Hort Innovation

Final Report

Coordinated Development of the Australian Tree Nut Industry

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Australian Nut Industry Council

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NT12001

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Summary

The Australian tree nut industry has experienced a 50% increase in production in the last five years. This has largely been a result of orchards planted in the late 1990s/early 2000s coming into bearing. Projected growth is a further 43% by 2025, with this next expansion being driven by improved productivity and further new plantings. ANIC members recognise that the industry needs to support this expansion and development at an industry-wide level to ensure information is made available to all of industry in a timely, consistent and comprehensive manner to aid better decision making. This is particularly the case for the smaller industries who lack the resources and coordination to conduct many of these activities themselves in the short-medium term.

As the Australian nut industry continues to grow, additional capacity is required to undertake industry development planning and implementation. The needs of the industry are broad and complex. The allocation of resources to provide industry development services will accelerate existing planning and bring new information to the industry collectively.

The Coordinated development of the Australian tree nut industry project provided for a part- time (0.2 FTE) Industry Development Manager (IDM). Through this project the IDM was engaged in an education and communication role so that across nut industry activities were coordinated and information shared across the industries collectively. Fundamental to this role is the coordination of these activities across all seven tree nut industries of almonds, macadamias, walnuts, pecans, pistachios, chestnuts and hazelnuts.

The IDM has had the capacity to provide vital information to empower the individual nut industries and support the investments each of them are making in industry development and importantly to avoid duplication of effort where possible.

The project worked across the key activity areas of:

1. Coordination, collection and collation of industry production statistics
2. Provision of general market access information
3. Communication and dissemination of information on food safety issues
4. Communication and dissemination of information on nut industry biosecurity issues and practices
5. Coordination of multi-industry chemical registrations and minor use permits
6. Review and update the Australian Nut Industry Strategic Plan.

A range of outputs were produced over the life of the project and they are detailed in this report. ANIC believes the intended project outcomes were achieved. These include:

- A more empowered nut industry,
- Greater consistency of information provided to all nut industries to incorporate into their extension and delivery capacity,
- Greater awareness of the individual nut industries as to the issues of commonality between them, and areas they might collaborate on, and
- Improved efficiency and effectiveness of the wide range of private and public funded R&D that many ANIC member already undertake.

This project has involved the Australian tree nut industries of almonds, macadamias, walnuts, pecans, pistachios, chestnuts and hazelnuts collaborating through the Australian Nut Industry Council (ANIC). The Australian Nut Industry Council (ANIC) is the federation representing the seven commercial tree nut industries in Australia.

Keywords

nuts; almonds; macadamias; pecans; walnuts; pistachios; industry; development; collaboration

Introduction

The Australian Nut Industry Council (ANIC) is the federation representing the seven commercial tree nut industries in Australia. Its members are the peak industry representative bodies - the Almond Board of Australia, Australian Macadamia Society, Australian Walnut Industry Association, Pistachio Growers Association, Hazelnut Growers of Australia, Australian Pecan Growers Association and Chestnuts Australia Inc. ANIC's scope is to provide efficiency of service and value in activities where benefit exists of collective action, rather than several times over. ANIC's engagement in activities such as this are at the request of its members.

The Australian tree nut industry has experienced a 50% increase in production in the last five years. This has largely been a result of orchards planted in the late 1990s/early 2000s coming into bearing. Projected growth is a further 43% by 2025, with this next expansion being driven by improved productivity and further new plantings.

The Australian tree nut industry has been the leading horticultural exporter for several years now. In calendar year 2016 the value of tree nut exports exceeded $1 billion for the first time. Several of the industries (almonds, macadamias, walnuts and pecans) have been developed in Australia with the export market as a focus. The other smaller sectors are also now starting to look outside the domestic arena as their production begins to increase to levels where continuity of supply can be maintained year on year. The interest in the industry, both from existing growers wishing to expand and new investment continues to grow – almonds are predicting a further five million trees to be planted in the next three years – is strong as both demand and consumption of nuts globally continues to rise. New markets need to be identified and secured for our increasing production, and existing relationships that have been developed through hard work and investment for several years nurtured and grown (competition from northern hemisphere producing nations is strong and much older than in Australia).

ANIC members have recognised that the industry needs to support this expansion and development. This is particularly the case for the smaller industries that lack the resources and coordination to conduct many of the activities outlined in this project themselves in the short- medium term. This project was established to align with several of the objectives of the 2009-2014 Australian Nut Industry Council's Strategic Plan:

Objective 1. To support and foster nut growing in Australia

1.2. Industry planning, research and communication on issues of common interest
1.4. Foster information exchange and goodwill between member nut industries and relationships between executives in these industries
1.5. Support the Australian nut growing, processing, packing and marketing industries

Objective 3. To facilitate export market growth for Australian-grown nuts

3.3. Inform industry bodies of opportunities and threats to export market growth
3.4. Encourage cooperation in export markets

Areas identified as requiring development and management include the:

- Coordination, collection and collation of industry production statistics,
- Provision of general market access information,
- Communication and dissemination of information on food safety issues,
- Communication and dissemination of information on nut industry biosecurity issues and practices,
- Coordination of multi-industry chemical registrations and minor use permits
- Review and update the Australian Nut Industry Strategic Plan,

A number of the ANIC members have their own industry development projects in place, supported by both public and private investment. This project was designed to be complementary to this investment and add value to the investment made, by working with these resources to coordinate at an industry wide level, providing information back down to these resources for use in their own activities and programs.

Methodology

To achieve the objectives of this project ANIC engaged the services of an appropriately skilled Industry Development resource at 0.2 FTE (one day per week).

The Industry Development Manager (IDM) role was established with an education and communication focus. Two principle communication channels were utilized by this project. The first was direct to specific interest groups such as ANIC's exporter database and the ANIC members themselves. The second was growers/industry stakeholders via existing industry development/communication resources of those member industries who have them. Each industry agreed to integrate the information generated by this project into their programs and communications to growers where relevant.

The IDM collected/collated information to disseminate to the industry from various sources:

- Attending and representing the industry at meetings of interest to the industry (e.g. Food Safety Australia and New Zealand (FSANZ), Federal government, Plant Health Australia, Horticultural Industry Network, etc.)
- Statistics from the Australian Bureau of Statistics, cross checked and validated with industry production and export data
- Reviewing general communications from various groups and distributing to industry representative bodies and nut industry development resources as relevant for action or forwarding to growers
- Coordinating meetings/teleconferences of industry representatives on particular issues to disseminate ideas across the group and gather feedback on issues to better understand industry needs
- Attending industry events and conferences.

This information was then disseminated in various ways - emails containing important information to targeted recipients (e.g. exporter database), distribution to industry communication or IDO resources and industry representative bodies, presentations delivered to member meetings, via teleconferences on various issues and publications such as the Statistics Handbook.

Another aspect of the project had the IDM coordinate contribution of activity and engagement across the sector.

A Project Steering Committee comprising Jolyon Burnett (macadamias), Ross Skinner (almonds) and Trevor Ranford (small industries) was established to oversee project activities and provide guidance and support as necessary. This Committee met twice per annum for the life of the project, reviewing and confirming the annual workplan each July, conducting a mid-year progress review in January each year and reviewing the outcomes against the workplan at year end (July, when confirming next year's workplan).

A mid-term project review was conducted by the former Horticulture Australia Ltd (HAL) prior to the commencement of year three of the project. This review involved the project Steering Committee, the Industry Development Manager and the HAL R&D Portfolio Manager. The structure of this review was determined by the HAL R&D Portfolio Manager and its outcomes were fed into the development of the year three project workplan.

Outputs

Outputs achieved over the life of the project include:

- An annual workplan for each of the 4 years of the project, detailing objectives, activities, timelines, expected outputs and outcomes, and results against the annual workplan for years 1-3.
- Two-day Nut Symposium negotiated, designed and delivered at the International Horticultural Convention, 2014.
- One-day, hands-on owner reimbursement cost (ORC) framework meeting for the seven tree nut industries (Aug 2013). The requirement to have an ORC framework is contained within the Emergency Plant Pest Response Deed, of which six of the seven ANIC members are signatories to.
- Almond, macadamia, pistachio and chestnut SARPs updated (hazelnuts haven't prepared a SARP, however identified priority chemicals), which have fed into the prioritization of chemicals and registration needs presented by Hort Innovation at the AgVet Chemical Summits (June, biennially).
- Endorsed Australian Nut Industry Strategic Plan 2015-2020 (Appendix 1).
- Published Australian Tree Nut Industry Biosecurity Plan 2016 (Appendix 2).
- Information disseminated to industry on food quality and safety issues and standards.
- Information disseminated on market access issues via direct communications to exporters and market access updates to industry.
- Several multi-industry chemical permits that would have been submitted individually but not for the across nut communication. Currently investigating phos acid use across several of the nuts and how some coordinated work on residues might be conducted.
- Information disseminated on across nut industry biosecurity issues.
- Biosecurity training completed for hazelnuts (2014) and chestnuts (2014) by PHA, pistachios (2015). (NB: Macadamias and pecans were completed in 2012/13.)
- Industry annual export statistics (example in Appendix 3), in addition to the production of the Growing for Success 2016 booklet (Appendix 4).
- Identification of topics/issues that present the most opportunity for across nut industry collaboration in research and development, with subsequent work in a number of areas (Appendix 5).
- Briefing with the Nursery Garden Industry Australia (NGIA) and a subsequent paper to the ANIC Board on progressing a nursery industry standard for nut trees (Appendix 6).
- Across nut input into the successful Almond Centre of Excellence / Research for Profit project (2016).
- Australian Nut Conference 2015 and 2017 – ANC provides an excellent platform to communicate with the industry on topics across the supply chain. It is an educational, networking and collaborative event touching on everything from industry updates, labelling and food safety requirements, processing technology, supply chain issues and consumer market research.
- All of nut application to the Federal Government's Leadership in Agricultural Industries Fund 2016-2020 Programme to support the development of the next generation of leaders in the industry.

- IDM has attended on average two industry conferences/farm walks per year for the life of the project, ensuring engagement with growers and service providers across all seven industries. Program dependent, the IDM has presented industry statistics and activity updates on the key areas of operation to amplify the knowledge. Through this process

Activities

- Attendance at meetings to learn and collect information to report back to industry. These include:
  - Food Standards Australia and New Zealand (FSANZ) (3 – June 2014, Dec 2015, Jun 2017),
  - Plant Health Australia (two meetings per year (May, Nov), for the life of project),
  - National Horticultural Industry Network (HIN),
  - All former Office of Horticulture Market Access (OHMA) meetings, facilitated by (former) HAL.
- Attendance at no less than two trade briefings per year (over life of project) conducted by the Federal Government (TPP, RCEP and various FTA) to represent industry's trade issues and remain up to date with trade negotiation progress.
- At least four teleconferences between industry chemical representatives/IDOs/IDMs to discuss issues, seek areas of commonality of activity and gather new ideas to implement in their industries.

Outcomes

The outcomes for the project identified in the project proposal centred around a more informed industry, greater consistency of information through enhanced communications, greater awareness of potential areas of collaboration and greater efficiency and effectiveness in a range of R&D and other activities that members largely all undertake.

Intended outcomes for the project include:

1. A more empowered nut industry
2. Greater consistency of information provided to all nut industries to incorporate into their extension and delivery capacity
3. Greater awareness of the individual nut industries as to the issues of commonality between them, and areas they might collaborate on
4. Improved efficiency and effectiveness of the wide range of HIA funded R&D that each ANIC member already undertakes.

Some of the key outcomes the project has achieved that deliver against the intended outcomes include:

Australian Nut Conference 2015, 2017

Held biennially, the nature of the Australian Nut Conference (ANC) means it is a key delivery mechanism for outcomes 1-3 listed above, which in turn lead to outcome 4. The IDM had a key role in the development of the conference programs to ensure the event facilitated learning, information sharing and above all, industry empowerment and positivity.

Potential Collaborative R&D Issues

At the time this project commenced with Hort Innovation's predecessor, ANIC was working with HAL staff member Brad Wells on work to identify priority issues across the tree nut sector (see Appendix 1). Collectively we came up with a list of five issues:

1. Germplasm repository site – insect screened site (ground work for project)
2. Phytophthora – developing a longer-term strategy for growers
3. Nursery standards for nut trees
4. Common and agreed measures of productivity improvement
5. Mapping supply chain with specific focus on quality

It is pleasing to note that the industry has progressed a number of these issues:

- Whilst not specifically a germplasm repository, with assistance from the R&D for Profit project and NSW DPI, a number of developmental/experimental orchards plantings for the various tree nut species have now been occurring (almonds – Mildura, pistachios – Dareton and Irymple, walnuts – Orange (being established) and discussion with establishing Chestnuts at the Orange site also). This will serve to provide the industry with varietal 'banks' for both research purposes and perpetuity.
- Industry in discussion with NSW DPI regarding incorporating Phytophthora research into the Orange experimental site.
- Nursery standards for nut trees was explored in detail with the Nursery Garden Industry

Australia (NGIA). A paper was put to the ANIC board in September (Appendix 2) and several industries are progressing elements of the suggestions from NGIA, based on work to date.

- Several of the smaller industries (hazels, walnuts, chestnuts) have progressed the development of productivity surveys to collect more reliable industry data. The macadamia survey was circulated and used where practical. This information will greatly enhance industry reporting to Hort Innovation, state and federal governments and other stakeholders as necessary.
- The Chestnut industry has, within the last month, been successful in a grant from the Farming Together Program to look at quality along the supply chain.

Facilitating collaboration between Industry Development/Productivity staff & Communications staff

A task the IDM undertook was to develop a level of consistent communication between nut industry development/productivity staff. This has been achieved through the facilitation of semi-regular teleconferences, focusing on key issues of interest across the group. Topics covered have included chemical permits, current pest and disease issues and management, methods for engaging with growers (e.g. the MacGroup model shared), priority chemical issues for input to the AgVet Stakeholder Forum. Outcomes apart from the growth of awareness of the participants of what others in similar roles are doing/focusing on have included multi-industry chemical permits, progress on registrations for phosphoric acid for other nuts based on the experiences of the macadamia industry and the successful application by Hort Innovation for the macadamia industry for federal government funds to progress some of their ag-vet chemical registration priorities.

In 2016 the IDM extended the concept of across nut collaboration to communications staff working in the various nut industries. Discussion involved how the members could potentially collaborate and share resources across media monitoring; the evolution of industry newsletters from hard copy to electronic, what the response has been and pitfalls to think about; how industry communications materials are prepared (from data collection to software used): website hosting, maintenance and management and even tips to prepare project reporting to Hort Innovation. This concept is now being amplified across other industries, with the organisation by the IDM and macadamia industry communications manager of a meeting of Tropical Horticulture industry communications resources[1]. This meeting will occur on the 9th August 2017 to engage on communication issues common to all and foster a sharing and learning network.

And in a similar vein, in early July a teleconference has been organized by the IDM for ANIC members to discuss industry levies (statutory and/or voluntary). Three of the seven nut industries do not have a levy of any sort (R&D or marketing, statutory or voluntary) and all three have expressed the need to better understand levy options and consider the possibility as a means of supporting R&D into the future. By bringing the industries together, those investigating how they might go about establishing one can learn off those industries who do have levies and discuss advantages, disadvantages, pitfalls and process. This will mean better informed discussions and personnel as these industries explore the levy process further.

[1] A voluntary group of industry representative bodies geographically located in Qld/Nthn NSW that meet on a regular basis to discuss issues of importance across horticulture

Tree nut industry Biosecurity Plan

Coordination of input of the sector to the preparation of the Biosecurity Plan for the Tree Nut Industry, v3 2016 has been a major outcome of the role. The IDM worked with PHA initially on their application to HAL for matched funding to complete the plan, and then coordinated relevant industry participants at the various stages of preparation to prepare and then review the scientific pest and disease material contained within the final plan. The previous version of the plan was January 2010.

Go Nuts Symposium at the International Horticultural Convention

The IDM was able to negotiate with the International Society of Horticultural Science for a two-day tree nut research symposium to be included in the 2014 International Horticulture Convention. The Go-Nuts Symposium was considered an excellent opportunity to bring to Australia the research and development underway in the tree nut industry worldwide. The event, which included 26 oral presentations and 30 short poster talks attracted Australian and international tree nut researchers, growers and consultants. The benefit to the Australian industry was the opportunity to hear first-hand about international research, network with both researchers and growers from outside their nut industry and for those that presented, the experience presenting to an international audience.

The International Horticultural Convention format served to provide delegates with the opportunity to learn about ground breaking research and development underway in different horticultural industries, and provided an insight into the future of R&D in tree nuts.

The Go Nuts Symposium program was developed by the IDM. Session topics ranged from plant physiology and canopy management, pests and diseases, variety improvement and new technology, health, orchard management and postharvest storage and quality. Four international tree nut researchers were commissioned to peer review the presentation abstracts and guide the program content.

Evaluation and Discussion

This project was developed around the identified need for targeted and coordinated communication and education across the seven tree nut industries, to support the continued growth the sector as a whole is experiencing. Through providing a resource to drive communication and activity in defined areas of common interest, the project has eliminated the need to duplicate investment and effort, and amplified learnings and information across the seven industries.

