak industry body feels that a large amount of pollination occurs via wild honey bees, sometimes acting as the sole method of pollination. Some growers noted that the reliance on native bees varied year to year with large numbers sometimes observed in the crop. One grower believes that a large amount of pollination occurs incidentally due to hives located in a national park that is close to the property.

On average, the stocking rate of 6 hives per hectare is used for the pollination of apples and pears with the majority of hives (60%) sourced from within the same state as production (Figure 5c). There is increasing pressure for growers to produce fruit that is not only high in quality but also fits specific colour and shape requirements. These selective requirements means honey bees need to pollinate a high percentage of flowers to produce enough ideal fruit to be profitable for growers with over 40% of respondents feeling that their pollination requirements will increase because of this. The peak industry body also notes that acreage and orchard density is increasing in the apple and pear industry which will also increase pollination requirements. The dependence of the apple and pear industry on pollination by wild honey bees and commercially managed honey bees means that a Varroa mite incursion would have a significant impact on the industry (Figure 5d). Apple and pear growers believe a Varroa mite incursion will have a high impact on their industry as there are no viable pollination alternatives currently available and no current funding for research into this area.

Avocados

Represented by Avocados Australia

Varroa impact rating: HIGH

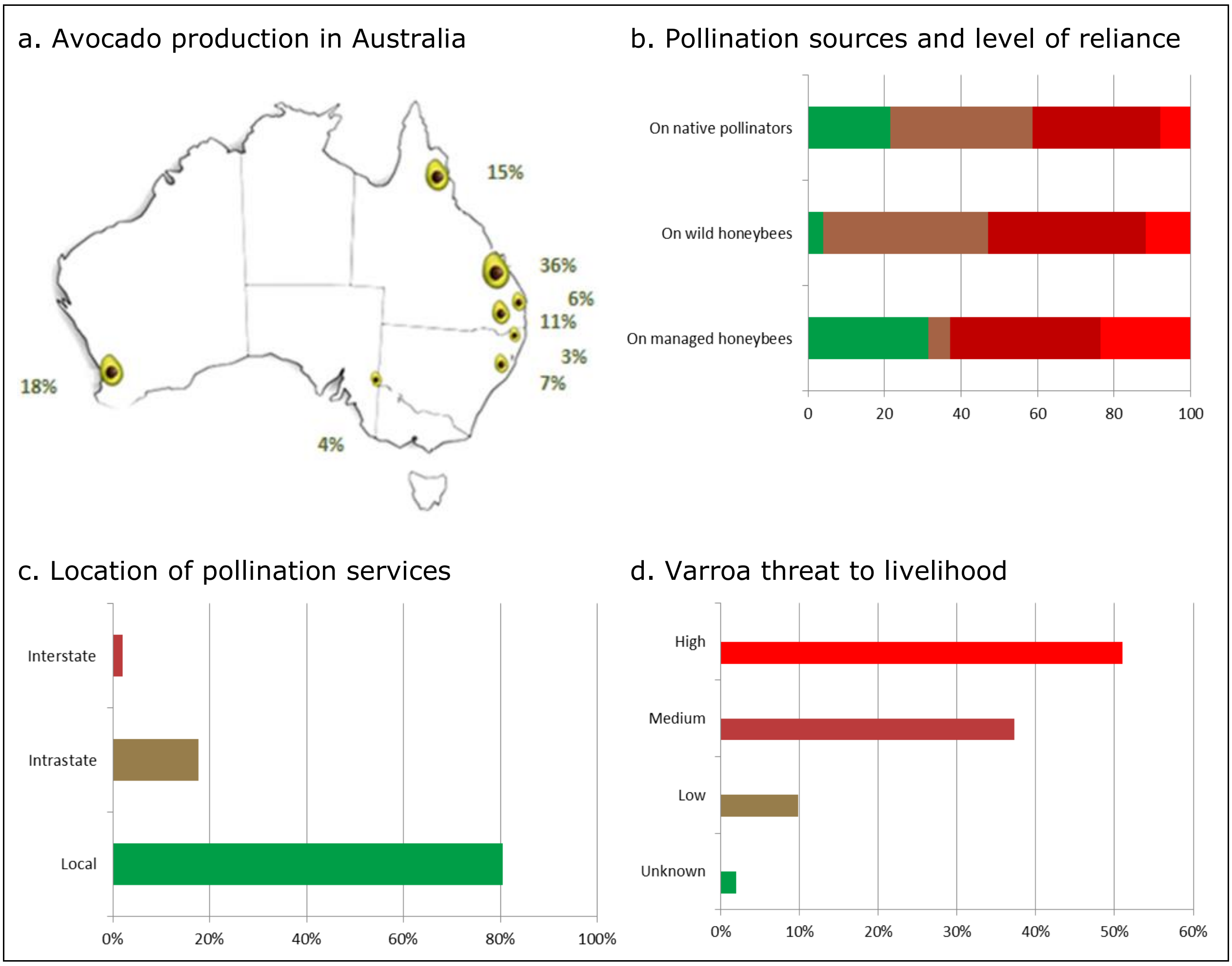

Figure 6 (a-d): Snapshot of the pollination dependence of the avocado industry (data from 51 growers)

The Australian avocado industry comprises of around 1,000 growers and several large corporate suppliers encompassing 6,900 hectares of avocado orchards (Plant Health Australia 2011a). Queensland dominates Australia’s avocado production with the north, central and south east of the state producing over half of the total 51,113 tonnes (Figure 6a) valued at $183 million. The key international markets that import Australian avocados are Singapore, Thailand, the United Arab Emirates and Hong Kong (Plant Health Australia 2012a). The yield of avocados is dependent upon insect pollination as avocados flower twice– the first functionally as a female flower and the following day functionally as a male flower (RIRDC 2009c). This also requires varieties/cultivars that flower at different times to be interplanted to allow for pollination to occur (Ish-am and Eisikowitch 1998).

The pollination of Australian avocados currently relies on a mixture of native bees, wild honey bees and commercial honey bees. While only 11% of growers rely exclusively on wild honey bees for the pollination of avocados, 41% report that over half of their pollination requirements can be attributed to this source (Figure 6b). Native bees and other insects such as hover flies and beetles are also present in avocado orchards and play a role in the pollination of avocado flowers. However, avocado growers still rely heavily on honey bee pollination services with 63% of growers using pollination services in high or medium quantities. There are also known cases of incidental pollination as some avocado growers allow beekeepers to use their orchards as a nectar resource to build up hives as well as providing a safe location for hive storage. Avocado growers that rely on this incidental pollination acknowledge that this form of pollination service will not always be available to them and they will need to invest in alternatives in the future.

Currently, the pollination of avocado crops is obtained from hives located within the same state and region as production (Figure 6c). If state borders were closed due to a Varroa mite incursion, the majority of growers believe they would still have access to the required amount of hives to pollinate crops at current levels. However there is an expectation that the production area of avocados (especially in South Australia) will increase which in turn will increase the pollination requirements. In the event of a Varroa mite incursion, avocado growers indicate that the reliance on native bees and other pollinating insects will increase to make up for the reductions in wild honey bee populations. There is also a belief that in the absence of wild honey bee populations, native bee colonies will increase and fill the pollination void. However, it should be noted that the arrival of European honey bees to Australia did not severely impact the population of native bee species indicating that the reverse of this would most likely be the same (Paton and RIRDC 1999). The threat of Varroa mite to the avocado industry is still considered high by over 50% of respondents (Figure 6d) even with the expected increase in the availability of native bees as pollinators. There has been no industry specific planning for Varroa mite with a large reliance still on the honey bee industry themselves to maintain bee health and biosecurity.

Cherries

Represented by Cherry Growers of Australia

Varroa impact rating: HIGH

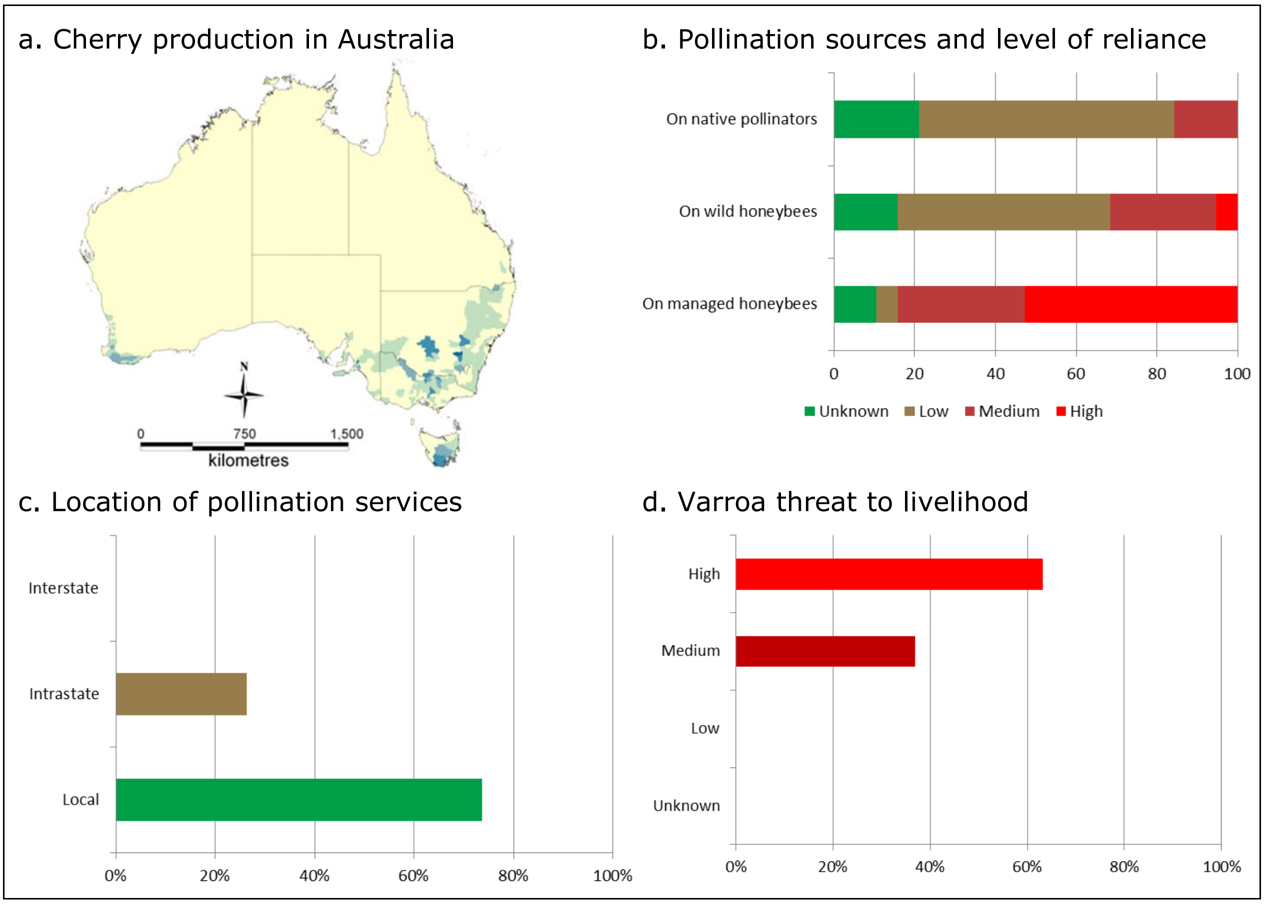

Figure 7 (a-d): Snapshot of the pollination dependence of the cherry industry (data from 19 growers)

The Australian cherry industry comprises of an estimated 575 growers producing cherries across almost 3,000 hectares (Plant Health Australia 2011b). Cherries are grown in all states and territories except the Northern Territory (Figure 7a) and is currently valued at approximately $120 million with the majority sold domestically (Plant Health Australia 2012a). Cross-pollination is required to ensure a satisfactory crop of cherries with studies showing that 97% of the pollinators that visit cherries are honey bees (RIRDC 2008c). This may be due to the fact that cherry blossoms occur too early in the year for other insect pollinators to be in high enough density to be adequate pollinators of cherry trees. Without effective pollination, cherries will only develop to the size of garden peas (Mcgregor and Bean 2009).

In general, wild honey bees account for a proportion of cherry blossom pollination yet over 50% of cherry growers depend entirely on commercial pollination services to pollinate their crop (Figure 7a). There was some response regarding reliance on bumble bees however, bumble bees were not considered in this report as they are only found in Tasmania.

All hives sourced for the pollination of cherry trees come from within the same state as production (Figure 7c) with pollination services averaging in costs of $130 per hive. The cherry industry is not expected to expand which indicates that there will be no increases in pollination requirements. However, there are expectations that pollination service prices will continue to increase as there are often more attractive flora for beekeepers during this period. This is because the hive densities required in cherry orchards means bees are unlikely to store any surplus honey. Some growers have started owning hives in a bid to overcome this problem of expensive pollination services. Overall Varroa mite is considered a high threat to the livelihood of cherry growers (Figure 7d) as cherries in Australia are directly dependent on honey bee pollination. There are currently no commercially available alternative pollination techniques available to the cherry industry and there is no industry specific Varroa mite incursion plan.