The mid project review in 2015 found that the project was providing considerable value to the Australian nut industries. This view has not changed at the conclusion of the project. It has been valuable for capacity building and outcome delivery; a relatively low-cost project high on practical activities and outcomes.

The across industry collaborative approach to industry development is seen as a good model by both industry and government. The project and the IDM are considered an essential element by the nut industries to drive working efficiently with each other, Hort Innovation and Government (DFAT, PHA, DoA) in the areas of R&D, biosecurity and market access. For the smaller nut industries who are particularly under resourced, the project and its communications have been particularly beneficial. Having a resource to share has taken the pressure off having to each find a resource.

Providing coordinated and factually correct industry data and intelligence to DFAT for Free Trade Agreement negotiations, the nut industry biosecurity and SARP plans, driving collaboration and engagement of the individual nut industry development officers (IDOs) and being able to coordinate events such as a Tree Nut Symposium (International Hort Convention 2014) and the Australian Nut Conferences are specifically highlighted as evidence of the value of the project to the Australian nut industry.

What cannot be ignored in this model is the value it delivers from the identification of areas of common interest for coordination and collaboration, which create efficiencies in time and cost. Prior to this project, individual industries were funding some activities themselves, duplicating efforts. Others had no resources to even participate in these issues. Meetings such as FSANZ and PHA were not being attended at all or on an ad hoc basis due to competing commitments/lack of resources. By attending these events the IDM has now established a consistent presence for the nut sector and developed networks and relationships that can be called upon as and when necessary. This model has allowed IDOs of individual industries to focus more on on-farm issues rather than across industry issues, avoiding duplication of efforts.

The facilitation of opportunities to draw together nut industry development/productivity staff has been very well received by the staff/volunteers themselves and their industry representative bodies. These people know picking up the phone is a good idea, however they don't take the time to actually do it and when you are new in a role, this can be daunting. By having the IDM to schedule these meetings and ensure people respond and participate, we have been able to amplify learnings and experiences across the group. Knowledge and ideas have been taken back to their own industries. An example of this is the sharing by the macadamia industry development officer their engagement process of the Mac Groups they run. The almond and macadamia industries have shared their templates on data collection (tree numbers, production). Several of the smaller industries are now using this information to improve their data collection methodologies and questions. There is also the benefit of moving towards more standardized data collection processes across nuts. This will help us with more accurate reporting across the sector.

The collection of data has had the benefit of encouraging the small nut industries to collect better data through increasing the understanding of the need for quality data and projections. Several of the smaller nut industries have had to improve (or develop) data collection methodologies across their industry, driving them to better understand their industry dynamics. The nut industry over time is improving knowledge of production levels, trends and numbers of growers.

Industry engagement for the project has been high. The project is driven by the ANIC members; engagement and communication is very good due to ownership of the project. The IDM has worked with and provided information to nut industry executive officers, IDOs, nut industry researchers, Hort Innovation (e.g. Portfolio Manager – Chemicals, R&D Strategy Implementation Manager), PHA, DAWR and DFAT. The project is discussed at every ANIC meeting so all members have access to the project and input to the work plan. The annual workplan is circulated to the ANIC members for input before finalisation by the project steering committee.

Is the job finished? **No**. This project ran for four years. In that time, the industry has seen investment and growth step up yet again. Smaller nut industries are now grappling with the issue of implementation of levies (statutory or otherwise) to better support R&D within their industries. The learning from others doesn't stop. Any help that a coordinating resource can provide will continue to be of benefit to the nut sector.

Recommendations

Over the life of the project the nut industry has enjoyed profitable times (even including the global price correction almonds encountered in 2016). This project has played a significant role in providing the confidence and capacity for the nut industry to keep growing. Strong growth in both volume and value is forecast to continue and the nut sector faces the challenge of resourcing itself appropriately to support this growth. Projects facilitating collaboration and communication and reducing duplication (time and cost) should be supported. This project was successful for a number of reasons, and any similar model adopted should consider these carefully:

- Ownership – a coordination role will work when there is real engagement by those being coordinated.
- A uniting factor(s) – there is merit in seeking areas of collaboration where efficiency gains can be achieved by working together. But there has to be common ground between those involved otherwise the efficiency being sought may not be delivered.
- Defined scope of activities – the position should have a clearly defined scope so everyone's roles are clear and there is no 'turf protecting'.
- Real value add – the position should add value/amplify existing resources. Where this is evident, all parties will be keen to engage.
- Encourage and facilitate coordination and collaboration – investors should seek to encourage and facilitate coordination of resources where the above characteristics exist as it can amplify the investment in R&D.

Intellectual Property/Commercialisation

No commercial IP generated.

Acknowledgements

ANIC would like to thank the members of the project steering committee – Jolyon Burnett, Ross Skinner and Trevor Ranford, for their contribution to the project during its life.

Appendices

Appendix 1 – Australian Nut Industry Strategic Plan 2015 – 2020

Appendix 2 - Australian Tree Nut Industry Biosecurity Plan (accompanying document)

Appendix 3 - Growing for Success 2016 (accompanying document)

Appendix 4 - Nut (and horticulture) export statistics

Appendix 5 - Report to ANIC: Priority Multi-Industry Activities, 2014

Appendix 6 - Discussion paper: Developing nursery industry standards for nut trees

Appendix 1

The Australian Nut Industry Council

Strategic Plan 2015-2020

Aim: To support the Australian nut growing industries

Objective 1	Strategy	Actions
To support and foster nut growing in Australia	Develop and distribute information of relevance to growers, processors, packers, retailers, marketers and policy makers	• Produce the Australian Nutgrower Journal • Develop and publish the Australian Nut Industry Booklet (biennial) • Maintain information of relevance on the ANIC website • Provide information and leads to ANIC members to include in their publications • Utilise and support other nut specific publications as available and necessary
	Lead or support as necessary industry planning, research and lobbying on issues of common interest	• Together with members, identify those issue of common interest as they arise and pursue necessary action • Represent industry as requested at forums and meetings on issues such as (but not limited to) biosecurity, food safety • Play a coordination role in minor use permits, SARPS • Coordinate lobbying efforts with
	Encourage professionalism and growth of member organisations	• Support members with requests for assistance and information
	Foster information exchange and goodwill between member nut industries and relationships between executives in these industries	• Encourage collaboration on projects and areas of common interest • Encourage and facilitate regular communication between member staff such as Executive and Industry Development staff
	Support the Australian nut growing, processing, packing and marketing industries	• Host the Australian Nut Industry Conference every two years

Objective 2	Strategy	Actions
To increase per capita nut consumption in Australia	Research and communicate the health benefits and other consumer benefits of nuts	• Nuts for Life to maintain current up to date knowledge on the health benefits of nuts and communicate these key messages to public health policy makers and health professionals through education via distribution of Nuts for Life resources, website and attendance at conferences as appropriate. • Nuts for Life to stay abreast of public health and food regulatory issues to educate and help members promote the health benefits of nuts
	Research, record and respond to marketplace data	• Nuts for Life to undertaken biennial consumer and health professional tracking market research to monitor the program's success. • Nuts for Life to collate annually Australian nut industry statistics for value and

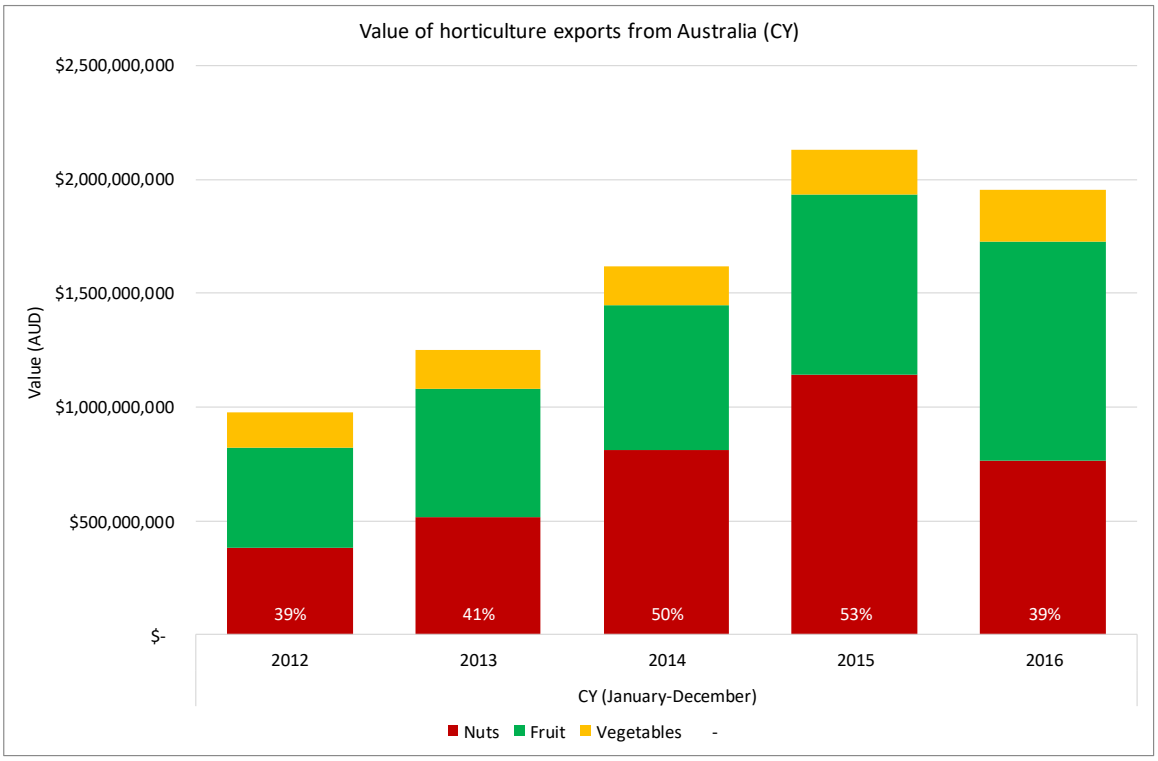
		volume of nuts sold at wholesale as a measure of increasing apparent nut consumption.
	Support the promotion of nuts	• Nuts for Life to undertake and evaluate an annual public relations media program to promote the health benefits of nuts to media and consumers via traditional and social media channels.

Objective 3	Strategy	Actions
To facilitate export market growth for Australian-grown nuts	Seek to remove trade barriers that limit market access	• Lobby in support of international market access for Australian nuts via the appropriate avenues • Provide information on the industry and export priorities to Government and other appropriate bodies to facilitate trade discussions • Inform industry bodies of opportunities and threats to export market growth • Encourage cooperation in export markets • Represent the industry on appropriate export groups/committees/forums and report back to industry

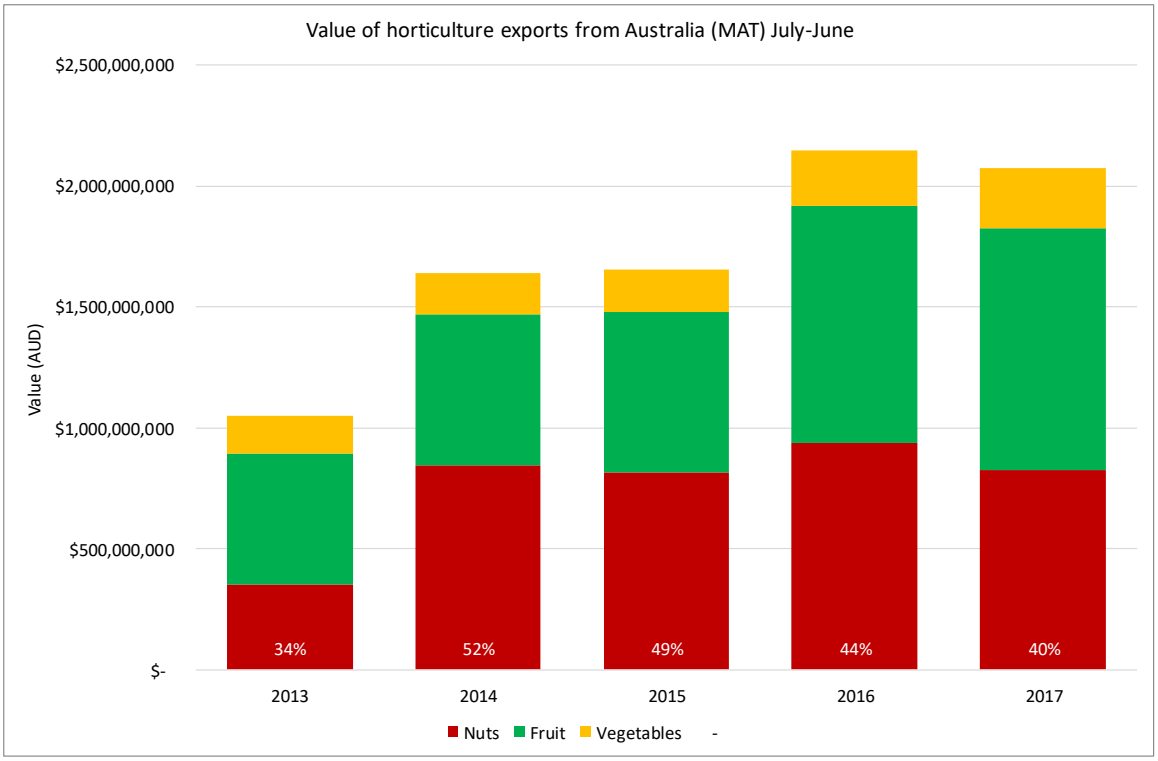
Objective 4	Strategy	Actions
To generate and allocate resources in support of our aim	Secure appropriate financial resources from member organisations, government and sponsors	• Identify project opportunities aligned with ANIC goals and objectives • Secure funding for core activities where aligned with funding available • Run a biennial Australian Nut Conference that contributes to the organisation's operating costs
	Continue to engage an executive position to support the organisation and deliver its strategic plan and activities	

Appendix 4

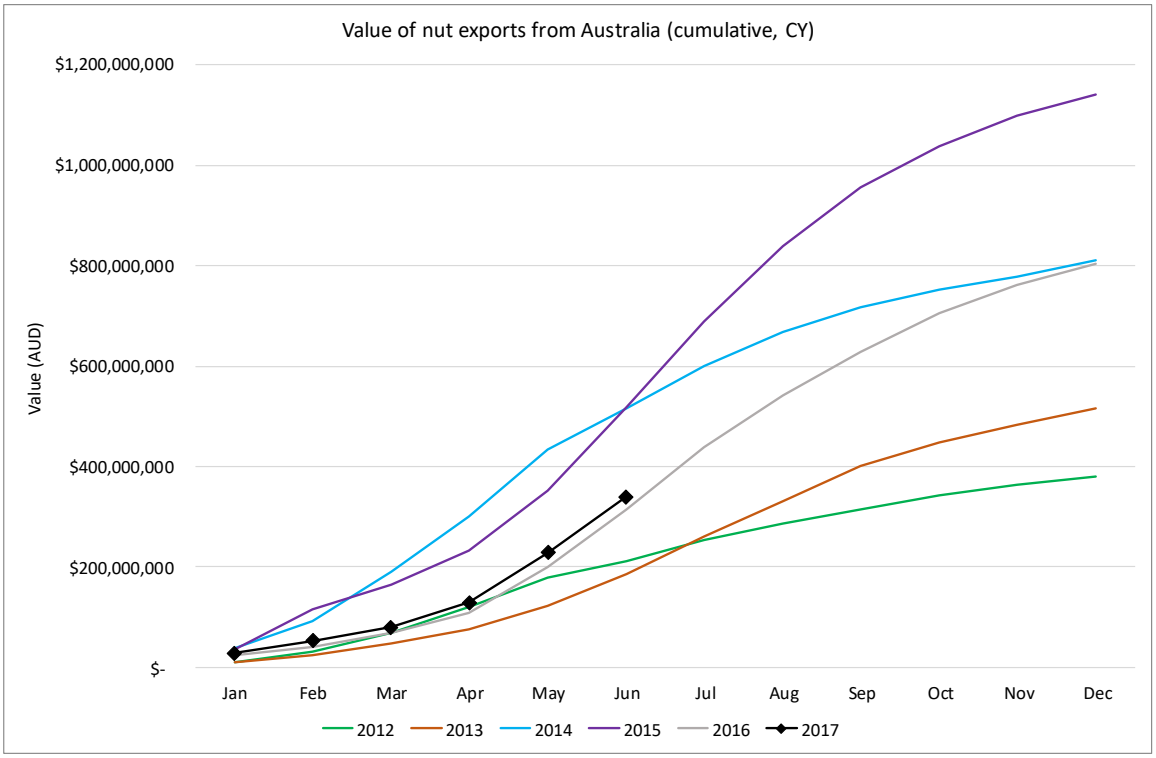
Latest horticulture export statistics, one of the outputs provided to industry and Hort Innovation from the project. Data taken from Australian Bureau of Statistics an augmented with industry data.



Source: Australian Bureau of Statistics



Source: Australian Bureau of Statistics



Source: Australian Bureau of Statistics

Appendix 5

Report to ANIC

Priority Multi-Industry Activities

Brad Wells

HAL R&D Strategy Implementation Manager

27th February 2014

CONTENT

INTRODUCTION

The four key objectives from the Terms of Reference for Brad Wells are:

1. To investigate opportunities for R&D collaboration across the tree nut sectors.
2. To increase the value of HAL resources to meet industry objectives
3. To improve linkages with R&D providers (old and new) and investigate leveraging with non-industry R&D partners.
4. To reduce habitual R&D investment to help ensure that the R&D program is effective and focused

Ultimately, the outcome of this project will be greater cross-commodity collaboration in projects, more efficient project initiation and greater investment in tree nut R&D.

From feedback from the project reference group, the ANIC Board and in consultation with Chaseley Ross, the following five activities have been identified as the priority for action over the next 6 months.

- Activity 1 - Germplasm repository site – insect screened site (ground work for project)
    - Strategic Areas of Breeding and Germplasm
- Activity 2 - Phytophthora – developing a longer term strategy for growers
    - Strategic Areas of Pest Management
- Activity 3 - Nursery standards for nut trees
    - Strategic Areas of Breeding and Germplasm
- Activity 4 - Measuring productivity
    - Strategic Areas of Best Management Practice
- Activity 5 - Mapping supply chain with specific focus on quality
    - Strategic Areas of Quality Assurance

These five activities are presented in greater detail below:

ACTIVITY #1	Germplasm repository site – insect screened site (ground work for project)
INDUSTRIES INVOLVED	All
EXPECTED or DESIRED RESULT	The ANIC industries have identified the importance of preserving the germplasm of the nut crops. How this could be done is unclear, and members would like to get a greater understanding of what is possible and the likely cost of providing a place to protect necessary nut germplasm (repository site) for all relevant nut tree species. At the end of this activity period, ANIC should have an understanding of: - how other industries maintain access to their key germplasm (e.g. Auscitrus) - the next steps towards the provision of a repository facility for nut germplasm. This could be in the format of a project proposal providing an indication of investment required by each industry
SUGGESTED IMPLEMENTATION PROCESS	1. Confirm requirements and needs of industry on maintaining access to clean germplasm 2. Review process with Alok Kumar (HAL R&D) 3. Review facilities which are currently being utilised by other industries - Budget, facilities, practicality, long term, etc. 4. Write a brief for ANIC – to confirm next steps 5. Form an industry working group (2-6) 6. Determine what stock requires storing and potential 7. Scope funders - industry, botanical gardens? DPIs?, other? 8. Scope out project proposal and present to industry
RESOURCES	Site visits Develop industry working group Workshop / meetings
PARTICIPANTS	Alok Kumar, site visits (to other facilities, nurseries), key industry champions, successful germplasm repositories.
TIMEFRAME	10-15 days initially Final draft of the project proposal might be available beyond the next 6 months but could be built on - key risk management project.

ACTIVITY #2	Phytophthora – developing a longer term strategy for growers
INDUSTRIES INVOLVED	Most nut industries as well as non-nut industries including avocados.
EXPECTED or DESIRED RESULT	Clarity on how best to manage phytophthora Next steps on the way toward understanding improvements in phytophthora root rot management (esp. Longer term management) Longer term options to manage phytophthora
SUGGESTED IMPLEMENTATION PROCESS	1. Determine the attendees required for an initial meeting at the IHC2014 (Aug 2014). E.g. *Lampinen (USA), Drenth, Femi + IDOs, Ben C (HAL R&D)* 2. Access available phytophthora research projects and current practices from the various tree crops 3. Organise meeting of key and available people at IHC2014 (probably small group) 4. The IHC meeting to identify next steps / initial Reference Group a. is there potential for improved management / decision making on phytophthora root rot? b. Form a reference group if required c. Possible workshop to progress towards next steps / multi-industry project proposal (?) 5. Workshop / production of a paper for industry or project proposal
RESOURCES	Meeting of relevant phytophthora researchers at IHC2014 – adequate roo IDOs, growers who are able to manage phytophthora root rot or not Site visits
PARTICIPANTS	ANIC and other industries having to manage phytophthora (e.g. Avocado) Relevant researchers and experienced consultants, chemical company (?), growers managing phytophthora, Chaseley Ross
TIMEFRAME	Initial planning: 3 days IHC2014 meeting in August 2014: 0.5 day Follow on: 5 -8 days to organise workshop, if required Workshop: 2 days Project development / communications: 3-5 days TOTAL: up to 20 days

ACTIVITY #3	Nursery standards for nut trees
INDUSTRIES INVOLVED	All
EXPECTED or DESIRED RESULT	Several ANIC members have expressed an interest in/have commenced work on developing nursery standards for nut trees. The NGIA are currently developing a best practice manual on nursery standards. This could have implications for the nut sector and/or provide as useful base for ANIC members to adopt without having to develop new standards. There may also be existing resources in other industries that can be adopted/adapted for nuts. At the end of this activity ANIC should have - Input into the NGIA consultation process on nursery tree standards. An understanding of what resources exist in other industries that may be adopted/adapted
SUGGESTED IMPLEMENTATION PROCESS	1. Nuts to be involved in the nursery discussions: Work with the nursery industry as they develop a tree standard with stakeholders. While it is predominately focussed on landscape trees, this 'may' include other trees including some nut trees. Much of the tree standard can apply to tree stock for citrus/nut production and would be a good starting point for both industries considering this direction in the near future. Public consultation on the draft will continue in the next week or so for a 6 week period. Brad will be notified of this development from Anthony Kachenko and will provide this through to Brad's Project Review Committee. 2. Get access to draft tree standard 3. Investigate APFIP further (apple and pear) 4. Determine what is required for (each) nut a. to be a part of the nursery tree standard b. develop own tree standards – would require a project in itself
RESOURCES	Work with the nursery industry on their tree standard work before further work. If continuing, a Reference / Working Group to develop strategy and next steps
PARTICIPANTS	PIBs, nursery, HAL Portfolio Manager/s, key people within the nut production nurseries
TIMEFRAME	Attend meeting/s and start discussion: 2 to 4 days to Next steps: up to 5 more days allocated

ACTIVITY #4	Common and agreed measures of productivity improvement
INDUSTRIES INVOLVED	All: note that macadamias already have small productivity survey
EXPECTED or DESIRED RESULT	Recommendations on a set of productivity data that all industries can collect that will be meaningful for nuts More robust, trustworthy, repeatable and collectable productivity data with identified limitations
SUGGESTED IMPLEMENTATION PROCESS	1. Determine the productivity indicators needed by: a. Government b. Industry c. HAL 2. Review by HAL (IS, R&D) a. Including how practical 3. Review by ANIC 4. Place into project proposals (currently number of trees planted, yield, etc.) Limitations? e.g. leakage through farm gate sales, Farmers' Markets, waste.
RESOURCES	Current and drafted surveys (macadamia, nursery, blueberries) HAL reports
PARTICIPANTS	HAL Industry Services and R&D, ANIC (Project Review group), PIBs, Growers, processors (?)
TIMEFRAME	Up to 5 days

ACTIVITY #5	Mapping supply chain with specific focus on quality
INDUSTRIES INVOLVED	All in first phase Potential for all in second phase
EXPECTED or DESIRED RESULT	Develop a research proposal for consideration by ANIC members to investigate where and what in the supply chain impacts on nut quality. Stage 2 would be identifying solutions to address these issues. Industry would consider the proposal and required investment to proceed. Completing the project would deliver an understanding of each industry supply chain (if not already known). This information can be synthesised to provide an understanding of the commonalities of the supply chains of the various nuts, and whether there are common quality issues across the nuts.
SUGGESTED IMPLEMENTATION PROCESS	1. Review quality issues via PIB / IDOs / processors 2. Literature survey on what is currently available and the key gaps (where quality issues arise and what resources currently available - collate from each industry) 3. Project proposal developed, identifying costs for individual industries to undertake supply chain assessments as first step (will need to be individual, based on existing info available, as this step could be progressed individually) 4. With a small multi-nut industry (2-4) working group, review and develop a work plan to move forward
RESOURCES	Time Site visits - PIB, processors, Reference team, Research agency/ies,
PARTICIPANTS	PIBs, IDOs, HAL R&D / IS, possible processor/s
TIMEFRAME	Initially: 5 -10 days to undertake research and prepare a research proposal

Appendix 6

CONFIDENTIAL

Nursery and Garden Industry Australia (NGIA)

Nursery Production Farm Management System (NPFMS)

Nursery & Garden Industry Australia

Overview for the Australian Nut Industry Council Board – 2 September 2016 meeting

Background

The Nursery Production Farm Management System (NPFMS) is the overarching framework binding the Australian nursery industry's Best Management Practice (BMP), Environmental Management and Biosecurity programs into a cohesive interlocked support system for production nurseries.

Operating under national guidelines, it consists of a suite of three programs, designed to facilitate the adoption by production nurseries of robust risk management systems driven by R&D outputs, sustainable resource utilisation and best management practices. The programs are detailed below:

1. Nursery Industry Accreditation Scheme, Australia (NIASA)

NIASA is the nursery industry BMP program, first released in 1994 and underpins the NPFMS. The focus of the program is the on farm adoption of industry best management practice facilitated through a process of continuous improvement. Key aspects of NIASA include:

- NIASA provides a set of guidelines that details industry BMP for crop hygiene, crop management practices, water management and general site management.
- NIASA is the national program for the adoption of best management practice for production nurseries, growing media manufacturers and greenlife markets.
- NIASA accreditation is the formal recognition of a business's commitment to continuous improvement underpinned by a professional system to reduce business risk.
- NIASA Accredited businesses are independently audited against more than 130 individual criteria at least annually generating an Action Plan to drive change.

2. EcoHort

EcoHort is the nursery industry Environmental Management System (EMS) and was introduced in 2006. EcoHort is a systematic method for businesses to assess their environmental and natural resource responsibilities as part of daily business management. NIASA accreditation is a prerequisite to obtaining EcoHort certification. Key aspects of EcoHort include:

- EcoHort addresses on-farm land, water and energy use as well as structures around managing pesticides, noise, waste and odour.
- EcoHort is the industry specific EMS for NIASA accredited businesses to further improve business sustainability and resilience whilst addressing environmental and natural resource responsibilities.

- EcoHort provides businesses with the resources to ensure they can demonstrate to industry, government and the community their sound environmental and natural resource stewardship and compliance with the diverse range of environmental legislation.
- EcoHort offers businesses a risk assessment based pathway to continuously improve their management systems through guidelines, independent auditing and documented Action Plans.

3. BioSecure HACCP

BioSecure HACCP is the nursery industry specific on-farm biosecurity program and was introduced in 2008. The program is a set of protocols and procedures which enable businesses to manage their biosecurity risk through establishing effective internal quarantine procedures. NIASA accreditation is a prerequisite to obtaining BioSecure HACCP certification.

- BioSecure HACCP is a program that has assessed the protocols of NIASA Accreditation and has built on these under the seven defining principles of Hazard Analysis Critical Control Point (HACCP) to manage plant pest/weed risks at a farm level.
- Through a defined system of crop monitoring, site surveillance and consignment inspections the production nursery makes informed pest, disease and weed management decisions that support overall biosecurity integrity.
- The program is designed to allow a production nursery to implement a rigorous pest, disease and weed management program through robust documented procedures and record activities on appropriately designed templates which can be easily stored in the electronic audit management system (AMS).
- Certified businesses have the opportunity to take on an extra level (Entry Condition Compliance Procedures - ECCP) for specific quarantine pests that meet interstate market access requirements and can self-certify consignments through the AMS.

NOTE: NGIA has negotiated and received agreement, through Plant Health Committee, from all States and Territories for BioSecure HACCP certified businesses to use the program, as the first and only industry developed legal market access instrument, for the inter and intra state movement of horticultural produce.

NPFMS – Changing Funding Arrangements

Following a government initiated review of Horticulture Australia Limited (HAL) the government developed a new statutory funding agreement (SFA), which in turn led to the transition of HAL to Horticulture Innovation Australia Limited (HIAL) in November 2014. This change represented a major transformation to a grower-owned company along with a new operating model and new methodologies for sourcing industry advice on investment.

In conjunction with this change all currently contracted nursery levy funded projects were required to undergo review and if not compliant with the provisions of the SFA would be required to cease prior to December 2015. The contracted projects, including the Nursery Industry Development Network (IDN) Project, supporting the NPFMS fell into this category and ceased operation in November 2015.

A new five year levy funded project with NGIA commenced in December 2015 - NY15004 National Nursery Industry Biosecurity Program. The Program targets industry biosecurity management at a farm and strategic level. An element of this project includes the management and delivery of BioSecure HACCP with the intent of establishing BioSecure HACCP as an interstate market access tool through the issuing of legal authorities under state and territory governments.

As a result of the above factors the NPFMS will not receive direct levy funded support. The NIASA and EcoHort programs will however still be required to operate not only due to the benefit they provide industry and leveraging of previous industry investment but also because NIASA is the underpinning program for the BioSecure HACCP program.

NPFMS - Transition of Management and Administration to NGIA

Due to the changes in funding arrangements and program administration for the NPFMS, the NGIA Board has supported the transition of the management and administration arrangements into NGIA. The key elements of this process include:

1. NGIA Centralising Administration of the Program - The NPFMS Programs are owned by NGIA and have been managed by NGIA with support from the State NGI Associations linked to the recently completed IDN project. With the completion of the IDN project, and the national recognition of BioSecure HACCP as a legal interstate market access program, the centralising of administration and governance for the NPFMS has become a priority for NGIA.
2. Inspection/Auditing/Certification Process – NGIA working with the State NGI's will service all NIASA and EcoHort accredited/certified businesses through to the end of 2016 including audits and certificates. Businesses who apply for or are certified under BioSecure HACCP will be serviced (for BioSecure HACCP only) by NGIA under the National Biosecurity Program. NGIA will take over full management of the program from 1 January 2017.
3. NIASA Fees - Due to the withdrawal of levy funds from the NPFMS, the programs will need to function on a cost recoverable basis. From January 2017 the annual fees charged will need to cover all costs of providing the administration, service delivery, program resources (manual, etc) and marketing. Invoices will be issued by NGIA.

   The indicative (still to be finalised) fee structure for the NPFMS is:

   <u>Certification Fee – annual</u>

Program	NGI member	Non member
NIASA	$1,000.00	$2,500.00
EcoHort	$360.00	$450.00
BioSecure HACCP	$1,000.00	$2,000.00

   <u>Audit fees</u>

   Based on hourly rates – NGI member $150.00; Non-member $300.00

Value Proposition for the Australian Nut Industry

The NPFMS enables businesses to critically evaluate each component of their business identifying areas of concern in order to better manage the identified risks while being guided by detailed Action Plans. It allows businesses to validate their integrity within the supply chain through an independent auditing process across the disciplines of demonstrated best management practice, environmental stewardship and biosecurity systems.

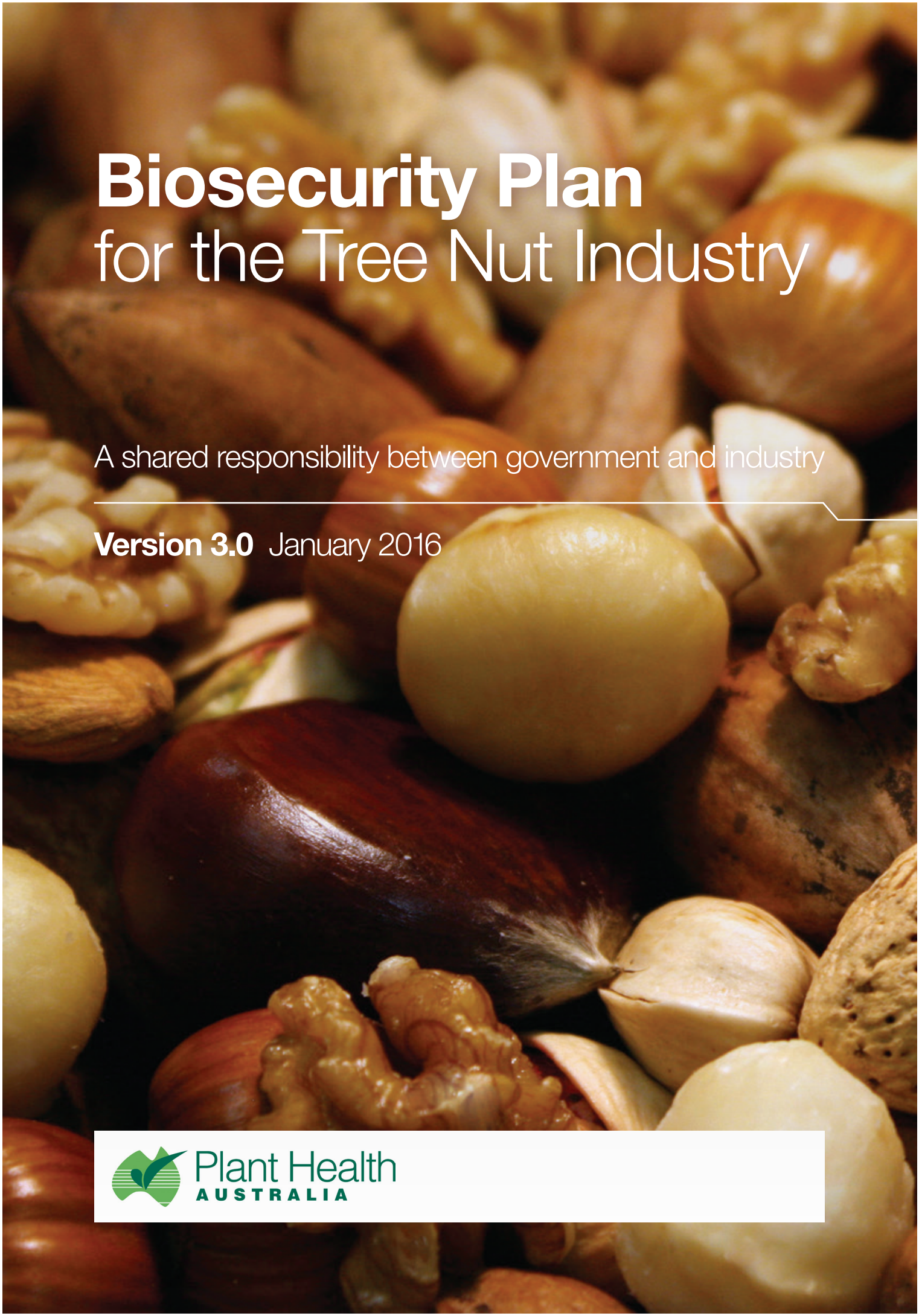
The NPFMS is the platform from which industry drives best management practice change/improvements, implements sound risk management processes and also applies the guidelines that support the expectations of the supply chain. Specifically, the NPFMS achieves the above through a number of areas that support the quality expectations of tree crop producers and can be summarised as follows:

1. High health trees through approved growing media that meets industry standards from composting through to storage and use preventing contamination, irrigation water quality and disinfestation standards plus approved growing surfaces and structures that prevent soil contact and contamination from overland water flow.
2. Crop identification within the production nursery is a critical aspect of professional plant production with NIASA requiring production nurseries to have a documented propagation record that identifies varieties, source of growing material and crop location plus true to type identification within the cropping system via appropriate crop labelling and recording system.
4. Crop management system that ensures an appropriate fertiliser and irrigation schedule is implemented that ensures the crop is fit for purpose such as the structure of the tree scaffold, root system development and condition plus plant size all in-line with customer/market expectations.
3. Pest, disease and weed management within the cropping system is achieved through a number of disciplines including managing on-farm access (vehicles and people), quarantine and inspection of incoming plant material, approved suppliers, staff hygiene, crop monitoring, site surveillance, weed management and appropriate pesticide applications.
5. Capacity to demonstrate the cropping system has been managed as per the NPFMS guidelines and that the grower has implemented the appropriate procedures and activities as required through the mandatory record keeping stipulations within each program.
4. Field establishment rates are improved through the nursery stock being fit for purpose, in good health, true to type and meeting clients specified standards. Production nurseries under the NPFMS must approach any failures to provide as expected/contracted in a professional manner and where at fault must address issues within expected/contracted timelines.

Production nurseries operating under the NPFMS have an enhanced management system that provides a high degree of surety that nursery stock is of a quality expected by the client and that the traceability of the plant material is robust. The NPFMS has the ability to adopt key criteria that may be of importance to specific clients with recent additions to the NIASA program being driven by the banana and avocado industries which will adopt NPFMS accreditation as the prerequisite for Quality Banana Approved Nursery (QBAN) and Avocado Nursery Voluntary Assurance Scheme (ANVAS) certification.

The Way Forward

For the Australian Nut Industry Council Board to review this overview of the NGIA NPFMS and determine how the tree nut nursery sector could benefit from trees produced under these programs. The ANIC Board meet with NGIA management to discuss how the program could be integrated into the tree nut nurseries.



Biosecurity Plan for the Tree Nut Industry

A shared responsibility between government and industry

Version 3.0 January 2016

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The *Biosecurity Plan for the Tree Nut Industry* was coordinated by Plant Health Australia and developed through a partnership approach using government and industry resources and expertise. The following organisations and agencies were involved in the development and finalisation of the plan:

Endorsement

The *Biosecurity Plan for the Tree Nut Industry* (Version 3.0) was formally endorsed by the tree nut industry (through industry) in November 2015, and all state and territory governments (through the Plant Health Committee) in January 2016. The Australian Government endorses the document without prejudice for the purposes of industries planning needs and meeting the Department's obligations under Clause 13 of the EPPRD. In providing this endorsement the Department notes page 33 of the Plan which states: "This Document considers all potential pathways by which a pest might enter Australia, including natural and assisted spread (including smuggling). This is a broader view of potential risk than the IRA conducted by the Department of Agriculture and Water Resources which focus only on specific regulated import pathways."

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Figures

Tables

List of acronyms

ACPPO	Australian Chief Plant Protection Office
ANIC	Australian Nut Industry Council
APVMA	Australian Pesticides and Veterinary Medicines Authority
AQIS	Australian Quarantine and Inspection Service
AS/NZS	Australian Standard/New Zealand Standard
BICON	Australian Biosecurity Import Conditions Database
BMP	Best Management Practice
BOLT	Biosecurity On-Line Training
CCEPP	Consultative Committee on Emergency Plant Pests
CPHM	State Chief Plant Health Manager
DAF Qld	Department of Agriculture and Fisheries, Queensland
DAFWA	Department of Agriculture and Food, Western Australia
DPI NSW	Department of Primary Industries, New South Wales
DEDJTR	Department of Economic Development, Jobs, Transport and Resources, Victoria
DPIF NT	Department of Primary Industry and Fisheries, Northern Territory
DPIPWE	Department of Primary Industries, Parks, Water and Environment, Tasmania
EPP	Emergency Plant Pest
EPPRD	Emergency Plant Pest Response Deed
FAO	Food and Agriculture Organization of the United Nations
HACCP	Hazard Analysis Critical Control Point
HIA	Horticulture Innovation Australia Ltd
HPP	High Priority Pest
IBG	Industry Biosecurity Group
IBP	Industry Biosecurity Plan
ICA	Interstate Certification Assurance
IGAB	Intergovernmental Agreement on Biosecurity
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRA	Import Risk Analysis
ISPM	International Standards for Phytosanitary Measures
MICoR	Manual of Importing Country Requirements
NAQS	Northern Australian Quarantine Strategy
NDP	National Diagnostic Protocol

NMG	National Management Group
NPBDN	National Plant Biosecurity Diagnostic Network
NPBS	National Plant Biosecurity Strategy
NPSRT	National Plant Surveillance Reporting Tool
NT	Northern Territory
PaDIL	Pest and Disease Image Library
PHA	Plant Health Australia
PHC	Plant Health Committee
PIRSA	Primary Industries and Regions South Australia
QA	Quality Assurance
QRAA	Queensland Rural Adjustment Authority
RD&E	Research, Development and Extension
SA	South Australia
SARDI	South Australian Research and Development Institute
SDQMA	Sub-Committee for Domestic Quarantine and Market Access
SPC	Secretariat of the Pacific Community
SPHD	Subcommittee on Plant Health Diagnostic
SPS	Sanitary and Phytosanitary
SQF	Safe Quality Food
TST	Threat Summary Table
Vic	Victoria
WA	Western Australia
WQA	Woolworths Quality Assurance
WTO	World Trade Organization

Definitions

The definition of a **pest** used in this document covers all insects, mites, snails, nematodes, pathogens and weeds that are injurious to plants, plant products or bees. **Exotic pests** are those not currently present in Australia. **Endemic pests** are those established within Australia.

Reporting suspect pests

Any unusual plant pest should be reported immediately to the relevant state/territory agriculture department through the Exotic Plant Pest Hotline (1800 084 881). Early reporting enhances the chance of effective control and eradication.

EXECUTIVE SUMMARY

Executive Summary

To ensure its future viability and sustainability, it is vital that the Australian tree nut industry minimises the risks posed by exotic pests and responds effectively to plant pest threats. The *Biosecurity Plan for the Tree Nut Industry* is a framework to coordinate biosecurity activities and investment for Australia's tree nut industry. It provides a mechanism for industry, governments and stakeholders to better prepare for and respond to, incursions of pests that could have significant impacts on the tree nut industry. It aims to assist tree nut producers to evaluate the biosecurity risks within their everyday farming and business activities, formally identify and prioritise exotic plant pests (not currently present in Australia), and focus on future biosecurity challenges.

The *Biosecurity Plan for the Tree Nut Industry* was developed in consultation with the Industry Biosecurity Group (IBG), a select group of industry, plant health and biosecurity experts. The IBG was coordinated by Plant Health Australia (PHA) and included representatives from ANIC, the almond, chestnut, hazelnut, macadamia, pecan, pistachio, and walnut industries, relevant state and territory agriculture agencies and PHA.

The development of Threat Summary Tables, constituting a list of more than 210 exotic plant pests and the potential biosecurity threat that they represent to the Australian tree nut industry was key to the industry biosecurity planning process. Each pest on that list was given an overall risk rating based on four criteria; entry, establishment, spread potential, and economic impact. In this biosecurity plan, endemic pests of biosecurity significance for the tree nut industry were also listed. It is well understood that good biosecurity practice is beneficial for the ongoing management of endemic pests, as well as for surveillance and early detection of exotic pests.

The *Biosecurity Plan for the Tree Nut Industry* also details current mitigation and surveillance activities being undertaken and identifies contingency plans, fact sheets and diagnostic protocols that have been developed for pests relevant to the tree nut industry. This enables identification of gaps and prioritises specific actions, as listed in the Biosecurity Implementation Table. The development of this table aims to increase industry's biosecurity preparedness and response capability by outlining specific areas of action which could be undertaken through a government and industry partnership.

This plan is principally designed for decision makers. It provides the tree nut industry and government with a mechanism to identify exotic plant pests as well as to address the strengths and weaknesses in relation to the industry's current biosecurity position. It is envisaged that a formal review of this Industry Biosecurity Plan will be undertaken in five years.

Implementing biosecurity for the Australian tree nut industry 2015-2020

Following the prioritisation and gap analysis through the biosecurity planning process, both industry and government have developed an implementation plan that sets out their shared biosecurity goals and objectives. This section contains a Biosecurity Implementation Table which should act as a guide for biosecurity activities for industry and the government over the upcoming five years. It is intended that the plan is visited by industry and government decision makers regularly through the life of the plan.

Biosecurity Implementation Table

The Biosecurity Implementation Table aims to build upon the themes outlined in the Intergovernmental Agreement on Biosecurity (IGAB)[1] and the National Plant Biosecurity Strategy (NPBS)[2] by providing a clear line of sight between the development of this Industry Biosecurity Plan and broader plant health policy and legislation.

This table aims to provide the focus and strategic direction for plant biosecurity activities relating to the tree nut industry over the next five years (i.e. the life of this Industry Biosecurity Plan (IBP)). The table provides specific recommendations on potential biosecurity activities which both the tree nut industry and relevant governments could undertake in partnership. This has been developed in an attempt to successfully fill in gaps which have been identified through this biosecurity planning process.

This table has been developed in the recognition that biosecurity is a shared responsibility between industry and governments, and for this reason, the Biosecurity Implementation Table has been produced to help coordinate industry and government actions and resources in the biosecurity system, with the view of creating an effective and productive industry and government biosecurity partnership. By implementing the specific actions listed in the Biosecurity Implementation Table, it will not only strengthen the tree nut biosecurity system, but also the broader plant biosecurity system. Future versions of this document will contain information on the progress made by governments and industry on the Biosecurity Implementation Table (Table 1).

[1] For more information visit **http://www.agriculture.gov.au/animal-plant-health/pihc/intergovernmental-agreement-on-biosecurity**
[2] For more information visit **http://www.planthealthaustralia.com.au/national-programs/national-plant-biosecurity-strategy/**

Table 1. *The Biosecurity Implementation Table for the Australian tree nut industries (2015-2020)*

Biosecurity theme	Action	Responsible party	Due date
Coordinated Surveillance Strategy (aligns with Strategy 2 of NPBS, Schedule 4 IGAB)	Development of a surveillance strategy for high priority pests across all tree nut industries. The strategy is to be developed as a collaborative exercise between relevant State Departments and Industry to understand what surveillance is currently taking place – and to identify the best path forward to achieve a robust surveillance program. The program will be implemented as appropriate by each individual industry but will seek opportunities to collaborate where pests are common across a number of nut crops.	State Departments; Industry; PHA	Ongoing 2016 onwards
	Almond industry is a significant funder of the redesigned National Bee Pest Surveillance Strategy, which is designed to detect new incursions of exotic bee pests and pest bees.	Industry, Australian government, PHA	2015
Building capacity and capability (aligns with Strategy 4 of NPBS, Schedule 6 of IGAB)	The establishment of a biosecurity reference group for the nut industry to annually review the biosecurity implementation plan, to consider emerging biosecurity issues, and to develop annual priorities.	Industry; PHA	2016 – 2020 (annually)
	The almond, macadamia, walnut, chestnut, pistachio and hazelnut (at the time of publication) industries are members of PHA and are signatories to the EPPRD. The macadamia industry will investigate the cost/benefit of an increase in the PHA levy to allow a moderate but ongoing commitment to improved biosecurity preparedness. The walnut, pistachio and hazelnut industries need to establish a mechanism to fund a response to an EPP.	Industry	2016-17
	The pecan industry has indicated its interest in becoming a member of Plant Health Australia and also in signing up to the EPPRD. Broad industry consultation with the industry will be required to gain support for a mechanism to fund a response to an EPP.	Industry	2015-17
	Investigate the potential to share current almond industry facilities, such as the Almond Budwood Program, with other tree nut industries.	Industry	2016-20
Biosecurity Awareness/ Training (aligns with Strategy 7 of NPBS, Schedule 6 of IGAB)	All nut industries consider biosecurity awareness at the on-farm level to be of the highest priority. The development of pest and best practice factsheets, on farm manuals, and delivery of on farm biosecurity planning workshops would be of significant value to all nut industries.	Industry and PHA	2015-2020
	Incorporate best biosecurity management practice in general best management practice guides for each of the nut commodities.	Industry	2015-2020

Biosecurity theme	Action	Responsible party	Due date
	Develop a factsheet for Oriental chestnut gall wasp (*Dryocosmus kuriphilus*).	Chestnuts Australia	2016
Contingency plans and diagnostic protocols (aligns with Strategy 3&5 of NPBS, Schedule 4&7 of IGAB)	To develop diagnostic protocols and contingency plans for high priority pests, seeking opportunities to work across nut commodities where there are pests in common. Industry (macadamia, chestnut and hazelnut) will look to collaborate with NGIA as it reviews its current contingency plan for *Phytophthora ramorum*. The almond industry recognises the need to collaborate with other industries on projects. For example, diagnostic tools for almond pests are being developed as part of a HIA project funded by almonds, summerfruit and the Victorian Government.	Industry; State Departments; PHA	2015-2020
	Brown marmorated stink bug response strategy will be developed in 2015-2016.	Department of Agriculture and Water Resources, PHA (in consultation with potentially impacted industries)	21/3/2016
	Chestnuts Australia support preparedness activities for Verticillium wilt (*Verticillium dahliae* (exotic defoliating strains) and Chestnut blight (*Cryphonectria parasitica*).	Chestnuts Australia and potentially other impacted industries	2020
	Develop a contingency plan for Eastern filbert blight (*Anisogramma anomala*).	Hazelnut Growers of Australia	2020
	Impacted industries (pistachio, walnuts and almonds) to consider development of a contingency plan for Navel orange worm (*Amyelois transitella*).	Impacted tree nut industries	2020
	Develop a contingency plan for Oriental chestnut gall wasp (*Dryocosmus kuriphilus*).	Chestnuts Australia	2020

Biosecurity theme	Action	Responsible party	Due date
Management of established pests and weeds of biosecurity significance (aligns with Strategy 6 of NPBS, Schedule 5 of IGAB)	Opportunity to develop cross sectoral research program to manage *Phytophthora cinnamomi* in tree nut crops or tree crops more generally.	Industry	2015-2020
Responding to pest incursions (aligns with Strategy 3 of NPBS, Schedule 7 of IGAB)	For all nut industries that are signatories to the EPPRD, to develop an owner reimbursement cost framework	Nut industries that are signatories to the EPPRD	2016
	To investigate the development of shelf/emergency permits with the APVMA for high priority pests of the Australian tree nut industry.	Industry	2016-2020 (consider annually)
	Almonds to engage in the pest Categorisation process for honey bee pests.	Industry	2015 onwards
Biosecurity Research, Development and Extension (RD&E) (aligns with Strategy 8 of NPBS, Schedule 8 of IGAB)	To be most effective, development of biosecurity R&D priorities that are listed and agreed to in this table should have a mechanism to feed into the annual HIA investment planning process, allowing prioritisation within the overall RD&E portfolio	Industry	Ongoing 2015 onwards
	The almond industry will continue to establish the Almond Centre of Excellence, which will also provide significant opportunities for biosecurity research and development for all nut industries.	Industry	Ongoing 2015 onwards

Australian tree nut industry - biosecurity preparedness

This document represents the third industry biosecurity planning process undertaken for the Australian tree nut industry.

The following table (Table 2) has been populated with the high priority pests of the tree nut industry. The aim of this table is to document the current preparedness documents and activities which are available and are currently being undertaken. This will allow industry, governments and RD&E agencies to better prepare for these high priority pests and align future activities as listed in the Biosecurity Implementation Table (Table 1).