Melons

Represented by Australian Melon Association

Varroa impact rating: HIGH

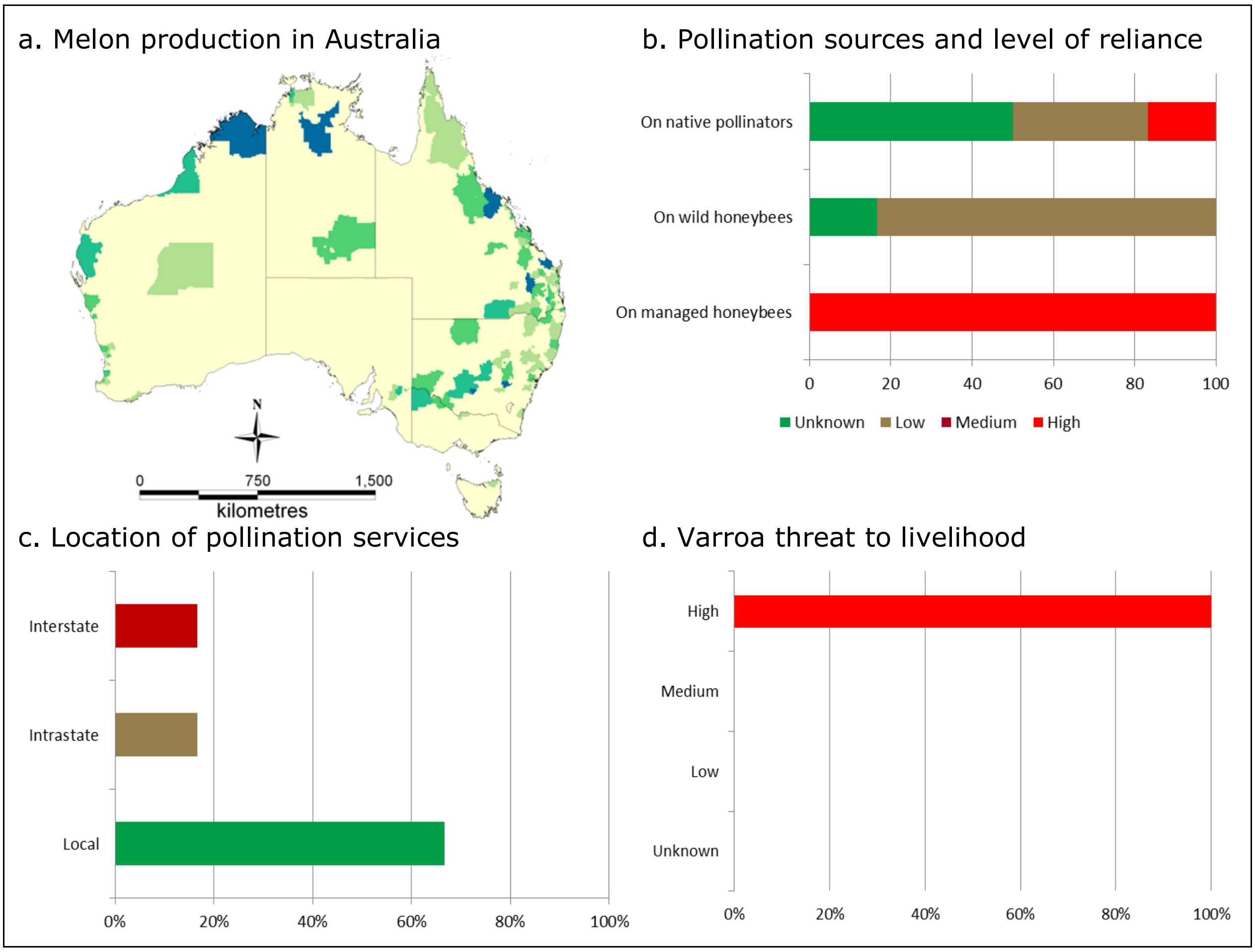

Figure 8 (a-d): Snapshot of the pollination dependence of the melon industry (data from 6 growers)

The Australian melon industry produces approximately 217,000 tonnes of melons annually across an area of around 8,500 hectares (Plant Health Australia 2012a). Melon production encompasses every state and territory except the ACT (Figure 8a) however around 50% of all Australian melons are grown in Queensland alone (RIRDC 2008d). The Australian melon industry is valued at approximately $150 million per annum and involves 400 growers who predominately produce watermelon, honeydew and rockmelon (Australian Melon Association Inc. 2008). The flowers of melons are exclusively pollinated by insects with honey bees recorded visiting melons at the peak flower opening times (Mcgregor and Bean 2009). Honey bees are critical for the transfer of pollen with studies indicating that little to no pollination occurs in melons without insect vectors (RIRDC 2008d).

Pollination services accounts for all the pollination needs of the melon industry with a slight contribution made by native bees (Figure 8a). The majority (74%) of commercial hives employed by the melon industry not only come from within the state requiring them but also from within the same region (Figure 8c). This local sourcing of hives indicates that if state borders were closed due to a Varroa mite incursion, melon growers would still have access to their required pollination services.

There are currently no viable alternatives to pollination for melons with seedless varieties still requiring vector pollination. Both the peak industry body and melon growers believe the threat of Varroa mite to the industry is high and could affect the livelihood and the ongoing viability of the industry (Figure 8d). There is currently no Varroa mite contingency planning conducted in the melon industry.


Stone fruit: apricots, peaches, nectarines and plums

Represented by Summerfruit, Canned fruit and Australian Prune Industry Association

Varroa impact rating: HIGH

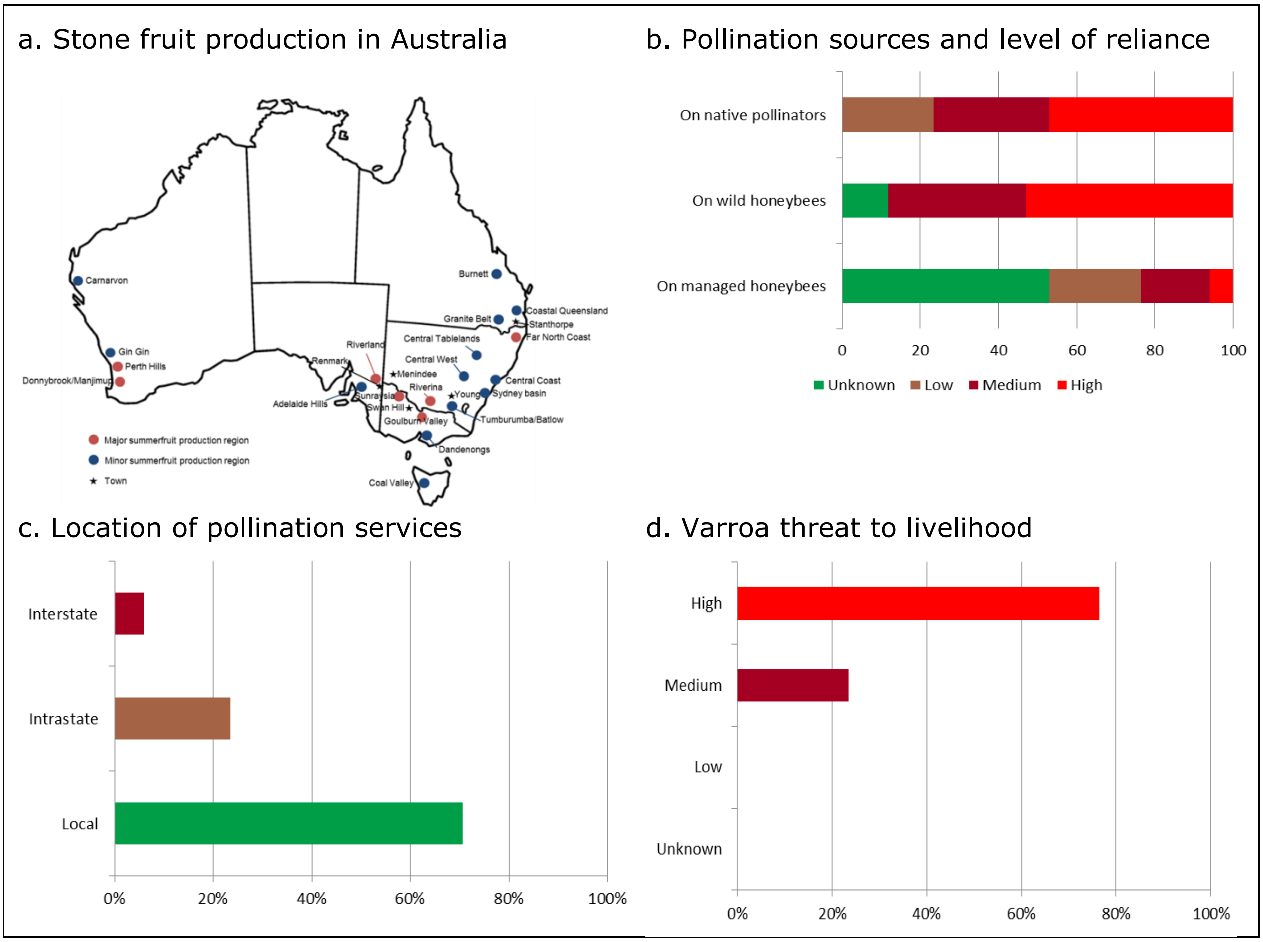

Figure 9 (a-d): Snapshot of pollination dependence of the stone fruit industry (data from 17 growers)

Fresh stone fruit is represented by the Summerfruit industry which is valued at around $300 million and produces 175,000 tonnes of fresh fruit per annum (Plant Health Australia 2012a). Stone fruit is predominantly grown in subtropical and temperate climates within Australia (Figure 9a) with the majority (72%) of produce coming from Victoria (Plant Health Australia 2011c). The Canned fruit industry is primarily based in the Goulburn-Murray Valleys of Victoria and has an annual farm gate value of $37 million (Plant Health Australia 2012a). There are around 70 farmers who grow plums to produce 5 tonnes of prunes annually and are found predominately in the temperate areas of Young and Griffith in New South Wales (RIRDC 2009d).

There is limited data on the pollination requirements of apricots, however it has been indicated that apricots must be cross-pollinated within the specific time of flowering which is often short and lasts less than two days (RIRDC 2008e). The sticky pollen of the apricot requires insect pollinators to carry out pollination as relying on wind as the primary pollinator is ineffective (Mcgregor and Bean 2009). The pollination dependence of peaches and nectarines varies due to the varieties available being either self-fertile or self-sterile. There is strong evidence however, that a satisfactory commercial crop cannot be obtained unless adequate numbers of insects pollinate the crop, regardless of variety (RIRDC 2009a). The flowers of peaches and nectarines are considered highly attractive to honey bees and are considered an easier crop to pollinate as only one ovule must be fertilised for fruit to form compared to hundreds of ovules needed in other fruits such as melons or papayas (Mcgregor and Bean 2009). Most variety of plums (including those dried into prunes) are self-incompatible and rely on honey bees to transfer pollen which has been documented to increase yield by 150% (compared to plums that had no insect vectors) (Mcgregor and Bean 2009). Honey bees have been recognised as the primary pollinating agent for plums since the early 1900s (RIRDC 2009d).

Half of the stone fruit growers believe wild honey bees are responsible for the pollination of their entire crop while over 40% believe their pollination requirements are met by native bees. Overall, only a small percentage (less than 6%) of growers were dependent on commercial pollination services (Figure 9b) which are located locally (Figure 9c). The future pollination requirements of the stone fruit industry is not uniform as only 30% expect an increase to their pollination requirements as they expand their production area. The prune industry is expected to actually decline in the next few years and therefore sees the current reliance on wild honey bees as economically viable. No growers managed any hives of their own and due to a lower dependence on pollination services, the majority of stone fruit growers feel they would be able to pollinate their crops sufficiently in the event of honey bee movement restrictions. However, due to the reliance on wild honey bees for pollination, any reductions in wild honey bee populations as a result of Varroa mite would have a great effect on all the stone fruit industries (Figure 9d). There is currently research being conducted into self-fertile varieties of stonefruit which may overcome the dependence of these industries on pollination.