Table 2. Documents and activities currently available for tree nut high priority pests[3] [4]

Scientific name	Common name	Commodity affected	National diagnostic protocol[5]	Surveillance programs[6]	Fact sheets[7]	Contingency Plan[8]	EPPRD Category[9]
INVERTEBRATES							
Amyelois transitella	Navel orange worm	Almond, pistachio, walnut	Not yet developed	Not covered by a pest specific surveillance program	Developed	Not yet developed	3
Chinavia hilaris (Syn. *Acrosternum hilare; Pentatoma hilaris; Chinavia hilare; Nezara hilaris*)	Green stink bug; Pistachio bug	Almond, hazelnut, pistachio	Not yet developed	Not covered by a pest specific surveillance program	Not yet developed	Not yet developed	
Dryocosmus kuriphilus	Oriental chestnut gall wasp	Chestnut	Not yet developed	Not covered by a pest specific surveillance program	Not yet developed	Not yet developed	

3 Copies of these documents are available from **www.planthealthaustralia.com.au/pidd**
[4] Information presented has been taken from the National Plant Health Status Report 2014 and confirmed or updated through either Plant Health Committee, the Subcommittee on Plant Health Diagnostic Standards, the Subcommittee on National Plant Health Surveillance or other stakeholders
[5] See Page 83 for further information
[6] For specific information about surveillance programs in place see Table 10.
[7] See Page 983 for more information.
[8] See Page 83 for more information.
[9] For further information please refer to Schedule 13 of the EPPRD. Available from: **www.planthealthaustralia.com.au/biosecurity/emergency-plant-pest-response-deed/**.

Scientific name	Common name	Commodity affected	National diagnostic protocol[5]	Surveillance programs[6]	Fact sheets[7]	Contingency Plan[8]	EPPRD Category[9]
Halyomorpha halys	Brown marmorated stink bug	Hazelnut, pecan, walnut	Not yet developed	Brown Marmorated Stink Bug surveillance Tas	Not yet developed	Under development	
Hypothenemus obscurus	Tropical nut borer	Macadamia	Not yet developed	Not covered by a pest specific surveillance program	Developed	Not yet developed	
Leptoglossus clypealis	Leaf footed bug	Almond, pistachio	Not yet developed	Not covered by a pest specific surveillance program	Not yet developed	Not yet developed	
Leptoglossus occidentalis	Western conifer seed bug	Almond, pistachio	Not yet developed	Not covered by a pest specific surveillance program	Not yet developed	Not yet developed	
Leptoglossus zonatus	Western leaf footed bug	Almond, pistachio	Not yet developed	Not covered by a pest specific surveillance program	Not yet developed	Not yet developed	
Lymantria dispar	Gypsy moth (Asian and European strains)	Chestnut, hazelnut, pecan, pistachio, walnut	Draft	Asian gypsy moth surveillance program NSW; Gypsy moth surveillance program Tas; Ports of entry surveillance SA;	Developed	Developed	
Trogoderma granarium	Khapra beetle	Stored almonds, pecan, pistachio, walnut	Not yet developed	CropSafe surveillance program Qld; Grain bulk handling surveillance program Qld; Grains Farm Biosecurity Program Qld; On-farm biosecurity and surveillance program WA; Grains surveillance program SA; CropSafe surveillance program Vic	Developed	Developed	2
Tropilaelaps clareae, Tropilaelaps mercedessae	Tropilaelaps mite	Honey bees and therefore pollination of almonds and macadamias	Not yet developed	National bee pest surveillance program; Exotic bee mites surveillance program NSW; Apiarist cooperator bee pest surveillance Qld	Developed	Developed	
Varroa destructor	Varroa mite	Honey bees and therefore pollination of almonds and macadamias	Not yet developed	National bee pest surveillance program; Exotic bee mites surveillance program NSW; Apiarist cooperator bee pest surveillance Qld	Developed	Developed	

Scientific name	Common name	Commodity affected	National diagnostic protocol[5]	Surveillance programs[6]	Fact sheets[7]	Contingency Plan[8]	EPPRD Category[9]
PATHOGENS & NEMATODES							
Anisogramma anomala	Eastern filbert blight	Hazelnut	Not yet developed	Not covered by a pest specific surveillance program	Developed	Not yet developed	3
Cryphonectria parasitica	Chestnut blight	Chestnut	NDP 11	Chestnut blight eradication program Vic	Developed	Not yet developed (However a Response plan has been developed)	2
Fusicladium effusum (Syn. *Cladosproium caryigenum*)	Pecan scab	Pecan	Not yet developed	Not covered by a pest specific surveillance program	Developed	Not yet developed	
Phytophthora ramorum	Sudden oak death	Chestnut, hazelnut, macadamia	NDP 5	Not covered by a pest specific surveillance program	Developed	Developed for the Nursery and Garden Industry	1
Verticillium dahliae (exotic defoliating strains)[10]	Verticillium wilt	Almond, chestnut, pecan, pistachio, walnut	Draft completed	Diseases of cotton surveillance NSW; Endemic and exotic diseases of cotton surveys Qld	Developed	Not yet developed	3
Xylella fastidiosa (including: *Xylella fastidiosa subsp. fastidiosa; Xylella fastidiosa subsp. multiplex; Xylella fastidiosa subsp. piercei*)	Almond leaf scorch; Pecan bacterial leaf scorch	Almond, macadamia, pecan	NDP 6	Urban hazard site surveillance NSW; Multiple pest surveillance program SA	Developed	Developed for the Nursery and Garden Industry	2

[10] Non-defoliating strains of *Verticillium dahliae* occur in Australia. The defoliating strain VCG 1A is known to occur in Australia and is currently under review.

INTRODUCTION

What is biosecurity and why is it important?

Plant biosecurity is a set of measures which protect the economy, environment and community from the negative impacts of plant pests. A fully functional and effective biosecurity system is a vital part of the future profitability, productivity and sustainability of Australia's plant production industries and is necessary to preserve the Australian environment and way of life.

Plant pests are organisms that have the potential to adversely affect food, fibre, ornamental crops and stored products, as well as environmental flora and fauna. For agricultural systems, if exotic pests enter Australia they can reduce crop yields, affect trade and market access, significantly increase costs and in the worst case scenario, bring about the complete failure of a production system. Historical examples present us with an important reminder of the serious impact that exotic plant pests can have on agricultural production.

Australia's geographic isolation and lack of shared land borders have, in the past, provided a degree of natural protection from exotic plant pest threats. Australia's national quarantine system also helps to prevent the introduction of harmful exotic threats to plant industries. However, there will always be some risk of an exotic pest entering Australia, whether through natural dispersal (such as wind) or assisted dispersal as a result of increases in overseas tourism, imports and exports, mail and changes to transport procedures (e.g. refrigeration and containerisation of produce).

The plant biosecurity system in Australia

Australia has a unique and internationally recognised biosecurity system to protect our plant production industries and the natural environment against new pests. The system is underpinned by a cooperative partnership between plant industries and all levels of government.

The framework for managing the cooperative partnership for delivering an effective plant biosecurity system is built on a range of strategies, policies and legislation, such as the

Intergovernmental Agreement on Biosecurity[11] and the National Plant Biosecurity Strategy[12]. These not only provide details about the current structure, but provide a vision of how the future plant biosecurity system should operate.

Australia's biosecurity system has been subject to several reviews in recent times, with the recommendations recognising that a future-focused approach is vital for maintaining a strong and resilient biosecurity system that will protect Australia from new challenges. As a result, there is a continuous improvement from industry and governments to Australia's plant biosecurity system, with the key themes including:

- Targeting what matters most, including risk-based decision making and managing biosecurity risks across the biosecurity continuum (pre-border, border and post-border).
- Good regulation, including reducing regulatory burden and having effective legislation in place.
- Better processes, including service delivery modernisation with electronic, streamlined systems.
- Sharing the responsibility, including maintaining productive relationships with all levels of government, primary industries and the wider Australian public.
- Maintaining a capable workforce.

Through these themes, a focus on the biosecurity continuum better supports consistent service delivery offshore, at the border, and onshore, and provides an effective biosecurity risk management underpinned by sound evidence and technical justification.

The benefits of the modern biosecurity system are realised by industry, government and the community, with positive flow on effects to the economy more generally. This is through streamlined business processes, productivity improvements and reduced regulatory burden in a seamless and lower cost business environment, by emphasising risk based decision making and robust partnerships.

Plant Health Australia

Plant Health Australia (PHA) is the national coordinator of the government-industry partnership for plant biosecurity in Australia.

[11] For more information visit **http://www.agriculture.gov.au/animal-plant-health/pihc/intergovernmental-agreement-on-biosecurity**
[12] For more information visit **http://www.planthealthaustralia.com.au/national-programs/national-plant-biosecurity-strategy/**

PHA is a not-for-profit, subscription-funded public company based in Canberra. PHA's main activities are funded from annual subscriptions paid by members. The Australian Government, state and territory governments and 32 plant industry organisations are all members of PHA and each meet one third of the total annual membership subscription. This tripartisan funding model ensures the independence of the company.

The company was formed to address high priority plant health issues, and to work with all its members to develop an internationally outstanding plant health management system that enhances Australia's plant health status and the sustainability and profitability of plant industries. Through PHA, current and future needs of the plant biosecurity system can be mutually agreed, issues identified, and solutions to problems found. PHA's independence and impartiality allow the company to put the interests of the plant biosecurity system first and support a longer-term perspective.

For more information about PHA visit **www.planthealthaustralia.com.au**

The Emergency Plant Pest Response Deed

The Emergency Plant Pest Response Deed (EPPRD) has been negotiated between government and industry members of PHA to cover the management and funding arrangements of eradication responses to Emergency Plant Pest (EPP) Incidents. It covers the management and funding of responses to emergency plant pest (EPP) incidents, including the potential for owner reimbursement costs for growers. It also formalises the role of plant industries' participation in decision making, as well as their contribution towards the costs related to approved responses.

The ratification of the EPPRD in 2005 significantly increased Australia's capacity to respond to emergency plant pest incursions. The key advantage of the EPPRD is more timely, effective and efficient response to plant pest incursions, while minimising uncertainty over management and funding arrangements. Other significant benefits include:

- potential liabilities are known and funding mechanisms are agreed in advance
- industry is directly involved in decision making about mounting and managing an emergency plant pest response from the outset
- a consistent and agreed national approach for managing incursions
- wider commitment to risk mitigation by all parties through the development and implementation of biosecurity strategies and programs
- motivation and rationale to maintain a reserve of trained personnel and technical expertise
- provision of accountability and transparency to all parties.

To become a signatory to the EPPRD the industry must:

- form a national peak industry body
- become a member of PHA
- become a signatory of the EPPRD
- provide a mechanism to fund a PHA and EPPRD levy within six months of becoming a signatory to the EPPRD.

The EPPRD is described in greater detail on page 87. For further information on the EPPRD, including copies of the EPPRD, Fact Sheets or Frequently Asked Questions, visit **www.planthealthaustralia.com.au/epprd and www.planthealthaustralia.com.au/epprd-qa/**.

The biosecurity plan

The *Biosecurity Plan for the Tree Nut Industry* was developed in consultation with the Industry Biosecurity Group (IBG), a select group of industry, plant health and biosecurity experts. The IBG was coordinated by PHA and included representatives from ANIC, the almond, chestnut, hazelnut, macadamia, pecan, pistachio, and walnut industries, relevant state and territory agriculture agencies and PHA.

The Biosecurity Plan not only details exotic pest threats of the Australian tree nut industry but also contains information on the current mitigation and surveillance activities being undertaken and identifies contingency plans, fact sheets and diagnostic protocols that have been developed for pests relevant to the tree nut industry.

The plan is a framework to coordinate biosecurity activities and investment for Australia's tree nut industry and to address the strengths and weaknesses in relation to industry's current biosecurity position. It provides a mechanism for industry, governments and stakeholders to better prepare for and respond to, incursions of pests that could have significant impacts on the tree nut industry.

Biosecurity planning

Biosecurity planning provides a mechanism for the tree nut industry, government and other relevant stakeholders to actively determine pests of highest priority, analyse the risks they pose and put in place practices and procedures that would rapidly detect an incursion, minimise the impact if a pest incursion occurs and/or reduce the chance of pests becoming established. Effective industry biosecurity planning relies on all stakeholders, including government agencies, industry, and the public (Figure 1).

Ensuring the tree nut industry has the capacity to minimise the risks posed by pests, and to respond effectively to any pest threats is a vital step for the future sustainability and viability of the industry. Through this pre-emptive planning process, the industry will be better placed to maintain domestic and international trade, and reduce the social and economic costs of pest incursions on both growers and the wider community. The information gathered during these processes provides additional assurance that the Australian tree nut industry is free from specific pests and has systems in place to control and manage biosecurity risks, which assists the negotiation of access to new overseas markets.

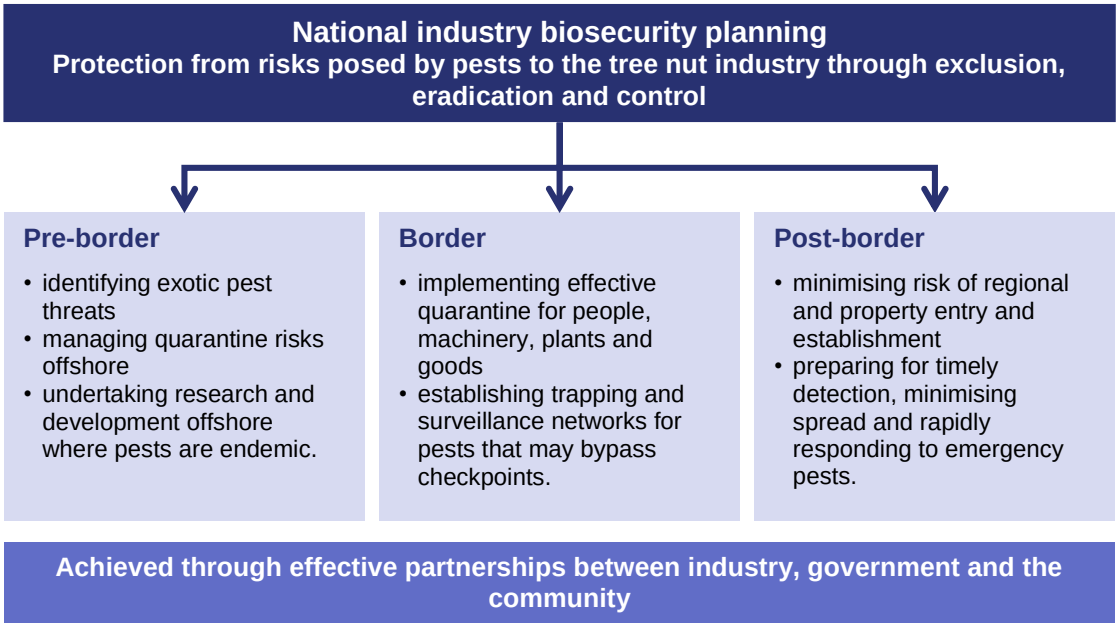


Figure 1. *Industry biosecurity: a shared responsibility*

Industry Biosecurity Plan development

With the assistance of ANIC, an Industry Biosecurity Group (IBG) was formed to work on the development of a national Biosecurity Plan for the Tree Nut Industry. The IBG was coordinated by Plant Health Australia and included representatives from ANIC, the almond, chestnut, hazelnut, macadamia, pecan, pistachio, and walnut industries, relevant state and territory agriculture agencies and PHA (Table 3 and Table 4).

Key steps in the development of the tree nut IBP included:

- identifying and documenting key threats to the tree nut industry
- confirming an agreed high priority pest (HPP) list
- documenting pest-specific fact sheets, contingency plans, diagnostic protocols and surveillance programs for HPPs
- documenting the roles and responsibilities of stakeholder groups.
- developing a biosecurity implementation table for future biosecurity related work to be conducted over the life of this IBP

Table 3. *Members of the tree nut IBG*

Name	Organisation
Rohan Burgess	Plant Health Australia
Matthew Durack	Stahmann Farms Enterprises Pty Ltd
Jacky Edwards	Department of Economic Development, Jobs, Transport and Resources, Victoria
Sallianne Faulkner	Hazelnuts Growers of Australia
Ruth Huwer	Department of Primary Industries, New South Wales
Chris Joyce	Pistachio Growers' Association Inc.
Carol Kunert	Australian Walnut Industry Association
David Madge	Department of Economic Development, Jobs, Transport and Resources, Victoria
Steve McLean	Australian Macadamia Society
Rebekah Niall	Department of Primary Industries, New South Wales
Trevor Ranford	Chestnuts Australia Inc. Hazelnuts Growers of Australia Pistachio Growers' Association Inc.
Chaseley Ross	Australian Nut Industry Council
Alison Saunders	Plant Health Australia
Jacquelyn Simpson	Department of Primary Industries, New South Wales
Ross Skinner	Almond Board of Australia Inc.

Table 4. *Scientists and others who contributed information for review of the IBP*

Name	Organisation
Jolyon Burnett	Australian Macadamia Society
Fiona Constable	Department of Economic Development, Jobs, Transport and Resources, Victoria
Chin Gouk	Department of Economic Development, Jobs, Transport and Resources, Victoria
Shane Hetherington	Department of Primary Industries, New South Wales
David McIntyre	Chestnuts Australia Inc.
Mali Malipatil	Department of Economic Development, Jobs, Transport and Resources, Victoria
Lenny Wells	University of Georgia

Review processes

With the support of the relevant tree nut industry bodies and PHA this plan should be reviewed on a 5 year basis. The review process will ensure:

- Threat Summary Tables are updated to reflect current knowledge
- pest risk assessments are current
- changes to biosecurity processes and legislation is documented
- contact details and the reference to available resources is accurate

In addition to the formal review process above, the document should be reviewed/revisited annually by industry and government to ensure currency and relevance and to consider progress with implementation. As an example, the industry biosecurity priorities identified within the plan could feed directly into industry R&D priority setting activities on an annual basis.

Opportunities to make out of session changes to the IBP, including the addition/subtraction of high priority pests or changes to legislation are currently being investigated. Such changes would need to include consultation and agreement of industry and government. This flexibility will facilitate the plan's currency and relevance.

Document overview

The biosecurity package developed for the Australian tree nut industry focuses on three key areas which when considered together identify the biosecurity needs to be implemented through the life of the plan 2015-2020.

Threat identification and pest risk assessments

Guidelines are provided for the identification and ranking of biosecurity threats through a process of qualitative risk assessment. The primary goal is to coordinate identification of exotic pest threats that could impact on productivity, sustainability, and marketability and to assess their potential impacts. This plan strengthens risk assessment work already being done both interstate and overseas. Key tree nut biosecurity threats are detailed in threat summary tables (TST; Appendix 2), along with the plant pest threat priority list (the top ranked threats to the tree nut industry). Endemic pests of biosecurity significance are also listed in this section of the plan.

Risk mitigation and preparedness

This section provides a summary of activities to mitigate the impact of pest threats on the Australian tree nut industry, along with a set of guidelines for managing risk at all operational levels. Many pre-emptive practices can be adopted by plant industries and government agencies to reduce risks. The major themes covered include:

- Barrier quarantine
- Surveillance
- Training
- Awareness
- Farm biosecurity
- Reporting of suspect pests

A summary of pest-specific information and preparedness documents, such as fact sheets, contingency plans and diagnostic protocols are also described to help industry prepare for an exotic pest incursion. Information for industry on how to align preparedness activities with R,D&E, such as researching IPM strategies, resistance breeding and chemical control is also provided.

Response management

This section provides a summary of what is in place should the Australian tree nut industry be faced with responding to an emergency plant pest incursion. Areas covered in this section include the Emergency Plant Pest Response Deed (EPPRD), categorising pests under the EPPRD, PLANTPLAN (a generic response plan for Australian plant industries), industry specific response procedures and industry communication.

THREAT IDENTIFICATION AND PEST RISK ASSESSMENTS

Introduction

This section identifies high risk exotic pest threats to the tree nut industry, and presents a framework for assessing the potential economic, social and environmental impacts associated with each threat. This part of the biosecurity plan uses a nationally consistent and coordinated approach to threat identification and risk assessment to provide a strong base for future risk management in the tree nut industry.

By identifying key threats a pre-emptive approach may be taken to risk management. Under this approach, mechanisms can be put into place to increase our response effectiveness if pest incursions occur. One such mechanism is the EPPRD that has been negotiated between PHA's government and industry members. The EPPRD ensures reliable and agreed funding arrangements are in place in advance of EPP incursions, and assists in the response to EPP incursions, particularly those identified as key threats.

Identification of high risk exotic pests will also assist in the implementation of effective grower and community awareness campaigns, targeted biosecurity education and training programs for growers and diagnosticians, and development of pest-specific incursion response plans.

Endemic pests and weeds of biosecurity significance have also been listed in this plan. It is well understood that good biosecurity practice is beneficial for the ongoing management of endemic pests and weeds, as well as for surveillance and early detection of exotic pests. Endemic pests cause ongoing hardships for growers and these pests have been listed with the support of industry and government in recognition that they need a strategic, consistent, scientific and risk-based approach to better manage these pests for the tree nut industry.

Exotic pests of the tree nut industry

Threat identification

Information on exotic pest threats to the tree nut industry described in this document came from a combination of:

- past records
- existing industry protection plans
- relevant experience
- industry practice and experience
- relevant published literature
- local industry and overseas research
- specialist and expert judgment.

Pest risk assessments

The assessment process used in this IBP was developed in accordance with the International Standards for Phytosanitary Measures (ISPM) No. 2 and 11 [Food and Agriculture Organization of the United Nations (FAO), 2004; 2007]. A summary of the pest risk analysis protocol followed in this IBP is shown in Table 5, and the complete protocol used for pest risk analysis in this IBP can be found on the PHA website[13].

While there are similarities in the ranking system used in this document and the Import Risk Analysis (IRA) process followed by the Department of Agriculture and Water Resources, there are differences in the underlying methodology and scope of consideration that may result in different outcomes between the two assessment systems. This includes different guidance to assignment of qualitative probabilities when compared with the Department of Agriculture and Water Resources' IRA process.

Modifications of the Department of Agriculture and Water Resources protocol (DAFF 2011) have been made to suit the analysis required in the IBP development process, including, but not limited to:

- **Entry potential:** The determination of entry potential in this IBP takes into account multiple possible pathways for the legal importation of plant material as well as illegal pathways, contamination and the possibility of introduction through natural means

[13] Available from **www.planthealthaustralia.com.au/biosecurity/risk-mitigation**

such as wind. Therefore the scope is wider than that used by the Department of Agriculture and Water Resources in their IRA process, which only considers legal importation of plants or plant commodities.

- **Potential economic impact** of pest establishment in this document only takes into account the impacts on the tree nut industry. The Department of Agriculture and Water Resources IRA process has a wider scope, including the effects to all of Australia's plant industries, trade, the environment and public health.
- **Risk potentials and impacts:** The number of categories used in this IBP for describing the entry, establishment, spread, and potential economic impact (see 'Description of terms used in pest risk tables', page 33) differs in comparison to that used in the Department of Agriculture and Water Resources IRA process.

Table 5. *Summary of pest risk assessment process used in IBPs*

Step 1	Clearly identify the pest	• Generally pest defined to species level • Alternatively a group (e.g. family, genus level) can be used • Sub-species level (e.g. race, pathovar, etc.) may be required
Step 2	Assess entry, establishment and spread likelihoods	• Assessment based on current system and factors • Negligible, low, medium, high or unknown ratings
Step 3	Assess likely consequences	• Primarily based on likely economic impact to industry based on current factors • Negligible, low, medium, high, extreme or unknown ratings
Step 4	Derive overall risk	• Entry, establishment and spread likelihoods are combined to generate a likelihood score • Likelihood score combined with the likely economic impact to generate an overall risk score
Step 5	Review the risk	• Risk ratings should be reviewed with the IBP

The objective of risk assessment is to clearly identify and classify biosecurity risks and to provide data to assist in the evaluation and treatment of these risks. Risk assessment involves consideration of the sources of risk, their consequences, and the likelihood that those consequences may occur. Factors that affect the consequences and likelihood may be identified and addressed via risk mitigation strategies.

Risk assessment may be undertaken to various degrees of refinement, depending on the risk information and data available. Assessment may be qualitative, semi-quantitative, quantitative, or a combination of these. The complexity and cost of assessment increase with the production of more quantitative data. It is often more practical to first obtain a general indication of the level of risk through qualitative risk assessment, and if necessary, undertake more specific quantitative assessment later [Australian Standard/New Zealand Standard (AS/NZS) ISO 31000, 2009].

At this time, only invertebrate pests (insects, mites, molluscs and nematodes) and pathogens (disease causing organisms) have been identified for exotic pest risk assessment.

Ranking pest threats

Key questions required for ranking the importance of pests include the following:

- What are the probabilities of entry into Australia, establishment and spread, for each pest?
- What are the likely impacts of the pest on cost of production, overall productivity and market access?
- How difficult is each pest to identify and control and/or eradicate?

The TSTs (Appendix 2) present a list of potential plant pest threats to the tree nut industry and provide summarised information on entry, establishment and spread potential, the economic consequences of establishment and eradication potential (where available). The most serious threats from the TSTs were identified through a process of qualitative risk assessment[14] and are listed in the HPP list (Table 6).

This document considers all potential pathways by which a pest might enter Australia, including natural and assisted spread (including smuggling). This is a broader view of potential risk than the IRA conducted by the Department of Agriculture and Water Resources which focus only on specific regulated import pathways.

When a pest that threatens multiple industries is assessed, the entry, establishment and spread potentials take into account all known factors across all host industries. This accurately reflects the ability of a pest to enter, establish and spread across Australia and ultimately results in different industries, and their IBPs, sharing similar pest ratings. However the economic impact of a pest is considered at an industry specific level (i.e. for the tree nut industry only in this IBP), and therefore this rating may differ between IBPs.

Description of terms used in pest risk tables

The descriptions below relate to terms in Table 6.

[14] An explanation of the risk assessment method used can be found on the PHA website (**www.planthealthaustralia.com.au/biosecurity/risk-mitigation**)

Entry potential

Negligible	The probability of entry is extremely low given the combination of all known factors including the geographic distribution of the pest, quarantine practices applied, probability of pest survival in transit and pathways for pest entry and distribution to a suitable host.
Low	The probability of entry is low, but clearly possible given the expected combination of factors described above.
Medium	Pest entry is likely given the combination of factors described above.
High	Pest entry is very likely and potentially frequent given the combination of factors described above.
Unknown	The pest entry potential is unknown or very little of value is known.

Establishment potential

Negligible	The pest has limited potential to survive and become established within Australia given the combination of all known factors.
Low	The pest has the potential to survive and become established in approximately one-third or less of the range of hosts. The pest could have a low probability of contact with susceptible hosts.
Medium	The pest has the potential to survive and become established in between approximately one-third and two-thirds of the range of hosts.
High	The pest has potential to survive and become established throughout most or all of the range of hosts. Distribution is not limited by environmental conditions that prevail in Australia. Based upon its current world distribution, and known conditions of survival, it is likely to survive in Australia wherever major hosts are grown.
Unknown	The establishment potential of the pest is unknown or very little of value is known.

Spread potential

Negligible	The pest has very limited potential for spread in Australia given the combination of dispersal mechanisms, availability of hosts, vector presence, industry practices and geographic and climatic barriers.
Low	The pest has the potential for natural or assisted spread to susceptible hosts within Australia yet is hindered by a number of the above factors
Medium	The pest has an increased likelihood of spread due to the above factors
High	The natural spread of the pest to most production areas is largely unhindered and assisted spread within Australia is also difficult to manage
Unknown	The spread potential is unknown or very little of value is known.

Economic impact

Negligible	There are very minor, often undetectable, impacts on production with insignificant changes to host longevity, crop quality, production costs or storage ability. There are no restrictions to market access.
Very low	There are minor, yet measurable, impacts on production including either host longevity, crop quality, production costs or storage ability. There are no restrictions to market access.
Low	There are measurable impacts to production including either host mortality, reduction in yield, production costs, crop quality, storage losses, and/or minimal impacts on market access.
Medium	There are significant impacts on production with either host mortality, reduction in yield, production costs, crop quality, storage losses, and/or moderate impacts on market access.
High	There are severe impacts on production including host mortality and significant impacts on either crop quality or storage losses, and/or severe impacts on market access.
Extreme	There is extreme impact on standing crop at all stages of maturity, with high host mortality or unmanageable impacts to crop production and quality, and /or extreme, long term, impacts on market access.
Unknown	The economic potential of the pest is unknown or very little of value is known.

Tree nut industry high priority exotic pests

Table 6 provides an overview of the top ranked threats to the tree nut industry. Further details on each pest along with the basis for the likelihood ratings are provided in the threat summary tables (Appendix 2). Assessments may change given more detailed research, and the priority list will be reviewed with the Biosecurity Plan on a 5 year basis. An explanation of the method used for calculating the overall risk can be found on the PHA website[15].

Table 6. *Tree nut industry high priority plant pest threat list*

Scientific name	Common name	Commodity affected	Plant part affected	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk[16]
ACARI (mites and spider mites)								
Tropilaelaps clareae, Tropilaelaps mercedesae[17]	Tropilaelaps mite	Honey bees and therefore pollination of almonds and macadamias	Pollination	MEDIUM	HIGH	HIGH	HIGH	HIGH
Varroa destructor[17]	Varroa mite	Honey bees and therefore pollination of almonds and macadamias	Pollination	HIGH	HIGH	HIGH	EXTREME	EXTREME

[15] Available from **www.planthealthaustralia.com.au/biosecurity/risk-mitigation**
[16] Note: where there are multiple commodities affected only the economic impact and overall risk for the most affected commodity are shown in the table.
[17] See Honey Bee Industry Biosecurity Plan for other honey bee pests.

Scientific name	Common name	Commodity affected	Plant part affected	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk[16]
COLEOPTERA (Beetles and weevils)								
Hypothenemus obscurus	Tropical nut borer	Macadamia	Nuts	MEDIUM	HIGH	HIGH	HIGH	HIGH
Trogoderma granarium	Khapra beetle	Almond, pecan, pistachio, walnut	Stored product	HIGH	HIGH	HIGH	HIGH	HIGH
HEMIPTERA (Stink bugs, aphids, mealybugs, scale, whiteflies and hoppers)								
Chinavia hilaris (Syn. *Acrosternum hilare; Pentatoma hilaris; Chinavia hilare; Nezara hilaris*)	Green stink bug; Pistachio bug	Almond, hazelnut, pistachio	Leaves, nuts	LOW	MEDIUM	MEDIUM	EXTREME-HIGH	HIGH-MEDIUM
Halyomorpha halys	Brown marmorated stink bug	Hazelnut, pecan, walnut	Nuts	HIGH	HIGH	HIGH	HIGH	HIGH
Leptoglossus clypealis	Leaf footed bug	Almond, pistachio	Nuts (kernels and epicarp)	LOW	MEDIUM	MEDIUM	EXTREME-HIGH	HIGH-MEDIUM
Leptoglossus occidentalis	Western conifer seed bug	Almond, pistachio	Nuts (kernels and epicarp)	LOW	MEDIUM	MEDIUM	EXTREME-HIGH	HIGH-MEDIUM
Leptoglossus zonatus	Western leaf footed bug	Almond, pistachio	Nuts (kernels and epicarp)	LOW	MEDIUM	MEDIUM	EXTREME-HIGH	HIGH-MEDIUM
HYMENOPTERA (Ants, bees and wasps)								
Dryocosmus kuriphilus	Oriental chestnut gall wasp	Chestnut	Buds	MEDIUM	MEDIUM	MEDIUM	HIGH-EXTREME	HIGH-MEDIUM

Scientific name	Common name	Commodity affected	Plant part affected	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk[16]
LEPIDOPTERA (Butterflies and moths)								
Amyelois transitella	Navel orange worm	Almond, pistachio, walnut	Leaves, nuts	MEDIUM	HIGH	HIGH	HIGH	HIGH
Lymantria dispar	Gypsy moth (Asian and European strains)	Chestnut, hazelnut, pecan, pistachio, walnut	Leaves	HIGH-MEDIUM	MEDIUM	HIGH	HIGH	HIGH-MEDIUM
BACTERIA (including mycoplasma-like organisms and phytoplasmas)								
Xylella fastidiosa (including: *Xylella fastidiosa* subsp. *fastidiosa; Xylella fastidiosa* subsp. *multiplex; Xylella fastidiosa* subsp. *piercei*) (Ratings with vector)	Almond leaf scorch; Pecan bacterial leaf scorch	Almond, macadamia, pecan	Leaves symptomatic, damages whole plant	MEDIUM	HIGH	HIGH	HIGH	HIGH
FUNGI								
Anisogramma anomala	Eastern filbert blight	Hazelnut	Branches, stems	MEDIUM	MEDIUM	HIGH-MEDIUM	EXTREME	HIGH
Cryphonectria parasitica	Chestnut blight	Chestnut	Branches, trunk, bark	MEDIUM	HIGH	MEDIUM	EXTREME-HIGH	HIGH-MEDIUM
Fusicladium effusum (Syn. *Cladosproium caryigenum*)	Pecan scab	Pecan	Nuts and leaves	LOW	HIGH-MEDIUM	HIGH-MEDIUM	EXTREME-HIGH	HIGH-MEDIUM

Scientific name	Common name	Commodity affected	Plant part affected	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk[16]
Verticillium dahliae (exotic defoliating strains)[18]	Verticillium wilt	Almond, chestnut, pecan, pistachio, walnut	Whole plant	MEDIUM	HIGH	HIGH	HIGH	HIGH
OOMYCETES								
Phytophthora ramorum	Sudden oak death	Chestnut, hazelnut, macadamia	Epicormic shoots, leaves	MEDIUM	HIGH	HIGH	HIGH	HIGH

[18] Non-defoliating strains of *Verticillium dahliae* occur in Australia. The defoliating strain VCG 1A is known to occur in Australia and is currently under review.

Established pests of biosecurity significance

Introduction

This section identifies established pests of biosecurity significance for the tree nut industry.

By identifying and prioritising established pests which tree nut producers already have to manage, mechanisms can be put in place to better align industry and government resources and provide a strong base for biosecurity risk management for the tree nut industry.

Identification of established pests of significance will also assist in the implementation of effective grower and community awareness campaigns, targeted biosecurity education and training programs for growers and diagnosticians, and development of pest-specific incursion response plans if the pest spreads further.