Vegetables and vegetable seed

Represented by AUSVEG Limited

Varroa impact rating: MEDIUM/HIGH

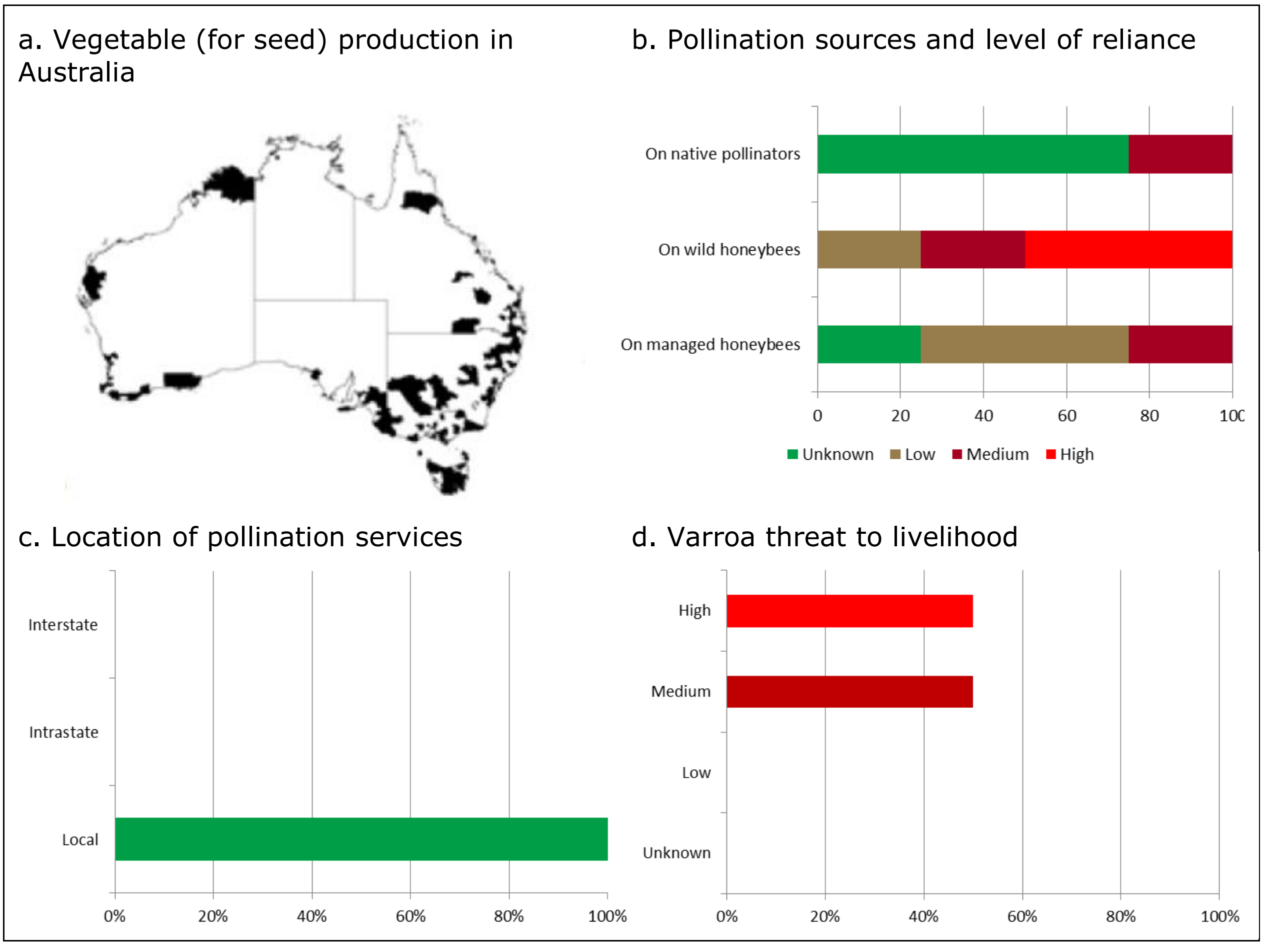

Figure 10 (a-d): Snapshot of pollination dependence of the vegetable for seed industry (data from 4 growers)

Vegetables are valued at $2.8 billion and are grown across Australia and largely sold for the domestic market (Plant Health Australia 2012a). Pollination is not essential for all crops represented by AUSVEG limited and is only required for cabbage (for seed), carrot (for seed), cauliflower (for seed), cucumber, pumpkins, potato (for seed) and zucchini. Pollination dependent vegetables and vegetable seed are grown in all states except the Northern Territory (Figure 10a). The pollination requirement varies depending on the vegetable, for example, cabbages and radishes require cross-pollination while others only require pollination to increase yield (RIRDC 2008f).

There was a strong reliance (50%) by vegetable growers on using wild honey bees to pollinate their crops. From the growers who completed the census, no one relied exclusively on paid pollination services (Figure 10b). The pollination services used in low-medium quantities were sourced locally (Figure 10c). The low reliance on pollination services can perhaps be attributed to vegetable growers owning and managing their own hives which was the practise of half the respondents. There are currently some alternatives to honey bee pollination available including the use of mechanical vibration and air blast pollination techniques. Yet neither of these options are as effective as honey bee pollination (Hanna 2004). The reliance of some vegetables growers on wild honey bees means that an incursion of Varroa mite in Australia would severely threaten the pollination of some vegetable corps. However, the overall effect on the entire vegetable industry would be minor, as only a sub-set of crops requires pollination.


Onion seed

Represented by Onions Australia

Varro impact rating: HIGH

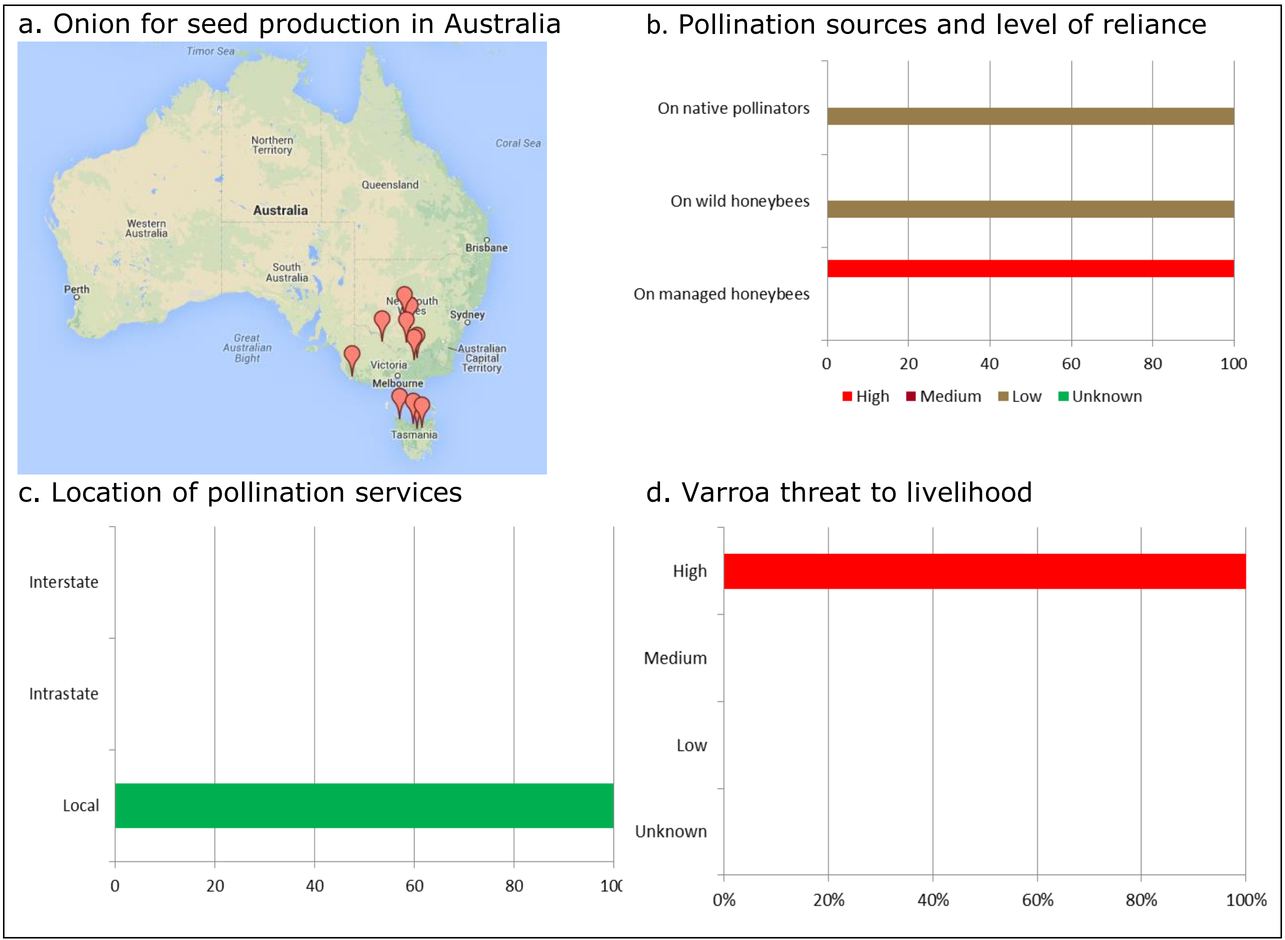

Figure 11: Snapshot of pollination dependence of the onion seed industry (data from peak industry body representative)

Onions in Australia are grown on 5,000 hectares with production reaching 250,000 tonnes (Plant Health Australia 2012a). Onions are the fourth largest vegetable crop in Australia with 248 growers with the major bulb production occurring in South Australia and Tasmania (Plant Health Australia 2012c). Onion production in Australia is valued at $274 million with exports accounting for $26 million (Plant Health Australia 2012a). When onions are planted for production, the plant is allowed to reach the proper size or condition before being harvested without pollination taking place and the plant produces no seeds (Mcgregor and Bean 2009). Onions that are grown for 'seed only' require pollination, with studies showing that the yield, quality and emergence rate of onion seed being significantly dependent upon pollination (RIRDC 2008f). In Australia, an estimated 400 hectares is used for onion seed production (Plant Health Australia 2012a) located in New South Wales, Victoria, South Australia and Tasmania (Figure 11). Self-pollination within onion flowers does not occur and therefore insect pollinators are required in high density to provide adequate pollination. Onions as a floral source are considered to be low in attractiveness to honey bees which limit the ability of growers to rely on native or wild honey bees as pollinators (Mcgregor and Bean 2009).

Unfortunately there were no grower responses to the census and all evaluation is based on the response on behalf of the peak industry body. All onion seed crops have hives supplied at flowering to ensure pollination, with all hives coming from within the region of production. The industry's pollination requirements are not expected to increase which means future expenditure on commercial pollination will depend exclusively on future hive costs. Very few industry members grow onion for seed crops with the majority of seed crop grown by seed companies. However, a Varroa mite incursion would severely impact the whole industry as onion seed crops provide seed for the industry to use in the production of onion as a crop.

Overall industry pollination dependence and Varroa mite preparedness

Pollination dependent industries do not have contingency plans available to mitigate the effects of Varroa mite on the availability of honey bees for pollination. This overall lack of preparedness could stem from a reliance on the honey bee industry to prepare for and respond to all bee pests and diseases and consistently maintain the availability of pollination services. However, as pollination dependent industries rely heavily on commercial pollination services to maintain adequate pollination of their crops this responsibility should be shared. This dependence necessitates the involvement of these industries in maintaining the health of wild and managed honey bees throughout Australia.

The distribution of hives around Australia varies to correspond with the levels of floral resources available for honey production and to meet the seasonal demand for pollination services. It is therefore not only hard to pinpoint their exact location at any time of the year but also difficult to predict future movements. The mobility of the beekeeping industry is an important factor to consider when planning ongoing access to seasonal nectar flows and to ensure pollination contracts can be fulfilled. Therefore, at the time of an incursion, previously used pollination services may not be available if pollination providers are restricted by state or regional quarantine controls. Figure 12 shows an example of the movement some hives undergo, with this particular beekeeper moving hives across states and multiple regions. The use of quarantine restrictions in the event of a Varroa mite incursion makes all pollination dependent industries vulnerable and could result in a significant reduction in the yield and quality of produce.

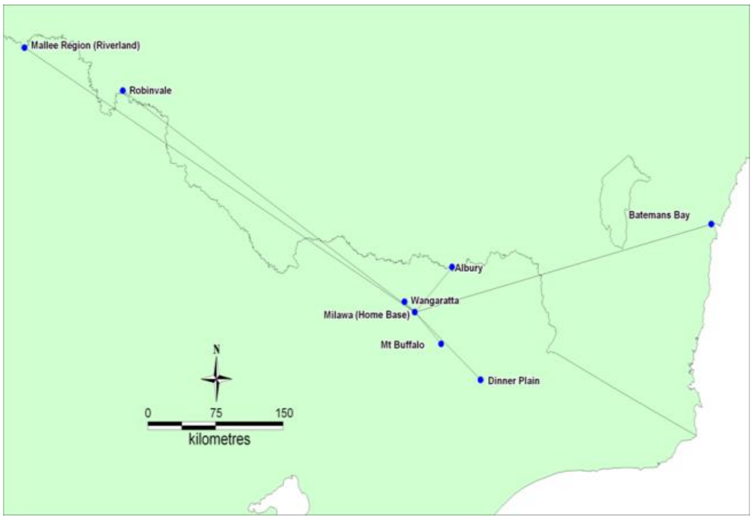

Figure 12: Movement of commercial hives by a Victorian beekeeper (Plant Health Australia 2009)

All industries projected some level of industry growth which would increase their pollination requirements. Participants also expected pollination costs to increase regardless of whether their requirements increased or not. The increase in costs is seen to be due to inflation and a monopolisation of the industry by a few key commercial pollination companies. The current costs associated with employing pollination services are already seen as a threat to the long term viability of industries. If Varroa mite were to enter Australia, these costs are expected to increase exponentially. There would be changes within the beekeeping industry to try and manage the ongoing effects of Varroa mite on honey bee health and numbers. These changes include increased management requirements to maintain healthy hives which would in turn make the job of beekeepers more labour intensive and costly. This would force beekeepers to pass on these increases in business costs to the grower employing their services. With Varroa mite expected to destroy 95% of the wild honey bee population, industries that have in the past managed without hiring any pollination services would have to employ commercial hives to maintain their current level of pollination. Due to many different crop types requiring pollination at similar times of the year, any increase in pollination requirements would also increase the amount of hives needed overall.

It is clear from the census responses that industries understand the important role that honey bees play in maintaining high levels of crop production and quality. Pollination dependent industries correlate the access and use of pollination providers to the viability of their industry; however there is currently limited investment from these industries towards protecting the honey bee industry. Through the census, only one respondent out of the total 156 questioned requested additional biosecurity practises from their pollination providers to ensure honey bee biosecurity was maintained.

With the potential impacts of Varroa mite well documented from past incursions overseas, research into alternative pollination techniques, selective plant breeding of self-fertilising plants and general honey bee biosecurity needs to be a priority for pollination dependent industries. Many industry R&D programs have to cover a wide variety of issues with limited funds which are usually allocated to pests that directly impact on crop health and production. This and the fact that wild honey bee numbers are strong and that pollination services are currently readily available may indicate the reason for absence of investment in this area. However, the overall lack of available alternatives to honey bee pollination means honey bee biosecurity and Varroa mite preparedness are crucial to the stability of all Australian pollination dependent industries.