Threat identification

Information on endemic pest to the tree nut industry described in this document came from a combination of:

- past records
- existing industry protection plans
- relevant experience
- industry practice and experience
- relevant published literature
- local industry and overseas research
- specialist and expert judgment.

Prioritising pest threats

Although endemic pests listed in this plan (Table 7) had to meet the criteria listed below for establishment, spread and economic impact, these pests did not undergo a formal pest risk assessment. These pests were considered in an effort to prioritise investment.

Spread: The natural spread of the pest to most production areas is largely unhindered and assisted spread within Australia is also difficult to manage. There may be state or territory specific regulations in place to prevent the pest spreading.

Establishment: The pest has the potential to survive and become established throughout most or all of the range of hosts. Distribution is not limited by environment conditions that prevail in Australia. Based upon its current distribution in Australia, and known conditions of survival, it is likely to survive in Australia in the majority of regions where the host is grown.

Economic Impact: There are severe impacts on production including host mortality and/or significant impacts on either crop quality or storage losses, and/or severe impacts on market access.

Table 7. Established pests of biosecurity significance

Scientific Name	Common name	Hosts	Distribution in Australia	Plant part affected	Comments
FUNGI					
Cryphonectria parasitica	Chestnut blight	Chestnuts	Victoria – Restricted distribution	Stems and trunk	Eradication program in progress
Diaporthe australafricana	Stem canker	Hazelnut, apple, blueberry, grapevines	WA, SA	Stems and trunk	Detected in WA on hazelnuts. Previously reported from WA and SA
***Monilinia* spp.** (*Monilinia fructicola* and *M. Laxa)*		Almond, apple, plum, peach, pears.	WA, NSW, ACT SA, Qld, Tasmania, Victoria	Nuts, leaves, stem.	*Monilinia fructicola* and *M. Laxa* are both present in Australia and cause damage to stone fruit (including almond).
Phomopsis amygdali (Syn. *Fusicoccum amygdali, Diaporthe amygdali*)	Constriction canker	Almonds, peach and apricot, but also grape, hazelnut and others	WA, Victoria	Branches, leaves, nuts	This species is present in Australia but not known to affect almonds. It was reported as an endophyte in *Pieris* sp. (Vic), grapevine and grevillea (WA) during a taxonomic study of these fungi in herbaria. It is not known whether the same isolates are pathogenic on almonds and other *Prunus* spp.
Pezicula cinnamomea (Syn. *Cryptosporiopsis grisea*)	Pezicula canker	Chestnut, hazelnut and Oak (including *Q. ilex and Q. robur*), cherry	SA	Branches	Root-inhabiting fungus that has been recorded as an endophyte in Chestnut (*Castanea sativa*), and has been recorded on hazelnut *(Corylus avellana*) in South Australia.
Phytophthora cinnamomi	Phytophthora root rot; Die back	Wide host range including chestnut, almond, pecan, walnut, macadamia,	All states and territories	Roots affecting whole plant	Fungus damages roots causing die back and death. Significant impact on eucalypts, macadamia and other tree nuts
***Sigastus* sp.**	Sigastus Weevil	Macadamia, brush cherry (*Syzygium australe*), figs (*Fiscus* spp.).	Qld, NSW	Nuts	The Sigastus Weevil larvae feeds inside the nuts of macadamia (AMS 2015a)
Ulonemia concave	Macadamia lace bug	Macadamia	Qld, NSW	Racemes	Macadamia lace bugs attack the flowers and can cause significant yield losses. Occur from Gympie to Nambucca (AMS 2015b).

Scientific Name	Common name	Hosts	Distribution in Australia	Plant part affected	Comments
Ulonemia decoris	Macadamia lace bug	Macadamia	Qld, NSW	Racemes	Macadamia lace bugs attack the flowers and can cause significant yield losses. Occur from Gympie to Nambucca (AMS 2015b).
Verticillium dahliae[19]	Verticillium wilt	Various including: cotton, olive, pistachio, chestnut, almond, pecan, walnut	NSW and Qld cotton growing areas	Whole plant	Non-defoliating strains of Verticillium dahliae occur in Australia. The defoliating strain VCG 1A was recently reported from cotton in NSW and Qld. Affects pistachio, almond, walnut and pecan overseas but not reported on these hosts in Australia.

[19] Non-defoliating strains of *Verticillium dahliae* occur in Australia. The defoliating strain VCG 1A is known to occur in Australia on cotton and is currently under review.

References

Australian Macadamia Society Ltd. (AMS) (2015b) Fact sheet 12 – Sigastus Weevil Pest Information and Management Options. Available from: **http://www.australian-macadamias.org/industry/for-growers/faqs-a-fact-sheets**

Australian Macadamia Society Ltd. (AMS) (2015b) Fact sheet 15 – Lace Bug Pest Information and Management Options. Available from: **http://www.australian-macadamias.org/industry/for-growers/faqs-a-fact-sheets**

RISK MITIGATION AND PREPAREDNESS

Introduction

There are a number of strategies that can be adopted to help protect and minimise the risks of exotic and emergency pests under International Plant Protection Convention (IPPC) standards (**www.ippc.int/standards**) and Commonwealth and State/Territory legislation.

Many pre-emptive practices can be adopted to reduce the risk of exotic pest movement for the tree nut industry (Figure 2). Such risk mitigation and preparedness practise are the responsibility of governments, industry and the community.

A number of key risk mitigation and preparedness areas are outlined in this guide, along with summaries of the roles and responsibilities of the Australian Government, state/territory governments, and tree nut industry members. This section is to be used as a guide outlining possible activities that may be adopted by industry and growers to mitigate the risk and prepare for an incursion response. Each grower will need to evaluate the efficacy of each activity for their situation.

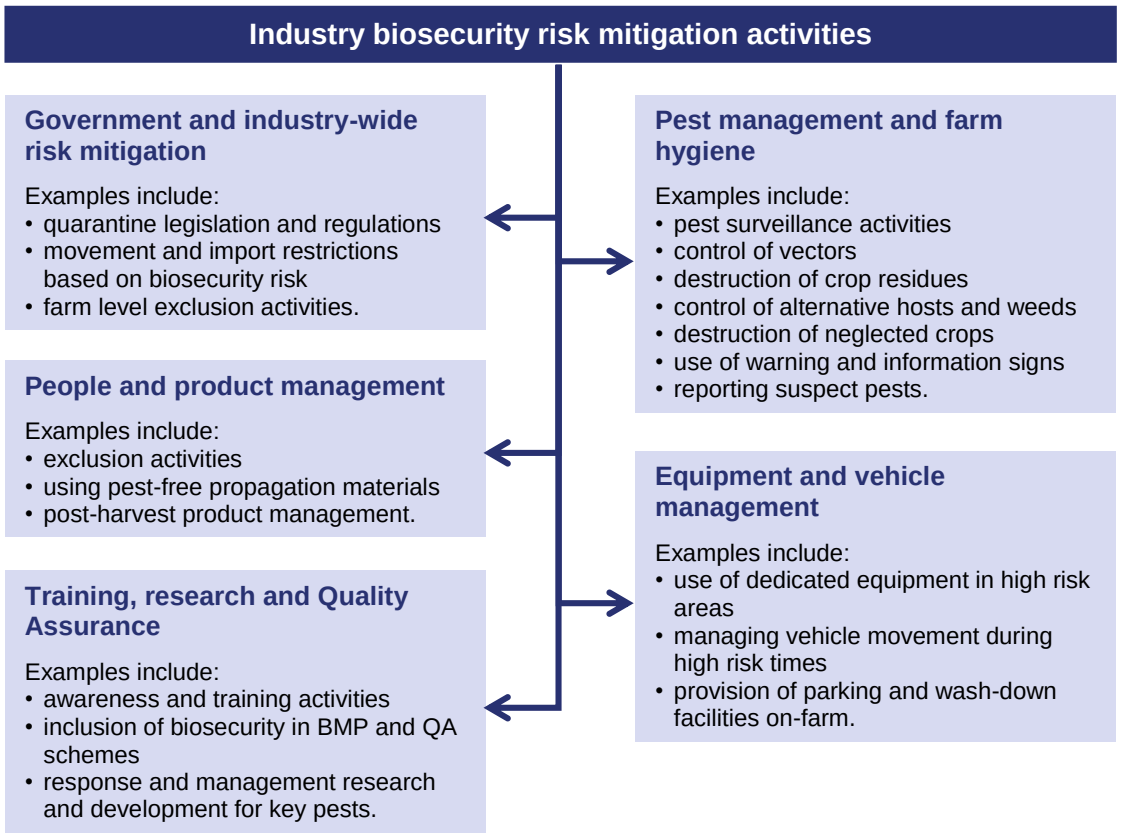


Figure 2. *Examples of biosecurity risk mitigation activities*

Barrier quarantine

Barrier quarantine refers to the biosecurity measures implemented at all levels of the tree nut industry including national, state, regional, and farm levels.

National level – importation restrictions

The Department of Agriculture and Water Resources is the Australian Government department responsible for maintaining and improving international trade and market access opportunities for agriculture, fisheries, forestry, and food industries. The Department of Agriculture and Water Resources achieves this through:

- establishment of scientifically-based quarantine policies
- provision of effective technical advice and export certification services
- negotiations with key trading partners
- participation in multilateral forums and international sanitary and phytosanitary (SPS) standard-setting organisations
- collaboration with portfolio industries and exporters.

The Department of Agriculture and Water Resources is responsible for developing biosecurity (SPS) risk management policy and reviewing existing quarantine measures for the importation of live animals and plants, and animal and plant products. In particular, the Department of Agriculture and Water Resources undertakes import risk analyses to determine which products may enter Australia, and under what quarantine conditions. The Department of Agriculture and Water Resources also consults with industry and the community, conducting research and developing policy and procedures to protect Australia's animal and plant health status and natural environment. In addition, the Department of Agriculture and Water Resources assists Australia's export market program by negotiating other countries' import requirements for Australian animals and plants. Further information can be found at **www.agriculture.gov.au**.

The administrative authority for national quarantine is vested in the Department of Agriculture and Water Resources under *Biosecurity Act 2015*[20]. Quarantine policies are developed on the basis of an IRA process. This process is outlined in the IRA Handbook 2011 (DAFF, 2011). The Department of Agriculture and Water Resources maintains barrier quarantine services at

[20] During the life of the biosecurity plan the Australian Government will transition from the *Quarantine Act 1908* to the *Biosecurity Act 2015*. The new Biosecurity Act will commence on 16 June 2016, 12 months after royal assent, replacing the *Quarantine Act 1908*.

all international ports and in the Torres Strait region. The management of quarantine policy, as it relates to the introduction into Australia of fruit, seed, or other plant material, is the responsibility of the Department of Agriculture and Water Resources.

The Australian Biosecurity Import Conditions (BICON) database[21] at **www.agriculture.gov.au/import/bicon,** contains the current Australian import conditions for more than 20,000 foreign plants, animal, mineral and biological products and is the first point of access to information about Australian import requirements for a range of commodities. It can be used to determine if a commodity intended for import to Australia requires a quarantine import permit and/or treatment or if there are any other quarantine prerequisites. There are currently a number of cases for tree nut listed on BICON (see Table 8). For export conditions see the Manual of Importing Country Requirements (MICoR) database at **www.daff.gov.au/micor/Plants/.**

The Department of Agriculture and Water Resources is responsible for the inspection of machinery and equipment being imported into Australia. Any machinery or equipment being imported into Australia must meet quarantine requirements. If there is any uncertainty, contact the Department of Agriculture and Water Resources on (02) 6272 3933 or 1800 020 504, or visit the website at **www.agriculture.gov.au**.

The World Trade Organization (WTO) Sanitary and Phytosanitary Agreement (SPS Agreement) facilitates international trade while providing a framework to protect the human, animal and plant health of WTO members. SPS measures put in place must minimise negative effects on trade while meeting an importing country's appropriate level of protection. For plant products these measures are delivered through the IPPC standard setting organisations and collaboration with portfolio industries and exporters. For more information on the IPPC visit **www.ippc.int**.

[21] Note BICON recently replaced the Import Conditions (ICON) database in November 2015.

Table 8. *Product types for which import conditions are listed in BICON (as at November 2015)*[22]

Crop	Product type
Almond	Cosmetics
	Dried fruit for human consumption
	Dried herbs for human consumption
	Highly refined organic chemicals and substances
	Processed grain and seed products for human consumption
	Processed nuts for human consumption
	Prunus spp. seed for sowing
	Raw almond nuts for human consumption
	Vacuum sealed nuts for human consumption
Chestnut	*Castanea* spp. for use as nursery stock
	Chestnuts for human consumption
	Chestnut seed for sowing
	Oak barrels and chestnut bark hoops
	Processed nuts for human consumption
	Wooden manufactured articles
Hazelnut	*Corylus* spp. for use as nursery stock
	Highly refined organic chemicals and substances
	Raw nuts for human consumption
	Vacuum sealed nuts for human consumption
Macadamia	Processed nuts for human consumption
	Raw nuts for human consumption
	Tropical and temperate species for use as nursery stock
	Vacuum sealed nuts for human consumption
Pecan	Processed nuts for human consumption
	Raw nuts for human consumption

[22] Please note, this is a summary only. Conditions change overtime and BICON (**www.agriculture.gov.au/import/bicon**), or the Department of Agriculture and Water Resources will need to be consulted to confirm the specific conditions that apply to a given situation.

Crop	Product type
	Vacuum sealed nuts for human consumption
Pistachio	Dried herbs for human consumption
	Food and food products
	Processed nuts for human consumption
	Raw nuts for human consumption
	Vacuum sealed nuts for human consumption
Walnut	Bark for human consumption
	Dried herbs for human consumption
	Juglans spp. for use as nursery stock
	Processed nuts for human consumption
	Raw nuts for human consumption
	Vacuum sealed nuts for human consumption

State and regional level – movement restrictions

The ability to control movement of materials that can carry and spread tree nut pests is of high importance. Each state/territory has quarantine legislation in place to control the importation of tree nut material interstate and intrastate, and to manage agreed pests if an incursion occurs (refer to Table 9). Further regulations have been put in place in response to specific pest threats and these are regularly reviewed and updated by state/territory authorities and the Sub-Committee for Domestic Quarantine and Market Access (SDQMA).

Moving plant material between states/territories generally requires permits from the appropriate authority, depending on the plant species and which territory/state the material is being transferred to/from. Moving plant material intrastate may also require a permit from the appropriate authority. Information on pre-importation inspection, certification and treatments and/or certification requirements for movement of tree nut can be obtained by contacting your local state or territory agriculture department directly (see Table 9), or through the SDQMA website **www.domesticquarantine.org.au** which lists relevant contacts in each state/territory as well as Interstate Certification Assurance (ICA) documents relating to each state/territory.

The movement of farm vehicles and equipment between states is also restricted because of the high risk of inadvertently spreading pests. Each state/territory has quarantine legislation in place governing the movement of machinery, equipment and other potential sources of pest contamination. Further information can be obtained by contacting your local state/territory department of agriculture and Water Resources (Table 9).

Table 9. *Interstate and interregional movement of plant products – legislation, quarantine manuals and contact numbers*

State	Administering authority	Legislation	Links to quarantine manual[23]	Phone
ACT	Environment ACT **www.environment.act.gov.au**	*Plant Disease Act 2002* *Pest Plants and Animals Act 2005*	See NSW conditions	13 22 81
NSW	Department of Primary Industries **www.dpi.nsw.gov.au**	*Plant Diseases Act 1924* *Plant Diseases Regulation 2008* *Noxious Weeds Act 1993* *Noxious Weeds Regulation 2008*	**www.dpi.nsw.gov.au/aboutus/about/legislation-acts/plant-diseases**	02 6391 3384
NT	Department of Primary Industry and Fisheries **www.nt.gov.au/d/Primary_Industry**	*Plant Health Act 2008* *Plant Health Regulations 2011*	**www.nt.gov.au/d/Primary_Industry/index.cfm?newscat1=&newscat2=&header=NT%20Quarantine**	08 8999 2118
Qld	Biosecurity Queensland, a part of the Department of Agriculture and Fisheries, Queensland **www.daf.qld.gov.au/biosecurity**	*Plant Protection Act 1989* *Plant Protection Regulation 2002*[24]	**www.daf.qld.gov.au/plants/moving-plants-and-plant-products**	132 523[25] 07 3404 6999[26]
SA	Primary Industries and Regions SA **www.pir.sa.gov.au**	*Plant Health Act 2009* *Plant Health Regulations 2010*	**www.pir.sa.gov.au/biosecurity/plant_health/importing_commercial_plants_and_plant_products_into_south_australia**	08 8207 7820
Tas	Department of Primary Industries, Parks, Water and Environment **www.dpipwe.tas.gov.au**	*Plant Quarantine Act 1997* *Weed Management Act 1999*	**http://dpipwe.tas.gov.au/biosecurity/plant-biosecurity/plant-biosecurity-manual**	1300 368 550
Vic	Department of Economic Development, Jobs, Transport and Resources **www.economicdevelopment.vic.gov.au/**	*Plant Biosecurity Act 2010* *Plant Biosecurity Regulations 2012*	**www.agriculture.vic.gov.au/psb**	136 186
WA	Department of Agriculture and Food **www.agric.wa.gov.au**	*Biosecurity and Agricultural Management Act 2007*	**www.agric.wa.gov.au/qtine/default.asp**	08 9334 1800

[23] If the link does not work, the relevant documents can be found by going to the department home page and checking the quarantine section of each website

[24] From July 2016 both the *Plant Protection Act 1989* and the *Plant Protection Regulation 2002* will be replaced by the *Biosecurity Act 2014* and *Biosecurity Regulation 2016*.