Case study: New Zealand

Australia is in the unique position of being the only mainland continent to be free from Varroa mite which allows for useful insight into overseas experiences with Varroa mite. New Zealand has a large beekeeping sector and has had the most recent experience with dealing with Varroa mite. Varroa mite was first detected in New Zealand in 2000 with the initial delimiting survey finding more than 20% of apiaries were infected in areas surrounding Auckland international airport and more than 10% were infected in the upper North Island (Martin et al. 2005). The Ministry of Primary Industries imposed movement controls within defined zones and conducted targeted sampling. An epidemiology study of the response found infested apiaries were highly clustered which supported the theory of radial spread (Martin et al. 2005). Due to the density of infestation in certain areas the results suggested that Varroa mite had probably been present in New Zealand for a number of years prior to detection. It was concluded that national eradication of Varroa was unlikely to succeed due to the:

- Lack of sensitivity of the testing methods
- Inability to detect infected premises before local spread had occurred
- Inability to eradicate Varroa mite from wild honey bee colonies
- Spread via beekeeper assisted movements
- Potential non-compliance by beekeepers (Plant Health Australia 2013b).

The Ministry of Primary Industries implemented a management strategy which involved the North Island to be separated by 'North Island Line' to restrict movement south. The National Pest Management Strategy was developed with key elements such as the maintenance of movement controls, education on Varroa mite spread and continuation of the surveillance program of outlier Varroa mite incursions. The National Pest Management Strategy allowed for shifting management zone to be established and adjusted based on surveillance and mandatory reporting programs. In 2006 Varroa mite spread to the South Island which overtime led to the dismantling of the movement control lines as preventing the further spread of Varroa mite was unfeasible due to the number of beekeeping operations already affected.

Key lessons from the New Zealand experience:

- The New Zealand national beekeeper database held details of all registered hives and beekeepers which enabled authorities to accurately and quickly locate potentially infected hives and at-risk beekeepers
- The New Zealand beekeeping industry is largely stationary due to limited movement involved in accessing nectar flows – this meant that the North Island line was an effective means of slowing the spread of Varroa mite
- The effective implementation of the Varroa Management Programme through maintenance of movement controls and surveillance programs provided New Zealand the time to develop and provide education and communication material to the beekeepers (Plant Health Australia 2013b).

Since the introduction of Varroa mite to the North Island almost all feral colonies and at least 20% of the managed colonies have disappeared (Mark et al.). Pollination costs have increased from an average of $80 per hive in 2001 to an average of $150 per hive in 2012 for example, onions $150, avocados $115 and Summerfruit $120 per hive (Ministry of Agriculture and Forestry 2001; Ministry for Primary Industries 2012). In the 2011/2012 years, treatments for Varroa mite ranged from $24-25 per hive, however these costs are expected to increase as resistance to treatments spreads (Ministry for Primary Industries 2012). Currently pollination requirements are still being met however the numbers of hives currently available are not predicted to be sufficient by 2015. If the predicted reductions in hive numbers due to Varroa mite and reduced honey prices eventuate, this situation will be more critical. It is estimated there is likely to be a shortfall of 72,950 hives nationally by 2015 (Simpson 2003).

Conclusion and Recommendations

The importance of Australia remaining free from Varroa mite has not only been economically proven [with an estimated benefit of $50.5 million per year (Cook et al. 2007)] but also shown through the response of growers through this census. Data collected clearly shows that the work of both managed and wild honey bees as pollinators is vital to pollination dependent industries and determines their overall sustainability. This in turn makes pollination dependent industries incredibly vulnerable to the effects of a Varroa mite incursion.

The location and availability of hives are not consistent or guaranteed as shown in the 2009 pollination report. The confidence that industries have on the availability of hives within their state, based on the previous season's hive availability, highlights an ongoing susceptibility to the potential impacts of Varroa mite. These industries run the risk of losing access to commercial hives during state or regional quarantine restrictions if the hives are located outside these borders due to location of nectar flows or to fulfill other pollination contracts.

Recommendation 1	Encourage floral and nectar resources

Pollination dependent industries can encourage the work of native bees, wild honey bees and other pollination insects by planting bee friendly crops/refuges that can provide valuable nectar and pollen sources throughout the year. This is especially important for crops that are considered less desirable to bees and need high density of populations to ensure adequate pollination.

Recommendation 2	Manage own hives

There is also the option of smaller growers owning and operating their own hives to help supplement their pollination needs. However, owning hives takes a lot of experience, is labour intensive and should not be undertaken lightly. If this approach was to be undertaken, it should be encouraged that growers contact their local department of agriculture apiary officer for more information.

Recommendation 3	Growers use specialised pollination contracts

Growers should aid in maintaining the biosecurity of honey bees through the use of specialised pollination contracts that require pollination providers to only supply pest and disease free honey bees. A pollination contract employs basic best management practices for both the grower and the beekeeper. Some specific clauses in the contract can require hives to be inspected before they enter a new property which will allow, in the event of a Varroa mite incursion, a traceable system of the health status of honey bees.

Recommendation 4	Chemical registration for Varroa mite chemical controls

Some of the key lessons gained from the New Zealand experience are the need to have chemicals (Miticides) readily available and registered in Australia to use in the eradication of Varroa mite through emergency use permits. By having a proven chemical already pre-registered an incursion response can be conducted rapidly without the need to spend time on registration paperwork. Shelf registration of Miticides should be encouraged.

Recommendation 5	Continue commitments to the National Bee Pest Surveillance Program

Australia currently undertakes a National Bee Pest Surveillance Program that includes the use of sentinel hives, floral sweep netting, hobby beekeepers and remote surveillance hives to monitor bee pests and pest bees at high risk ports of entry into Australia. Continuing with surveillance at key entry points into Australia will help in the early detection of Varroa mite which will increase the possibility of eradication. The earlier a new pest can be detected the greater the chance that it will be restricted to a limited area which may determine the technical feasibility of eradication.

Recommendation 6	Encourage compulsory beekeeper registration

The registration of beekeepers needs to become compulsory in every state and territory so that bee biosecurity can be monitored and in the event of a Varroa mite incursion, at risk hives can be quickly and efficiently located to help slow the spread of Varroa mite. Unlike New Zealand, the hives in Australia are every mobile which may increase the rate of Varroa spread in Australia once an incursion has taken place.

Recommendation 7	Increased R&D into pollination programs and alternative pollination techniques

Pollination dependent crop industries need to address the current gap in R&D work into alternative pollination techniques and selective breeding of crops to minimise reliance on pollination vectors. Options for investigation include increasing the use of native bees, investing in mechanical pollination techniques or selectively breeding for certain pollination traits. This will become particularly critical when the costs of pollination services increase and may become an unviable option for some growers.

Investment should also be increased into pollination programs that will aid in maintaining pollination services through resistance breeding of honey bees and alternative Varroa mite control methods. Increased preparedness for an incursion of Varroa mite will provide a mechanism for industry and growers to understand how they can maintain the growth and stability of production when the status of honey bees as readily available pollinators is destabilised.

Recommendation 8	Closer working relationship with the pollination dependent industries and the honey bee industry to include business planning and contingency planning

The impending threat of Varroa mite on the livelihoods of pollination dependent industries and beekeepers themselves is severe and will impact on the production of horticulture in Australia. Pollination dependent industries and beekeepers need to work together to mitigate the risk of Varroa mite entering the country and introduce contingency plans on how to maintain effective pollination if Varroa mite becomes established. Both beekeepers and growers of pollination dependent crops should undergo business management training to further understand what the increased costs of Varroa mite management would mean for their businesses, and how to absorb these costs into their business.

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Appendices

Appendix 1: Pollination Census: Peak Industry Body

1. Please indicate the peak industry body that you are representing: Almond Board of Australia Apple and Pear Australia Ltd Avocados Australia Ltd AUSVEG Limited Canned Fruit Industry Council of Australia Cherry Growers Australia Inc. The Australian Prune Industry Association Inc. Australia Melon Association Inc. Summerfruit Australia Limited Onions Australia
2. In which states and territories does your industry's production occur?
3. How would you describe the reliance of your industry on wild bees (European honey bees that are not managed by a beekeeper and live wild in the environment) for pollination services? a) High (wild bees account for all pollination needs of the industry) b) Medium (wild bees account for about half of the pollination needs of the industry) c) Low (wild bees may account for a minor amount of pollination needs for the industry) d) Unknown Comments:
4. How would you describe the reliance of your industry on native bees (bee species found naturally in Australia, not of the *Apis* genera) for pollination services? a) High (native bees account for all pollination needs of the industry) b) Medium (native bees account for about half of the pollination need of the industry) c) Low (native bees may account for a minor amount of pollination needs for the industry) d) Unknown Comments:
5. What proportion of pollination services employed by your industry is located in a different state to where production occurs? a) 100% (all hired hives are located outside the state where production occurs) b) 75% c) 50% d) 25% e) None (all hired hives are located in the same state as production) Comments:
6. If hives were restricted within state and territory borders, would your industry struggle to maintain access to existing levels of pollination services?

a) Yes b) No c) Unsure Comments:
7. Do you predict an increase in your industry's pollination requirements (e.g. from industry expansion)? Why?
8. Do you predict an increase in your industry's expenditure on pollination services in the next 5 years? Why?
9. In the event of a Varroa incursion where there is a major loss of wild bee colonies and managed hives, what alternative pollination techniques can your industry employ?
10. Does your industry fund any research into alternative pollination techniques?
11. What kind of information do you provide to growers on pollination options and alternatives to honey bee pollination?
12. What biosecurity practises does your industry request of hired pollination services to deter bee pest and diseases?
13. What level of impact would exotic pests of honey bees such as Varroa mite have on your industry's production? a) High (severe impact on production will occur) b) Medium (significant impact on production will occur) c) Low (minor impact on production will occur) d) Unknown (the potential impact is unknown) Comments:
14. Has your industry been involved in any specific Varroa incursion or pollination planning between growing regions? If yes, please specify.

Appendix 2: Pollination Census: Grower

1. What peak industry body best represents your crop? Almond Board of Australia Apple and Pear Australia Ltd Avocados Australia Ltd AUSVEG Limited Canned Fruit Industry Council of Australia Cherry Growers Australia Inc. The Australian Prune Industry Association Inc. Australia Melon Association Inc. Summerfruit Australia Limited Onions Australia
2. Please provide the following information about your farm: a) Postcode: b) Suburb/Town c) State d) Size (hectares) of each crop
3. How would you describe your reliance on wild bees (European honey bees that are not managed by a beekeeper and live wild in the environment) for pollination of your crops? a) High (wild bees account for all your pollination needs) b) Medium (wild bees account for about half of your pollination needs) c) Low (wild bees may account for a minor amount of your pollination needs) d) Unknown Comments:
4. How would you describe your reliance on native bees (bee species found naturally in Australia, not of the *Apis* genera) for pollination of your crops? a) High (native bees account for all your pollination) b) Medium (native bees account for about half of your pollination needs) c) Low (native bees may account for a minor amount of your pollination needs) d) Unknown Comments:
5. How would you describe your reliance on pollination services to pollinate your crops? a) High (100% all pollination comes from pollination services) b) Medium (around 50% of bee pollination comes from pollination services) c) Low (less then25% of bee pollination comes from pollination services) e) None (you employ no pollination services for your crops) Comments:
6. What stocking rate (per hectare) of hives do you use?
7. Where does your pollination service provide its hives from?

a) Within your region b) Within your state c) Out of state Comments:
8. What do you currently pay for pollination services (per hive) and do you expect an increase in this cost over the next 5 years? Why?
9. Will your pollination requirements increase (i.e. from increase in production area or increase in pollination dependent crops)? Why?
10. Do you manage any hives, if so how many?
11. If hives were restricted within state and territory borders, would you be able to pollinate your crops at existing levels?
12. In the event of a Varroa incursion where there is a major loss of wild bee colonies and managed hives, what alternative pollination techniques can you employ?
13. What level do you consider exotic pests of honey bees such as Varroa mite, a threat to your livelihood? a) High (threats to honey bees will have a direct and severe impact on my production) b) Medium (threats to honey bees will have a significant impact on my production) c) Low (threats to honey bees will have a minor effect on my production) d) None (threats to be honey bees will have no effect on my production) Comments:
14. What biosecurity practises do you request of hired pollination services to deter bee pest and diseases?

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WORKSHOP
acari

WORKSHOP REPORT

Workshop Acari

11-12 June 2014

Kathy Keatley Garvey, UC Davis Department of Agriculture

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About the report

The Report for Workshop Acari was authored by Plant Health Australia (PHA) with contributions from the planning committee[1]. The purpose of this report is to provide a summary of activities and a critical analysis of the outcomes and learnings.

The recommendations presented in the report were developed by the authors with the intent of providing direction on potential approaches to implement the learnings of the exercise. These recommendations have not been endorsed by all relevant stakeholders. Nonetheless, PHA will work with its members with the intent of implementing the recommendations, where appropriate.

Any feedback or questions in relation to this report, or the Workshop Acari activities and outcomes can be directed to PHA through the details below.

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[1] Refer to Appendix 4.1 for details on the planning committee.

Executive summary

Workshop Acari investigated preparedness and response options for the honeybee and pollination-dependent industries, primarily almonds, for a potential Varroa mite (*Varroa destructor*) incursion in Australia utilising a simulated scenario where the pest is detected in Melbourne. The workshop was delivered as part of the "*Model for industry planning and preparedness for an incursion of Varroa mite*" project funded by Horticulture Australia Limited[2] (HAL) and was conducted on the 11th and 12th of June 2014 in Mildura with 32 participants representing ten PHA member organisations.

Through a combination of research presentations and discussion exercises, Workshop Acari achieved its aim and objectives, and generated the following key outcomes:

- Restricting the movement of managed honey bee hives is an effective tool for limiting the spread of Varroa mite following its detection, but this approach can threaten production in a range of crops through the inability to access adequate hives to achieve full pollination. Key aspects in managing this risk include rapid and transparent decision making regarding the implementation and review of movement restrictions, together with clear communications to affected stakeholders.
- Australia's Varroa mite early detection surveillance program is a critical preparedness activity, benefiting the honey bee and pollination dependent industries. There is an opportunity to review the current program to identify aspects that limit its effectiveness.
- Broadening surveillance to formally engage growers and bee keepers provides an opportunity to significantly increase detection sensitivity without significant increases in required resources.
- Changes in pollination practices can limit the impact of Varroa mite on honey bees and the ability to achieve satisfactory pollination.
- Current Varroa mite preparedness activities are focused on the honey bee industry, leading to an opportunity for pollination-dependent industries to better engage and ensure collaborative approaches are implemented across the honey bee, agricultural and horticultural sectors.
- There are identified gaps to the provision of Owner Reimbursement Costs (ORCs) to all affected stakeholders in a Varroa mite response.
- Underpinning communication messages relating to Varroa mite are consistent across production sectors.

In consideration of the outcomes from Workshop Acari, six recommendations have been developed (Table 1).

Table 1. Summary of recommendations from Workshop Acari[3]

Recommendation 1	All beneficiaries of the National Bee Pest Surveillance Program to contribute to the implementation of the program
Recommendation 2	Undertake a review of the National Bee Pest Surveillance Program to ensure its resources are being implemented effectively
Recommendation 3	Document Varroa mite response options from the almond industry perspective
Recommendation 4	Prioritise Varroa mite preparedness research funding to address identified gaps
Recommendation 5	Develop a training plan for Affected Parties in a Varroa mite response
Recommendation 6	Finalise the ORC Evidence Framework for the Almond Industry

[2] Now Horticulture Innovation Australia Limited

[3] Additional explanation of the recommendations is provided in Section 3.

Image courtesy of Trevor Monson, Australian Pollination Services

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Acronyms

ABA	Almond Board of Australia
AHB	Asian Honey Bee
AHBIC	Australian Honey Bee Industry Council
CCEPP	Consultative Committee on Emergency Plant Pests
DAFWA	Department of Agriculture and Food, Western Australia
EADRA	Emergency Animal Disease Response Agreement
EHB	European Honey Bee
EPP	Emergency Plant Pests
EPPRD	Emergency Plant Pest Response Deed
HAL	Horticulture Australia Limited
HPP	High Priority Pest
IBP	Industry Biosecurity Plan
ILC	Industry Liaison Coordinator
ILO	Industry Liaison Officer
IP	Infected Premises
NMG	National Management Group
NSW DPI	New South Wales Department of Primary Industries
NZ	New Zealand
ORC	Owner Reimbursement Costs
PHA	Plant Health Australia
PIRSA	Primary Industries and Regions, South Australia
RIRDC	Rural Industries Research and Development Corporation
Vic DEPI	Victorian Department of Environment and Primary Industries[4]

[4] Now Victorian Department of Economic Development, Jobs, Resources and Transport

1 Workshop overview

1.1 Background

Over 65% of the horticultural and agricultural crops produced in Australia are pollination-dependent, relying on commercial European honey bee (*Apis mellifera*)[5] pollination services or the large wild honey bee populations[6]. This reliance poses a threat to crop production should a serious exotic pest that impacts on honey bees, such as Varroa mite, become established in Australia.

Varroa mites are external parasites that feed on the haemolymph of drone, worker, larvae, pupae and adult bees. This feeding weakens the bees, shortens their lives, and makes them more susceptible to viruses that otherwise would cause little harm. Without external management, infested colonies will slowly decline until all honey bees are dead[7].

Australia is the only major beekeeping country to remain free from Varroa mite, and our honey bee and pollination-dependent industries are investing in biosecurity activities to ensure this remains the case. However, they are also investigating options for mitigating the impact should it arrive and becomes established.

As part of these preparedness activities, Workshop Acari provided representatives from the almond and honey bee industries, together with government representatives, the opportunity to explore the issues arising from the early stages of a Varroa mite incursion, particularly focusing on the likely imposed movement restrictions and their impact on access to pollination services.

1.2 Aim and objectives

The design of Workshop Acari was based on the agreed aim and objectives as outlined in Table 2.

Table 2. Workshop Acari aim and objectives

Aim	To encourage the almond industry (and other pollination-dependent industries) to prepare for, and mitigate the effect of, a Varroa mite incursion on their business continuity and to encourage future planning between pollination providers and pollination-dependent industries to ensure ongoing honey bee biosecurity
Objectives	1. Test the ability of the almond industry to minimise the impact of possible movement restrictions as a consequence of emergency response actions. 2. Improve the awareness of pollination dependent industries on the current research on Varroa mite management and alternative pollination techniques. 3. Identify the role that pollination-dependent industries can provide to support honey bee biosecurity. 4. Identify recommendations for future contingency planning activities to be undertaken by pollination dependent industries in relation to maintaining their business continuity during a Varroa mite emergency response.

1.3 Planning

The planning of Workshop Acari was overseen by a planning committee (Appendix 4.1) comprising of members from Plant Health Australia (PHA), Almond Board of Australia (ABA), Rural Industries Research and Development Corporation (RIRDC), HAL, an independent pollination provider, New South Wales Department of Primary Industries (NSW DPI), Victorian Department of Environment and Primary Industries (Vic DEPI) and

[5] Herein referred to as “honey bees”.

[6] *Varroa Mite Preparedness of Pollination Dependent Industries*, a report prepared by PHA within the same project as Workshop Acari.

[7] Goodwin M and Taylor M (2007) Control of Varroa – A guide for New Zealand Beekeepers, New Zealand Ministry of Agriculture and Forestry.

the Australian Government Department of Agriculture. The planning committee developed the workshop aim, objectives, scope, activity structure and scenario. The activities and inputs were developed by PHA with technical contributions received from Vic DEPI.

1.4 Participating organisations

The participants included representatives from the almond industry, honey bee industry and government bodies. A full list of participants is outlined in Appendix 4.2.

1.5 Overview of workshop activities

The two day workshop was structured to include a variety of key note speakers and simulation activities (Table 3). For the simulation activities, participants worked together in groups of 6 to 8 people, with outcomes presented to the entire workshop for discussion. Participants worked together to compile overarching outcomes and future recommendations. A summary of the key points in each presentation is provided in Appendix 4.3.

Table 3. Summary of the presentations and simulation activities delivered at Workshop Acari

Session	Day 1 – 11th June 2014	Day 2 – 12th June 2014
Morning	Presentations: • Introduction and background (Ashley Zamek) • New Zealand experience with Varroa mite (Mark Goodwin) • Complexities of Australian beekeeping (Trevor Monson)	Presentations: • Owner Reimbursement Costs (Sophie Peterson) • Impacts of Varroa mite on crop pollination (Saul Cunningham)
Afternoon	Simulation activities: • Emergency response course of action • Industry representation and involvement • Effects of a hive standstill on pollination services	Simulation activities: • Development of key messages • Drafting of communications material • Identification of top impacts • Identification of top priorities

1.6 Workshop management and evaluation

The conduct of the workshop was managed by PHA, who were responsible for facilitating the workshop and group activities, together with monitoring the workshop activities to ensure the objectives were met.

Participant feedback forms and informal debriefing activities were used by PHA to evaluate the workshop against the aim and objectives, with a summary of the participant feedback provided in Appendix 4.4. Independent evaluation was considered, with the Planning Committee agreeing that it was not required due to the size of the workshop and no identifiable benefit from undertaking this role.

1.7 Scenario summary

The scenario for the workshop simulation activities was based around a fictional detection of Varroa mite in hives at two locations at the Port of Melbourne (Figure 1). This location was selected as it has been identified as a high risk entry site for the arrival of Varroa mite into Australia[8].

[8] Risk assessment of ports for bee pests and pest bees (2013) RIRDC. More information can be obtained from **www.rirdc.gov.au**.

In this scenario the initial detection was made as part of the National Bee Pest Surveillance Program and resulted in the implementation of response activities and movement restrictions for hives, beekeeping equipment and bees (Figure 2).

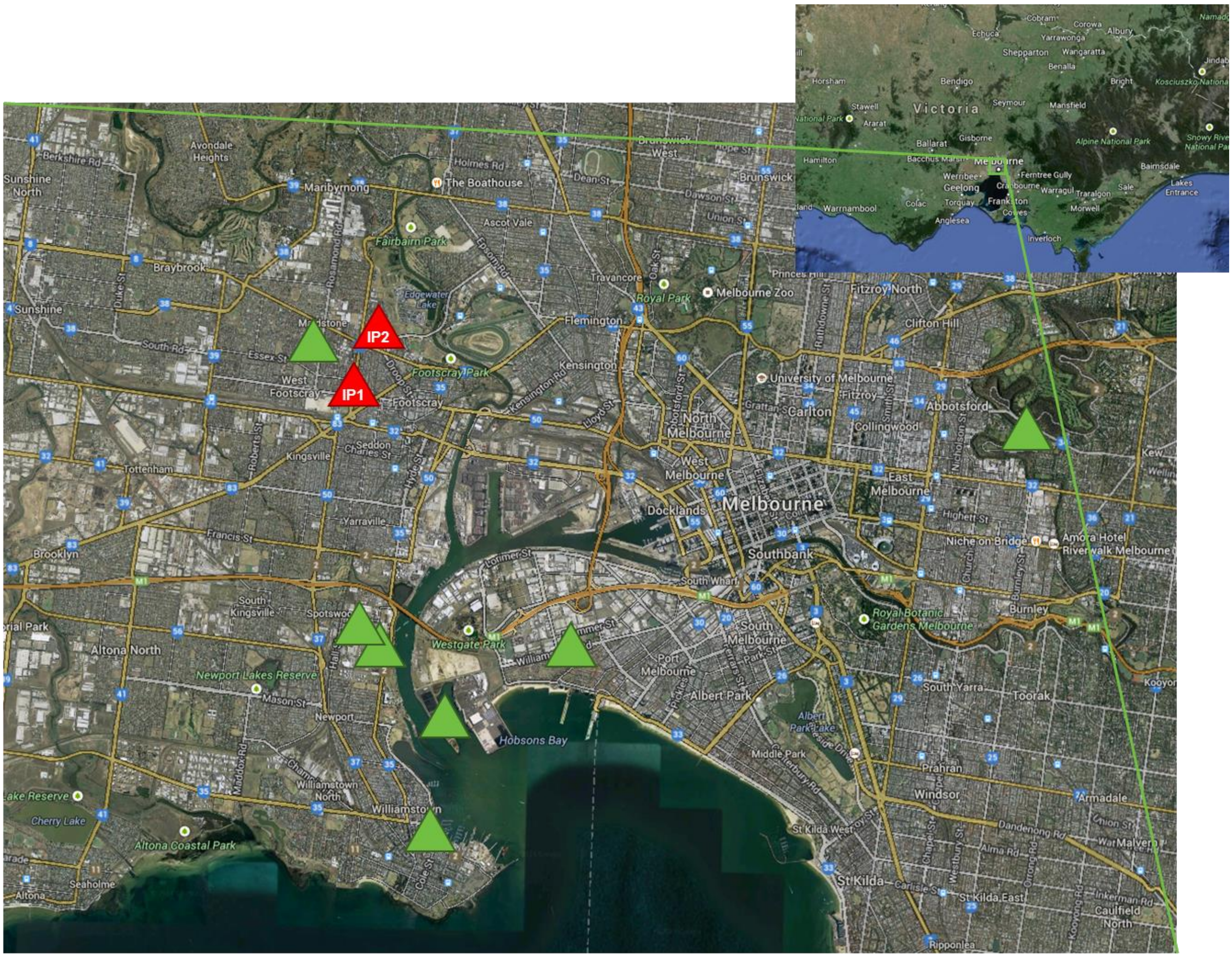

Figure 1. Location of the Varroa mite detections in the Workshop Acari scenario. Sentinel hives are located at the Port of Melbourne (green triangles), including the initial detection occurred (IP1, red triangle). The subsequent detection (IP2, red triangle) was located in a suburban backyard.

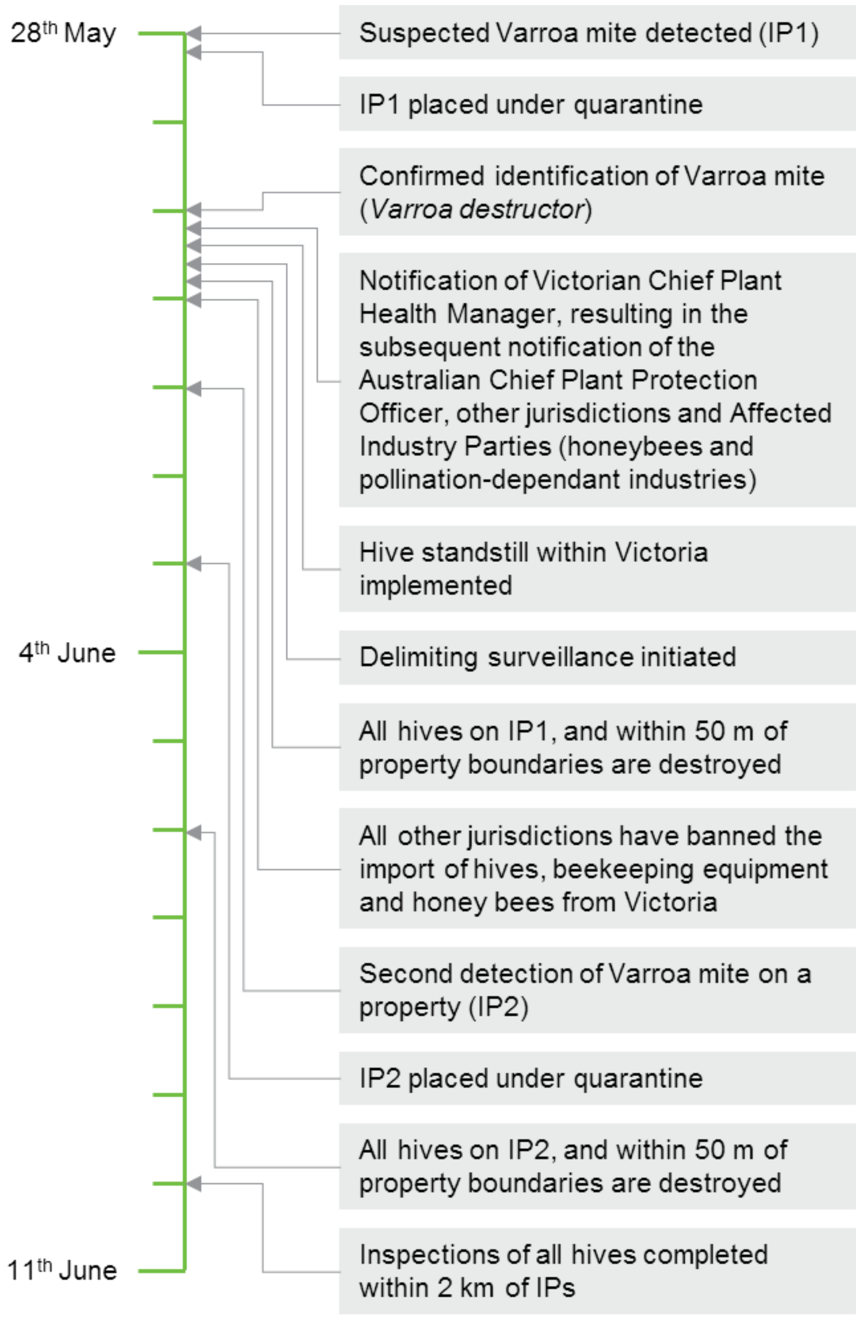

Figure 2. Workshop Acari scenario timeline

2 Analysis of workshop activities

2.1 Overview

Four key themes were identified based on the Workshop Acari structure, discussions and outcomes, and are used for grouping the analysis of workshop activities in this report. These themes are:

1. The impact of movement restrictions (page 12).
2. Varroa mite control and pollination alternatives (page 15).
3. The role of pollination-dependent industries in honey bee biosecurity (page 18).
4. Grower and beekeeper engagement (page 20).

Under each theme, a summary of the workshop activities and discussions are presented, together with the outcomes identified by participants. Throughout the summaries and identified outcomes, key points are highlighted in break out boxes to the right hand side.

Workshopping communication strategies to support a Varroa mite response.

2.2 The impact of movement restrictions

2.2.1 Summary of activities and discussions

Australia's unique beekeeping industry

Beekeeping in Australia is nomadic and locations vary year to year.

Australia's beekeeping industry is nomadic in nature, making it unique among major beekeeping countries. This is driven by our large geographic size, the inconsistencies of environmental conditions leading to an unpredictability in the location of quality floral resources for honey bee feeding, and the distribution of horticultural and agricultural industries requiring pollination services.

To highlight the hive movements seen in the industry, a real life example was presented where in a single year 1,500 hives were transported from the south coast of NSW, to Robinvale in Victoria and then up to Queensland through a total of eight separate movement events.

As a result of the nomadic and unpredictable nature of beekeeping, there are significant difficulties in predicting the location of hives at any given time point. For example, in 2009 the Batemans Bay region of NSW had an unusually high amount of hives in the area from May to July due to the local spotted gums flowering at an uncharacteristically higher rate[9]. In the following years, this flowering event was not repeated hence there was only a small number of hives needed in this region.

Accessing hives for pollination under movement restrictions

Hive movement restrictions are a likely response approach following a Varroa mite detection.

Hive movement restrictions would have a direct impact on the production of crops.

Pollination services provided to horticultural and agricultural industries may be sourced from outside the local area, aligning with the nomadic nature of the beekeeping industry described above. Therefore, should any level of movement restrictions be implemented for hives as a result of a Varroa mite detection, there is the potential for significant impacts on crop production. Outcomes from the activities held in Workshop Acari resulted in a realistic response approach, being that all states and territories closed their borders to hives from Victoria, and a state-wide hive standstill was implemented.

While some industries source the majority of their pollination contracts locally, there are a number, such as almonds and pomefruit, which identified that more than 70% of the pollination contracts are sourced from outside the local area[6]. Taken together with the limited timeframes for pollination (one or two months for most crops), the implementation of hive movement restrictions is likely to have a direct impact on crop productivity through loss of pollination.

Further, the variability of hive locations throughout and between years, means that the development of contingency strategies to respond to the application of movement restrictions will be difficult.

[9] Collection of data and information about pollination-dependent agricultural industries and the pollination providers (2009) Department of Agriculture, Fisheries and Forestry.

Hive standstills

Hive standstills are supported as an effective containment response for Varroa mite.

The implementation of a hive standstill in the event of a Varroa mite incursion is a documented response policy in some jurisdictions and would be a potential following any detection of Varroa mite in Australia. Hive standstills are an effective approach to limiting the spread of the pest, and participants supported this method of containment under the Workshop Acari scenario.

The impact of a hive standstill is dependent on its timing, with each pollination-dependent crop having a defined window for pollination[9]. The Workshop Acari scenario was identified as having limited impact on almond pollination due to the May-June timeframe, but any delay in removing the hive standstill and it continuing into July would see immediate impacts on the production of almonds for that season.

Owner Reimbursement Costs

ORCs do not cover pollination providers for loss of pollination contracts.

Almond crop ownership arrangements may limit growers' access to ORCs.

The implementation of an agreed Response Plan to eradicate Emergency Plant Pests[10] (EPPs) is likely to result in a financial loss to the owners of crops or honey bees. To encourage the reporting of suspect EPPs, the Emergency Plant Pest Response Deed (EPPRD) allows the provision of ORC to owners impacted in this way.

ORC provided a focus for discussions during Workshop Acari, with participants highlighting the benefits of having them in place, but noted two areas that require further investigation:

1. ORCs are potentially available to owners of pollination-dependent crops due to the unavailability of pollination services. However, the pollination service providers are not eligible for ORCs to cover the loss of income from not fulfilling pollination contracts.
2. The ownership arrangements for almond production can be complex, where a significant proportion of the almond trees in production are owned by investors, not the growers. These arrangements may impact on grower's ability to be defined as an Owner[11] under the EPPRD, which would impact on their eligibility for ORC.

[10] Definition of an Emergency Plant Pest can be found in the EPPRD (**www.planthealthaustralia.com.au/EPPRD**).

[11] Clause 1.1 of the EPPRD (**www.planthealthaustralia.com.au/EPPRD**).

2.2.2 Outcomes identified

The implementation of movement restrictions and a state-wide hive standstill were supported by participants as a response approach to a Varroa mite detection. However, the significant impacts on pollination-dependent industries were identified and two key polices for the implementation of hive standstills were proposed to limit this impact:

- Defining the timeframe of the hive standstill at implementation, followed by undertaking regular reviews of the operational need for it to remain in place. The intent of this is to ensure the standstill is only in place when necessary. Regular reviews will also provide comfort to growers in the knowledge that the hive standstill will not be permanent.
- Enabling the transition into a more localised hive standstill through intense delimitating surveillance to identify the highest risk area while allowing pollination-dependent industries outside of this smaller area to access pollination services.

Limit the impact to pollination-dependent industries through the regular review of hive standstills.

Furthermore, alternative operational approaches were proposed through the workshop discussions that have the potential to effectively restrict Varroa mite distribution together with limiting the impact on pollination-dependent industries:

- Regionalisation of restricted areas in contrast to a state-wide hive standstill, to allow access to pollination services from known safe areas.
- Allowing the import and direct transportation of hives from interstate to almond production areas to complete the required pollination services. Once onsite, imported hives would not leave the area, either remaining on site and managed or destroyed.
- Pollination-dependent industries always have the option to manage their own hives on site, or at least locally, to ensure there is a local source of bees at all times. However, this may not be viable to all growers due to the costs and labour requirements of owning and managing hives.

Alternative approaches that limit the impact of movement restrictions on pollination-dependent industries should be explored.

To facilitate these proposals, there is a substantial importance placed on swift decision making during the response, particularly through the Consultative Committee on Emergency Plant Pests (CCEPP) and the National Management Group (NMG). As an Affected Industry Party, ABA acknowledged it should play a major role in driving these decisions.

Swift decision making is required at CCEPP and NMG.

Developing the ORC Evidence Framework for the Almond Industry will provide the appropriate platform for investigating the options relating to almond ownership in relation to reimbursement payments.

Complete the almond ORC Evidence Framework.

2.3 Varroa mite control and pollination alternatives

2.3.1 Summary of activities and discussions

Varroa mite in New Zealand

Establishment of Varroa mite causes a significant increase in pollination service costs.

Varroa mite was first detected in New Zealand in 2000, and despite an eradication response, the pest is now established. Beekeepers must maintain good hive hygiene to minimise the impact of Varroa mite and allow them to continue producing honey and beeswax, and provide pollination services. While beekeepers are able to continue to provide these services, the increased input costs have resulted in the average fee for pollination double in comparison to prior to Varroa mite establishment. A similar increase in pollination service costs can be reasonably expected to occur in Australia if Varroa mite was to become established.

Miticide-resistant Varroa mites are a developing issue.

In combination with good hive hygiene approaches, miticides are utilised to reduce the Varroa mite numbers in managed hives. While this is an effective management technique, there is developing miticide-resistance being detected in New Zealand. It is thought that the resistance is being driven by the use of miticide (i.e. active ingredient) concentrations that are below the recommended dose together with the failure to replace miticide stripes at the recommended times.

This developing resistance has the potential to not only impact on New Zealand's beekeepers, but translates into an increased risk to Australian industries. The early detection system for Varroa mite in Australia relies on miticide strips in sentinel hives. Should the source of an incursion in Australia be a miticide-resistant population from New Zealand, it is likely that the National Bee Pest Surveillance Program will not effectively detect their presence. This delay to detecting the mite could have a significant impact on the ability of Australia to eradicate the pest.

A model for Varroa mite response and management

Australia can learn from overseas experience with Varroa mite.

No Varroa mite eradication response has been successful to date, but there are valuable lessons to be learned from past attempts. Through presentations to the workshop, participants were encouraged to engage with experts from countries dealing with Varroa mite to build on their knowledge specifically in the areas of the restriction of Varroa mite spread and the successful management following establishment.

Surveillance for early detection

The sensitivity of Australia's Varroa mite early detection surveillance should be assessed.

The workshop participants highlighted the need to review the National Bee Pest Surveillance Program to ensure it meets the early detection needs of Australia's industries. The need for a review became apparent due to the potential detrimental effects of miticide-resistance on surveillance sensitivity, in combination with the comparatively small number of hives in place. For example, there are approximately 140 hives deployed under the National Bee Pest Surveillance Program, where the surveillance program implemented to detect a Varroa mite incursion on the South Island of New Zealand utilised approximately 20,000 hives.

Pollination method effectiveness and alternatives

If Varroa mite was to enter and become established in Australia, the estimated cost would be an average of $30 million a year for the next 30 years[12], primarily through the loss of pollination services. To mitigate this impact, the honey bee and pollination-dependent industries are proactive in funding and undertaking research into alternative pollination techniques and improvements on current practices.

Managed honey bee hive placement throughout an almond grove has a substantial impact on the effectiveness of the pollination service provided. Current practice is using 6-7 hives per hectare, placing them in large placements of approximately 120 hives that are 500 m apart. In the event of Varroa mite establishment there would be a drive to reduce hive numbers due to availability and cost. To enable this, trials have demonstrated the same fruit set percentage can be reached in almonds by using only 4 hives per hectare. To achieve this, hives need to be placed with approximately 15 hives per placement, with each placement being about 200 m apart.

Hive densities can be reduced through alternative placements in almond groves.

Improvements to current honey bee pollination practices can improve efficiencies, but in some scenarios almond producers may have no access to managed honey bees. In these instances, the options for pollination are the use of mechanical pollination or self-fertile varieties, neither of which are viable for almonds at this time.

Mechanical pollination is highly effective in almonds, with over half of the flowers converted to nuts (higher than honey bee pollination). The down side is the intensive labour requirements, resulting in extreme input costs that mean that mechanical pollination is only viable to supplement low hive numbers, not as a standalone option.

Mechanical pollination is effective, but not viable on a cost basis.

Self-fertile varieties of almonds that yield similar quantities and quality of nuts as the current in use varieties would provide a suitable alternative. This is a research focus in the almond industry, but it is in its early stages without any commercially viable outcomes. This is a long term risk mitigation strategy that should and will continue to be developed.

Self-fertile almond cultivars are a long term option.

Management of wild honey bee populations

Within the Australian native environment there is a large population of wild honey bees, a combination of escaped European honey bees and other native bee species. This provides advantages to horticultural and agricultural producers as they provide free pollination services. However, these populations also pose a significant risk as alternative hosts of Varroa mite.

If not managed under eradication response operations, these wild populations would enable the rapid spread and hidden reservoirs of Varroa mite. Transmission of the mite to these populations could occur through direct contact or by using flowers as the transfer vehicle, as mites can live up to three days off their hosts. Therefore, consideration and treatment of the wild honey bee populations must be integral to an eradication response.

Wild honey bees would be a significant factor in a response to Varroa mite.

[12] Predicting the economic impact of an invasive species on an ecosystem service (2007) Cooke D, Thomas M and Cunningham S, *Ecological applications*, **17**(6), 1832-1840.

2.3.2 Outcomes identified

Through the consideration of the current research outcomes and the experience of managing Varroa mite in New Zealand, participants identified four research priorities relating to Varroa mite preparedness:

Four research priorities identified for Varroa mite preparedness.

1. Analysis of the surveillance system in place for early detection of Varroa mite in Australia, for
   a. Sensitivity based on hive numbers and placements.
   b. Sensitivity based on the developing miticide-resistance observed in other countries.
2. Development of self-fertile almond varieties that are commercially viable, enabling their deployment prior to Varroa mite establishment.
3. Breeding of Varroa mite resistant honey bees.
4. Improvements in tracking and destroying wild honey bee populations.

In conjunction with prioritising research relating to Varroa mite preparedness, participants noted the potential of implementing the alternative hive placements, small numbers closer together, to gain the same outcome utilising less hives. To facilitate this, awareness of this research needs to be raised through communication to growers and pollination service providers.

Promote alternative hive placements.

2.4 The role of pollination-dependent industries in honey bee biosecurity

2.4.1 Summary of activities and discussions

Varroa mite is not a death sentence for the honey bee industry. By implementing good hygiene practices the impacts of Varroa mite can be limited. Nonetheless, following the establishment of Varroa mite in other bee keeping countries, there has been a sudden decline in the number of available hives, mainly caused by the increased costs driving beekeepers from the industry. This results in a reduction in the number of hives available for pollination services in the short and medium term.

Honey bee biosecurity preparedness

The decline in available hive numbers would impact on the viability of the honey bee and pollination-dependent industries, and as such, the costs of honey bee biosecurity preparedness activities should be borne by all beneficiaries, not only the honey bee industry. As such, participants unanimously agreed that there needs to be an improved working relationship between the honey bee and pollination-dependent industries in relation to biosecurity.

Honey bee biosecurity must be undertaken collaboratively by all beneficiaries.

AHBIC, together with RIRDC, HAL and PHA, currently deliver biosecurity preparedness programs, such as the National Bee Pest Surveillance Program. As beneficiaries, the almond industry supported contributing funds and direction to these programs in collaboration with the honey bee and other pollination-dependent industries.

A formal mechanism linking the honey bee and pollination-dependent industries on biosecurity is the EPPRD. Fourteen EPPRD Parties have been identified as Affected in the case of an exotic honey bee pest Incident, and all potentially contribute to the decision making and funding. On the other hand, there are a number of pollination-dependent industries that are not a Party to the EPPRD, such as the melon and berry industries. As beneficiaries of the implementation of honey bee biosecurity, participants reinforced their support for these industries to sign the EPPRD and contribute to honey bee biosecurity research outcomes.

Pollination-dependent industries that are not Party to the EPPRD should contribute to honey bee biosecurity.

Workshop participants developed communication plans (documentation of communication objectives, audiences and key messages) and material (such as fact sheets) that are relevant to a Varroa mite response. Separate versions of each were developed targeting beekeepers and pollination-dependent crop producers. Identified messages and underpinning approach aligned between the audiences, further highlighting the justification for a close collaboration of the honey bee and pollination-dependent industries.

Communication to beekeepers and pollination-dependent industries closely align.

2.4.2 Outcomes identified

Broad engagement on honey bee biosecurity was supported by all participants, with three key areas identified as a focus – surveillance, contingency planning and communications.

Contributions to the National Bee Pest Surveillance Program by pollination-dependent industries would help ensure the programs future. In addition, the resourcing from pollination-dependent industries would enable an analysis of the sensitivity of the system and its expansion into additional geographical areas, increasing the likelihood of detecting Varroa mite early.

Improvements to the National Bee Pest Surveillance Program.

A coordinated and rapid response to Varroa mite under the EPPRD would be facilitated by the implementation of a relevant contingency plan. These documents provide a source of applicable information to guide response operations, strategic decisions and the development of Response Plans. Currently, there is a Varroa mite contingency plan that was specifically developed for the honey bee industry. The almond industry has identified the requirement to have a contingency plan that also covers specific requirement of a pollination-dependent industry.

The desired outcome is the development of a single contingency plan addressing all the needs, in preference to multiple documents. This outcome can be achieved through a collaboration to develop a supporting document or appendices to the current contingency plan.

Inclusion of almond considerations in the Varroa mite contingency plan.

Communication to beekeepers and pollination-dependent crop producers regarding honey bee biosecurity preparedness and a response is closely aligned. The collaborative development of communication material is essential to reduce duplication of effort and to ensure the provision of consistent messages. Therefore, all affected stakeholders should be contributing to honey bee biosecurity communications prior to, and in the event of, detection of Varroa mite.

All affected stakeholders require aligned communications relating to Varroa mite.

2.5 Grower and beekeeper engagement

2.5.1 Summary of activities and discussions

General surveillance

The National Bee Pest Surveillance Program provides one approach to monitoring for Varroa mite entering the country. Workshop participants identified the benefit of supplementing this program with additional surveillance activities provided by beekeepers monitoring their own hives specifically for Varroa mite. The provision of training and support material, such as surveillance fact sheets, would enable this surveillance to be carried out and as a result, improve the likelihood of early detection.

Improved beekeeper surveillance can supplement the National Bee Pest Surveillance Program.

In addition, almond producers could promote honey bee biosecurity by requesting all hives entering their properties are certified to be free from Varroa mite and other bee pests based on appropriate testing (which would need to be determined).

Response roles for industry participants

Industry participants will be engaged in a response to Varroa mite at the strategic decision making and the operation level. Workshop participants highlighted the following areas where training is required to support those personnel potentially involved:

Training for emergency response roles is desired for industry participants.

- Industry liaison roles in control
- Surveillance methods and testing protocols
- CCEPP and NMG roles and responsibilities
- Communication roles and protocols of Affected Parties

Accurate and auditable production data

A key focus of Workshop Acari was to investigate how to facilitate the provision of ORC in a honey bee pest emergency response under the EPPRD. Together with the work on the ORC Evidence Frameworks to be undertaken by the peak industry bodies (see Section 2.2), participants identified that the growers and beekeepers need to play a more active role in ensuring they have access to fair reimbursements in the event of ORC being available. Specifically, beekeepers and producers of pollination-dependent crops must keep accurate, thorough and auditable records of their production costs and product sale values.

Accurate and auditable data should be collected by producers and beekeepers.

2.5.2 Outcomes identified

Supporting beekeepers to undertake surveillance for Varroa mite in their own hives will supplement the early detection surveillance activities of the National Be Pest Surveillance Program. To enable this to occur, training on surveillance techniques and the identification of exotic bee pests must be made readily available and communicated. This should be achieved in conjunction with the promotion of how growers and beekeepers can report a detection of Varroa mite appropriately.

Encourage surveillance conducted by beekeepers through training and awareness activities.

The production of guidance material that outlines the requirements and supports the collection and recording of accurate and auditable production records is required. The promotion of this material to growers and beekeepers through the peak industry bodies will support the calculation of ORCs in a Varroa mite response.

Guidance for, and awareness of, production data recording required.

Developing a fact sheet to inform and engage bee keepers during a Varroa mite response.

3 Future considerations

The following recommendations were generated as a result of activities and presentations at Workshop Acari, consolidating the outcomes identified in Section 2 of this report.

Recommendation 1	**All beneficiaries of the National Bee Pest Surveillance Program to contribute to the implementation of the program**

The National Bee Pest Surveillance Program provides an early detection monitoring tool for exotic bee pests, which benefits the pollination-dependent industries together with the honey bee industries. The provision of resources from all beneficiaries would solidify the programs future and enable it to grow.

Recommendation 2	**Undertake a review of the National Bee Pest Surveillance Program to ensure its resources are being implemented effectively**

To ensure the National Bee Pest Surveillance Program can effectively detect exotic bee pests a review covering the following areas was identified:

- Modelling analysis of the hive locations, numbers and density at each site and at a national level.
- A benefit cost analysis to demonstrate the value of the program and analyse the outputs of the modelling analysis above.
- Understanding the impact of Varroa mite resistance on surveillance efforts and determining alternative approaches to ensure continued sensitivity.

Recommendation 3	**Document Varroa mite response options from the almond industry perspective**

The Varroa mite contingency plan developed for the honey bee industry should be broadened (through provision of a supplement or separate document) to provide response options from the almond industry's perspective. This should cover an analysis, based on scientific evidence and response experience, of the options explored in this workshop, including :

- Hive standstill and movement restriction alternatives.
- Potential regulated hive movements in low risk areas to undertake pollination services.
- Communication templates and distribution mechanisms.
- Wild honey bee management/control.

Recommendation 4	**Prioritise Varroa mite preparedness research funding to address identified gaps**

The identified gaps in Varroa mite preparedness for the almond industry that would benefit from research prioritisation were:

- The development of self-fertile almond varieties that are commercially viable.
- Varroa mite tolerance in commercial honey bee populations.
- Improved methods for wild honey bee colony detection, quarantine and eradication.

Recommendation 5	Develop a training plan for Affected Parties in a Varroa mite response
The delivery of training for exotic pest surveillance and emergency response roles was identified as a potential biosecurity preparedness activity. As the breadth of training identified throughout the workshop was large, a training plan that identifies the target audiences, key learning outcomes and priorities for training delivery should be developed to focus efforts.	

Recommendation 6	Finalise the ORC Evidence Framework for the Almond Industry
Completion and endorsement of the ORC Evidence Framework for the Almond Industry will support the provision of fair and timely potential reimbursements to growers in the event of a Varroa mite Incident. Through this process, the almond industry will also gain clarity around the ownership complexities and how they impact on ORCs. A completed Evidence Framework will also support the provision of guidance to growers to ensure they collect and record accurate and auditable production data.	

4 Appendices

4.1 Planning committee

Table 4. Membership list for the exercise planning committee

Name	Organisation	Name	Organisation
Ashley Zamek (chair)	PHA	**Melinda Black**	Vic DEPI
Stephen Dibley	PHA	**Doug Somerville**	NSW DPI
Peta Hudson	PHA	**Trevor Monson**	Monsons honey
Ben Brown	ABA	**Wendy Coombes**	Vic DEPI
Enrico Perotti	Department of Agriculture	**Dave Alden**	RIRDC
Mike McDonald	Department of Agriculture		

4.2 Attendees

Table 5. List of participants and their affiliated organisations

Name	Organisation or affiliation	Name	Organisation or affiliation
Neale Bennet	Almond Board of Australia	**Sophie Peterson**	PHA
Ben Brown	Almond Board of Australia	**Joe Riordan**	Vic DEPI
Greg Buchanan	Horticulture Australia Limited	**Brett Rosenzweig**	Almond Board of Australia
Mary Cannard	Select Harvests	**Craig Scott**	Pollination provider
Domenic Cavallaro	Cavallaro Angle Vale Almonds Trust	**Alison Seyb**	NSW DPI
Peter Cavallaro	Walker Flat Almonds	**Brendan Sidhu**	Jubillee Almonds
Saul Cunningham[13]	CSIRO	**Ross Skinner**	Almond Board of Australia
Stephen Dibley	PHA	**Brian Slater**	Macquarie Agricultural Services
Mark Goodwin	Plant and Food Research, New Zealand	**Elizabeth Smee**	PIRSA
Andrew Hobbs	CMV Farms	**Michael Stedman**	PIRSA
Graham Johns	RMONPRO Developments	**Jenny Treeby**	Vic DEPI
Daniel Martin	Vic DEPI	**Bill Trend**	DAFWA
Peter McDonald	AHBIC	**William Wang**	Olam Orchards Australia
Trevor Monson	Monson Honey	**Karla Williams**	DPIPWE
Tim Orr	Lake Cullulleraine Almonds	**Brenton Woolston**	Almondco Australia Ltd
Enrico Perotti	Department of Agriculture	**Ashley Zamek**	PHA

[13] Present only for the second day of the workshop

4.3 Workshop presentations

An introduction to Workshop Acari and four key note presentations were delivered at the workshop. A summary of the key information presented is provided below.

4.3.1 Welcome and introduction to Workshop Acari

Presenter: Ashley Zamek, PHA

- For every year Australia remains free of Varroa mite, industries receive a benefit of $50.5 million per year in saved management costs. Pollination can account for up to 50% increases in fruit set and Australian pollination-dependent industries represent over 65% of all the horticultural and agricultural crops in Australia.
- In 2013, PHA was commissioned by RIRDC and HAL to explore how the impact of honey bee movement restrictions potentially implemented as a result of Varroa mite incursion would affect pollination-dependent industries. A part of this project was a report that aimed to highlight the reliance of 10 key pollination-dependent industries on wild and managed honey bees and in turn the possible impact a Varroa mite incursion could have on both short term and long term pollination.
- Almonds, as an industry that is 100% dependent on honey bees and with most pollination occurring through managed hives were identified as an industry that was particularly at risk from the effects of a Varroa mite incursion. They identified Varroa mite as a high risk to their livelihood.
- The demand for honey bees by almond growers is at its peak in August with requirements estimated at over 23,000 hives. An important aspect to consider when determining the availability of hives for almond pollination is the location of hives in July. Throughout the year pollination providers will transport hives to source nectar and pollen before fulfilling pollination contracts to ensure bees are healthy and robust enough to be effective pollinators. This means there is no guarantee when trying to predict the location of hives before almond pollination as it directly correlates to the floral resources available at that time.
- In 2009, the Department of Agriculture (formerly DAFF) and PHA held a workshop to explore the impacts of a Varroa mite incursion and to identify potential improvements to Australia's response strategies and arrangements. The main outcomes were that the move of managing exotic honey bee pests from EADRA to EPPRD was logical as it incorporated pollination dependent industries; Australia has limited chemical options available to use against Varroa mite; enforcing a hive standstill during an incursion will be difficult; and feral hives will be a major problem during an eradication response.
- Over the last 5 years:
    - Chemicals (Apistan, Bayvarol, Apiguard and MAQS) have been registered and are available in Australia to use when Varroa mite is suspected.
    - Fifteen industries in total are identified as potentially affected industries in the event of a bee pest incursion.
    - Administrative changes to the honey bee levy are being conducted which raise funds for R&D and cover membership payments to PHA.
    - More than $1 million has been invested in Honey bee R&D since 2007 through the RIRDC pollination program.

4.3.2 The New Zealand experience with Varroa mite

Presenter: Mark Goodwin, Plant and Food Research New Zealand

- Since 1904, the spread of Varroa mite has been documented around the world; starting in Indonesia and spreading to all honey producing countries except Australia by 2014. Varroa mite was found in NZ 2000.
- In New Zealand the pre-2000 Varroa mite surveillance programs used Apistan despite it being known that Varroa mite has some resistance. The program targeted “high risk” areas based on human density

with surveillance concentrated on major cities and ports such as Auckland. However, the program was changed to only test commercial beekeepers who, primarily, are not located in the major cities.

- As predicted, when the Varroa mite was detected in New Zealand, it was found in Auckland and was close to where surveillance hives would have been kept. The first step was a hive standstill that was initiated to give time to decide what to do. This was possible due to the incursion being discovered in autumn when hives were not being moved much in any case.
- The decision not to eradicate was based on level of spread and potential cost of the response.
- Biosecurity legislation in New Zealand states any action that results in losses requires compensation. This covered issues such as initial hives losses, honey losses and pollination fees and was around $2 million in total.
- Once the spread of Varroa mite was determined, authorities attempted to slow the spread by creating a non-movement line to prevent hives from being moved to different region. Two lines were created; one dividing north island and the other dividing the south island. Hives could move within these zones but not across the lines.
- The North Island non-movement line was based on geographical terrain and the fact that bee movement did not usually occur across this area. From the time of the initial incursion in 2003 there was very little spread of Varroa mite below the line giving the industry located below the line two years of not requiring treatment.
- The results on the South Island were more successful, giving the industry located below the non-movement line an additional 8 to 9 years of without requiring treatment for Varroa mite. Additionally, New Zealand redesigned their Varroa mite surveillance program for the south island. The program was based on research that analysed the surveillance method sensitivity, natural spread of Varroa mite, beehive movements and what the region was prepared to eradicate (this determines the required sensitivity of the surveillance methods).
- The modelling in the South Island surveillance program identified Nelson, Picton, Christchurch, Leeston, Pleasant Point and Balfour as the key sites at most risk to a Varroa mite incursion. By focusing surveillance on these areas, it was predicted that a 90-95% probability of Varroa mite being detected early enough to be eradicated from the South Island.
- The surveillance strategy was funded by beekeepers, growers and some local councils. The program cost $760,000 per annum and included the surveillance of 20,000 hives.
- In 2007 Varroa mite was found on the South Island in Nelson (one of the identified high risk sites), however there was a decision not to undertake eradication at this location.
- New Zealand tried to use expertise and experience from overseas incursions to help combat the effect of Varroa mite. For example, Canada relies heavily on the broodless period over winter to manage Varroa mite, but this period does not always occur in New Zealand.
- The New Zealand government held a two day course for every beekeeper in New Zealand to be advised on Varroa mite management methods including Integrated Pest Management methods. They also produced a guide on how to control Varroa mite and taught beekeepers sampling methods for Varroa mite detection. In spite of what they were taught, New Zealand beekeepers when straight to using chemical control using the three registered chemicals, Apistan, Bayvarol and Apivar. This lead to no organic beekeeping and a calendar of chemical treatments that border key honey flow times.
- Before Varroa mite occurred in New Zealand, hive numbers were already declining due to low honey prices. From 2000, when Varroa mite occurred in New Zealand, there was a sharp reduction in hive numbers. After the first year of incursion, 16% of hives on the infected side of the North Island disappeared due to no treatment for Varroa mite. Most beekeepers in New Zealand are hobbyist while most hives in New Zealand are owned by contract pollinators. The initial loss of hives was mainly by hobbyists with some by contractors.
- The effect of Varroa mite on a beekeeping business per year is a $30 increase to hive costs, four extra hive visits and some losses to colonies and production. It is estimated that overall cost associated with these changes is at least $50 more per hive each year.

- In 2006, New Zealand also encountered deformed wing virus which was quite detrimental to the industry when paired with Varroa mite.
- Additionally, American foulbrood was in the midst of being eradicated before Varroa mite entered New Zealand, and because Varroa mites spread viruses, there was a spike in the percentage of American foulbrood in New Zealand. However, the spike was not too large due to American foulbrood being intensively managed at the time.
- Economics is a major issue that has arisen with the incursion of Varroa mite to New Zealand. Beekeepers needed to develop manageable processes that cost approximately $50 more per hive and continue to develop better managing practised. As previously stated, declining honey prices were having a negative impact on the economics of the beekeeping industry in New Zealand prior to the Varroa mite incursion. The arrival of Varroa mite to New Zealand resulted in a further decline in beekeeping numbers.
- As already stated, hive numbers initially dropped after the Varroa mite incursion. In the 14 years since there have multiple factors that have led to hive numbers increasing to 200,000. By chance, in 2002 China lost their export market due to chemical residues detected in their honey. New Zealand was able to meet the demand left behind leading to an increase in New Zealand's export sales. Moreover, the increase in popularity of Manuka honey has led to an export market now worth $100 million compared to the pre-2006 New Zealand honey export value of $30. The increase is primarily based on an increase in the price per kg rather than increased production. Manuka honey can bring in $80/kg which can mean an operation of 20 hives can result in generating an income of $40,000 a year on honey.
- Before the incursion of Varroa mite to New Zealand, there was little incidental pollination from wild honey bee colonies to crops that required commercial hives for pollination. Therefore, little has changed for pollination-dependent growers as they still have to lease hives. The largest impact to pollination-dependant growers is the price of hives, which has doubled since Varroa mite was found in New Zealand.
- Currently, the biggest issue to beekeeping in New Zealand is the resistance of Varroa mite to the chemical control methods. Resistance is predicted to increase the costs of beekeeping exponentially therefore cost of pollination will also increase. Beekeepers are likely with lose more hives, require more staff and have more of an issue with viruses (such as American foulbrood) that were previously under control.

4.3.3 Complexities of the Australian beekeeping industry

Presenter: Trevor Monson, Monson Honey, Pollination Co-ordinator

- To start a pollination business consisting of 1000 hives it costs a beekeeper $255,000 to set up and $80,000 per year for ongoing management.
- On average in Australia, bees are shifted five times a year.
- In Australia, it is not economically feasible to purely be a pollination provider and make a return on the investment of beekeeping.
- Key flowering events occur once every three years, hence the same feeding locations are not used every year.
- Competition for pollination at the same time as almonds includes blueberries, macadamias and seed canola. These crops are located in northern NSW and southern Qld. This is quite far away from the key almond areas centralised in Robinvale, northern Victoria.
- The bee industry is trying to convince the seed canola industry to delay planting so that key pollination times do not occur at the same time as almond pollination times.
- An example of beekeeper movement: 1500 hives moved from the south coast of NSW to Robinvale Victoria up to Qld. There were eight shifts in the year. This is considered an “average” type of schedule and includes a mixture of pollination contracts and available nectar flow.
- Varroa mite will remove inexperienced/lazy beekeepers from the industry.

- Varroa mite might even improve the business for pollination providers as Varroa mite will remove the wild honey bee pollination that provides free pollination.
- Varroa mite will therefore hit the agricultural industries reliant on pollination the hardest.

4.3.4 Owner Reimbursement Costs and pollination-dependent industries

Presenter: Sophie Peterson, PHA

- The EPPRD only operates for an eradication response of exotic plant pests
- ORCs are present in the EPPRD to promote early reporting and aim to reduce the financial impact of a response on the growers.
- A successful eradication aims to lower costs in the long term.
- ORC formulae are determined by crop types, currently there are 6 formulae present in the EPPRD covering broad acre to perennial etc.
- Guidance is needed to help advise and apply the formulae which is why evidence frameworks were created to provide agreed data sources to ensure consistency of application.
- The method for claiming ORC is in the EPPRD and includes a 90 day time limit to submit claims to the lead agency of the response following an order.
- ORC can be claimed for direct eradication costs, value of destroyed crops, enforced fallow periods, destroyed capital items and losses incurred from periods of non-bearing in crops.
- ORC only apply when a response plan has been approved by the National Management Group.
- ORC do not include the cost different between preferred and alternative crop and actual replanting costs (except for perennial crops).
- ORC are only paid to “owners” – does not cover managers/schemes.
- ORC only applies to EPPRD parties and productive/commercial growers; this excludes “backyard” and “hobbyists”.
- However the line between these two types of growers is not clearly defined.
- In the EPPRD, the honey bee industry is considered an Affected Party, however, only the hive, colony, honey and wax are eligible for ORC, and pollination services are not included.
- The pollination dependent industries involved in a response can receive ORC to losses in pollination services as it long as it is directly due to a response action.
- Thirteen industries (signatory to the EPPRD) are identified as pollination-dependent and will be an “affected” party for any honey bee pest response in conjunction to the honey bee industry.
- This list is not definitive; it can change when new industries become EPPRD signatories and are identified as pollination-dependent.
- Transition to Management phase is being looked at to consider the responses that are deemed to be unsuccessful and need to be removed from the EPPRD structure. Currently there is no process to determine how to do this and is solely managed by states.

4.3.5 Pollination of crops and the role of honey bees

Presenter: Saul Cunningham, Research Scientist, CSIRO

- There is a wide spectrum of reliance of crops on pollination ranging from 0% (self-pollinated crops) to 100% (entirely reliant on pollinators). However the majority of crops fall between the 65-95% range of dependence.
- Nevertheless, if you use the total volume of yield produced by plants, most crops are 0% reliant on pollination.
- The crops that are moderately reliant on pollination (i.e. 20-80% range) rarely use managed pollination and most likely receive pollination through incidental means (i.e. wild honey bees).

- Research modelling the impact Varroa mite could have on Australia predicts damage of approximately $30 million a year over 30 years.
- This figure indicates how much money should be spent on mitigation/biosecurity/research activities to prevent an incursion of Varroa mite in Australia.
- There are mixed experiences with Varroa mite overseas with the USA and Russia encountering declines in hive numbers attributed to Varroa mite and the diseases they spread. China and Argentina on the other hand, have had an increase in hive numbers. This could be credited to more money and effort spent on managing honey bees. This also indicates that Varroa mite is not the only reason people are leaving the beekeeping profession and that it is more likely a combination of factors.
- Pollination fees in California post Varroa mite have increased due to an increase in demand from pollination services.
- The most vulnerable grower group to Varroa mite are the crops that currently have a high reliance on wild honey bees to pollinate their crops and who only sometimes use pollination services. Growers in this category will now have to solely rely on pollination services, which will increase in price, and compete with growers/crops that already have established contracts hence there may be reduced hive availability.
- Research has been conducted into fruit set from hand pollination and open pollination. Hand pollination will give the highest fruit set in comparison the pollination that occurs from honey bees (open pollination).
- Hive density and arrangements matter. There is a disadvantage from setting hives farther away from trees. More hives per hectare does increase fruit set, yet specific arrangements of hives can make a difference to fruit set.
- Given a fixed number of hives, smaller placements closer together give a better fruit set outcome. If hives are in short supply, or more expensive, this will increase motivation to use different hive arrangements to obtain the best outcome per hive.
- Mechanical pollination will have a cost, and probably support rather than replace bees.

4.4 Participant feedback

Participants at Workshop Acari completed a questionnaire at the end of activities to support the evaluation of the event. Overall, participants provided positive feedback on the activities and the resulting learnings (Figure 3 and Table 6).

Figure 3. Collation of the quantifiable responses to the participant questionnaire for Workshop Acari.

Table 6. Top participant responses to free text questions on the feedback questionnaire

Question	Top responses[14]
Based on the workshop, what are the impacts that a Varroa mite incursion could have on almond production?	• Loss of pollination, leading to lower production, yield and income • Increased costs of pollination • Competition for hives • Loss or market confidence
What would be the most important measure to put in place to limit these impacts?	• Increase in resources towards surveillance • Contingency planning activities • Education and training for all pollination-dependent industries
In your opinion, what is the highest priority action to come out of this workshop?	• Surveillance methods for Varroa mite to New Zealand to be tested for their sensitivity • Develop an almond-specific contingency plan for Varroa mite
What were the best aspects of the workshop?	• Group discussions and interactions • Increased understanding of the impact of Varroa mite on pollination-dependent industries • A chance to hear from all aspects of the industry (beekeepers, growers and government) and expertise available

[14] Note that responses have be rephrased to allow collation


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