[25] Within Qld

[26] Interstate

New South Wales

Information on pre-importation inspection, certification and treatment requirements may be obtained from NSW DPI Regulatory Services by phone 02 6391 3384 or by visiting the NSW Department of Primary Industries website **www.dpi.nsw.gov.au/aboutus/about/legislation-acts/plant-diseases**.

Northern Territory

Administrative authority for regional quarantine in the Northern Territory (NT) is vested in the Department of Primary Industry and Fisheries (DPIF) under the *Plant Health Act 2008* and *Plant Health Regulations 2011*. The Act enables notifiable pests to be gazetted, quarantine areas to be declared and inspectors appointed to carry out wide ranging control and/or eradication measures. Plant import requirements for particular pests, plants or plant related materials are identified in the Regulations. Further information on NT import requirements and treatments can be obtained by contacting NT Quarantine on (08) 8999 5511 or email **quarantine@nt.gov.au.**

For more information refer to the DPIF website (**www.nt.gov.au/d**).

Queensland

Information on specific pre-importation inspection, treatments and/or certification requirements for movement of any fruit or plant material into Queensland, as well as maps of pest quarantine areas, may be obtained from the Biosecurity Queensland part of the DAF Queensland website (**www.daf.qld.gov.au/plants/moving-plants-and-plant-products**).

Further details can be obtained from the DAF Queensland Customer Service Centre (13 25 23 within Queensland, or phone 07 3404 6999 or fax 07 3404 6900 interstate).

South Australia

Information on pre-importation inspection, certification and treatments and/or certification requirements for movement of fruit or plant material in South Australia (SA) may be obtained from Biosecurity SA - Plant Health by phone (08) 8207 7820 or fax (08) 8207 7844. Further information can be found at **www.pir.sa.gov.au/biosecurity/plant_health**.

Primary Industries and Regions South Australia (PIRSA) have strict regulations and requirements regarding the entry of plant material (fruit, vegetables, flowers, plants, soil and seeds) into the State.

For further information on import conditions consult the Plant Quarantine Standard (**www.pir.sa.gov.au/biosecurity/plant_health/importing_commercial_plants_and_plant_products_into_south_australia**).

Tasmania

Information on specific pre-importation inspection, treatments and/or certification requirements for movement of any fruit or plant material into Tasmania may be obtained from the Department of Primary Industries, Parks, Water and Environment (DPIPWE) Biosecurity website (**www.dpipwe.tas.gov.au/biosecurity**) or by phoning 1300 368 550.

General and specific import conditions apply to the importation of plant material into Tasmania to prevent the introduction of pests and diseases into the State. Plants and plant products must not be imported into Tasmania unless State import requirements are met and a Notice of Intention to import has been provided to a Biosecurity Tasmania inspector not less than 24 hours prior to the importation.

For further information on import conditions consult the Plant Quarantine Manual (**http://dpipwe.tas.gov.au/biosecurity/plant-biosecurity/plant-biosecurity-manual**).

Victoria

The movement into Victoria of plants and plant products may be subject to a prohibition, or to one or more conditions which may include chemical treatments. These prohibitions and conditions are described on the Department of Economic Development, Jobs, Transport and Resources (DEDJTR) website (see link in Table 9). Some items may need to be presented to a DEDJTR inspector or an accredited business, for checking of details such as correct certification, labelling or treatment.

Further information on pre-importation inspection, certification and treatments and/or certification requirements for movement of fruit or plant material into or within Victoria may be obtained from DEDJTR on the web at **www.agriculture.vic.gov.au/psb** or by phone 136 186.

Western Australia

The lead agency for agricultural biosecurity in Western Australia is the Department of Agriculture and Food, Western Australia (DAFWA). Western Australia is naturally free from a large number of pests and diseases that are present in many other parts of the world. WA's geographical isolation in conjunction with a robust plant biosecurity system including border and intrastate regulations, industry and public awareness campaigns and surveillance programs maintains this status.

There are general and specific legislative requirements which underpin Western Australian plant biosecurity. Amongst other things the legislation regulates movement of potential carriers (such as plant material, honey, machinery, seeds etc.) into and within the state.

General conditions include (but are not limited to the following):

- The requirement for all potential carriers to be presented to an inspector for inspection upon arrival in WA
- Soil is prohibited entry and imported goods, including containers, must be free from soil
- Freedom from pests and diseases of quarantine concern to WA

In addition to the general requirements, specific requirements are also in place for movement into and within the state.

For further information on requirements contact Quarantine WA on (08) 9334 1800 or fax (08) 9334 1880.

Farm level – exclusion activities

A significant risk of spreading pests onto farms arises when propagation material, people, machinery and equipment move from property to property and from region to region. It is the responsibility of the industry and the owner/manager of each property to ensure these risks are minimised.

It is in the interests of industry to encourage and monitor the management of risk at the farm level, as this will reduce the probability of an incursion and increase the probability of early detection. This should in turn reduce the likelihood of a costly incident response, thereby reducing costs to industry, government and the community.

One major way this can be achieved is through management of industry biosecurity at the farm level using exclusion practices. Refer to the farm Biosecurity for more details (page 67).

Other components of the supply chain

This plan has a strong focus on mitigation activities on-farm. It is important to consider other sources of threat across the supply chain.

Other sources to be considered include:

- Management of propagation material
- Management of pickers/casual staff and machinery that may move between regions/farms
- Management of plant waste
- Management of packing/processing facilities

Surveillance

Surveys enhance prospects for early detection, minimise costs of eradication and are necessary to meet the treaty obligations of the WTO SPS Agreement with respect to the area freedom status of Australia's states, territories and regions.

The SPS Agreement gives WTO members the right to impose SPS measures to protect human, animal and plant life health provided such measures do not serve as technical barriers to trade. In other words, for countries (such as Australia) that have signed the SPS Agreement, imports of food, including fresh fruit and vegetables, can only be restricted on proper, science-based quarantine grounds. Where quarantine conditions are imposed, these will be the least trade restrictive measures available that meet Australia's appropriate level of quarantine protection. The Agreement also stipulates that claims of area freedom must be supported by appropriate information, including evidence from surveillance and monitoring activities. This is termed "evidence of absence" data and is used to provide support that we have actively looked for pests and not found them.

ISPM 6 (**www.ippc.int/sites/default/files/documents/20140528/spec_61_revispm6_2014-05-28_201405281352--150.18%20KB.pdf**) provides international guidelines for structured pest surveys. Structured pest survey planning and implementation depends on the risk involved, the resources available, and the requirements of trading partners (particularly when Australia wishes to access overseas markets). The intensity and timing of surveys also depend on the spread characteristics of the pest and the costs of eradication.

Early detection of an exotic incursion can significantly increase the likelihood of a successful eradication campaign, and reduce the associated costs. Effective surveillance plays a critical role in working toward this goal. Surveillance can be either targeted toward specific pests, or general in nature. General non-targeted surveillance is based on recognising normal versus suspect plant material. Targeted surveillance is important for establishing whether particular pests are present in each state or region, and if so, where these occur.

Industry personnel can provide very effective early detection of new or unusual symptoms through their normal management practices (i.e. 'passive surveillance'), provided individuals are aware of what to look for and of reporting procedures. Consultants and crop scouts can provide valuable information as they are regularly in the field, and hence can observe any unusual pest activity or symptoms on plants.

National surveillance programs

The Department of Agriculture and Water Resources maintains barrier quarantine services at all international ports and in the Torres Strait region. The Department of Agriculture and Water Resources also surveys the northern coast of Australia, offshore islands and neighbouring countries for exotic pests that may have reached the country through other channels (e.g. illegal vessel landings in remote areas, bird migrations, wind currents) as part of the Northern Australia Quarantine Strategy (NAQS). NAQS surveillance programs relevant to the tree nut industry are listed in Table 10.

State surveillance programs

State level surveillance depends on the participation of all stakeholder groups, particularly state/territory agriculture departments, industry representative groups, agri-business and growers.

The state/territory agriculture department can provide:

- planning and auditing surveillance systems
- coordination of surveillance activities between industry and interstate groups
- diagnostic services
- field diagnosticians for special field surveillance
- surveillance on non-commercial sites
- liaison services with industry members
- communication, training and extension strategies with industry
- biosecurity training
- reporting services to all interested parties (Department of Agriculture and Water Resources, national bodies, trading partners and industry).

Various pest surveillance programs are managed by the Department of Agriculture and Water Resources and the state/territory agriculture departments. Many state/territory departments run general surveillance programs whereby suspect samples can be forwarded and diagnosed for the presence of exotic pests free of charge. Official surveillance programs that target pests of the tree nut industry (exotic or those under official control in a region or state/territory) are shown in Table 10.

Table 10. *Official surveillance programs that target pests of the tree nut industry (as at December 2014)*[27]

Surveillance program	State/ region	Tree nut pests targeted	Host targeted
National bee pest surveillance program	National	Honey bee pests including: Tropilaelaps mites (*Tropilaelaps clareae, T. mercedessae*) and Varroa mite (*Varroa destructor*)	Honey bees
Aphid surveillance	NSW	Multiple species	Field crops, horticulture
Asian gypsy moth surveillance	NSW	Asian gypsy moth (*Lymantria dispar*)	Forestry
Diseases of cotton surveillance	NSW	Various including Verticillium wilt (*Verticillium dahliae*)	Cotton
Exotic bee mites surveillance program	NSW	Honey bee pests including: Tropilaelaps mites (*Tropilaelaps clareae, T. mercedessae*) and Varroa mite (*Varroa destructor*)	Honey bees
Urban hazard site surveillance	NSW	Various including: Glassy winged sharpshooter/Pierce's disease (*Homalodisca vitripennis/ Xylella fastidiosa*)	Multiple urban hosts
Apiarist cooperator bee pest surveillance	Qld	Honey bee pests including: Tropilaelaps mites (*Tropilaelaps clareae, T. mercedessae*) and Varroa mite (*Varroa destructor*)	Honey bees
CropSafe surveillance program	Qld	Various including Khapra beetle (*Trogoderma granarium*)	Stored grain
Endemic and exotic diseases of cotton surveys	Qld	Various including Verticillium wilt (*Verticillium dahliae*)	Cotton
Grain bulk handling surveillance program	Qld	Various including Khapra beetle (*Trogoderma granarium*)	Stored grain
Grains Farm Biosecurity Program	Qld	Various including Khapra beetle (*Trogoderma granarium*)	Stored grain
Gypsy moth surveillance	Qld	Gypsy moth (*Lymantria* spp.)	Multiple
Grains surveillance program	SA	Various including Khapra beetle (*Trogoderma granarium*)	Stored grain

[27] Information presented has been taken from the National Plant Health Status Report 2014 and confirmed or updated in January 2015 by the Subcommittee on National Plant Health Surveillance (sub-committee of the Plant Health Committee)

Surveillance program	State/ region	Tree nut pests targeted	Host targeted
Multiple pest surveillance program	SA	Various including: Glassy winged sharpshooter/Pierce's disease (*Homalodisca vitripennis*/ *Xylella fastidiosa*)	Multiple
Brown Marmorated Stink Bug surveillance	Tas	Brown Marmorated Stink Bug (*Halyomorpha halys*)	Fruit trees, woody ornamentals and some field crops
Gypsy moth surveillance	Tas	Asian gypsy moth (*Lymantria* spp.)	Forestry and pome fruit
On-farm biosecurity and surveillance program	WA	Various including Khapra beetle (*Trogoderma granarium*)	Stored grain
Chestnut blight eradication program	Vic	Chestnut blight (*Cryphonectria parasitica*)	Chestnuts
CropSafe surveillance program	Vic	Various including Khapra beetle (*Trogoderma granarium*)	Stored grain
National plant health surveillance program	Vic	Various including Asian gypsy moth (*Lymantria* spp.)	Forest and amenity trees

Farm surveillance activities

Farm level surveillance involves the participation and interaction of growers, agribusiness and industry representative groups. Examples of the surveillance activities that can be carried out by each of these groups are outlined in Figure 3. Conducting regular surveys of farms and nurseries provides the best chance of spotting new pests early and implementing eradication or management responses.

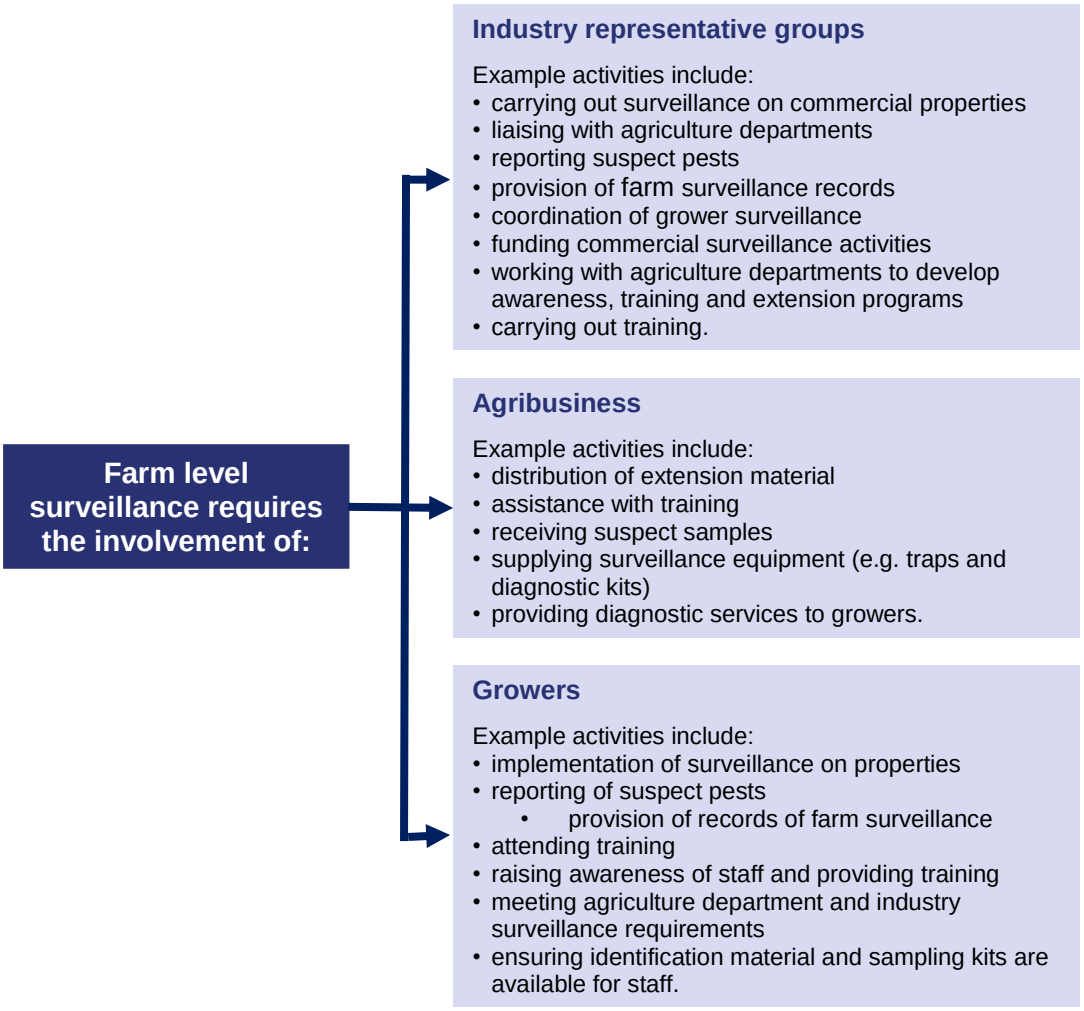


Figure 3. *Examples of farm level surveillance activities*

Training

A key component of biosecurity preparedness is ensuring personnel engaged are suitable and effectively trained for their designated roles in a response. Biosecurity preparedness training is the responsibility of all parties, government and industry, involved in the biosecurity system.

National EPP Training Program

PHA supports members in training personnel through the delivery of the National EPP Training Program. This program is focussed on ensuring personnel have the skills and knowledge to effectively fulfil the roles and responsibilities of parties under the EPPRD. This covers a range of areas, from representatives on the national decision making committees (i.e. the Consultative Committee on Emergency Plant Pests and the National Management Group) through to industry liaison personnel in the Local Control Centre.

Under the National EPP Training Program simulation exercises can also be conducted. These simulation exercises of an EPP incursion provide in-depth practical training, assess the preparedness of the industry to a pest incursion, increase understanding of the required roles and resources, identify communication gaps and highlight the interaction between industry and governments during an incursion response.

In addition to face to face training delivered to members and the provision of simulation exercises, PHA also offers biosecurity training through *BOLT*, and online training platform. Access to BOLT is free and open to any stakeholder interested in biosecurity, and is available through **www.planthealthaustralia.com.au/bolt**.

For more information on the National EPP Training program, refer to **www.planthealthaustralia.com.au/training**.

Awareness

Early reporting enhances the chance of effective control and eradication. Awareness activities (such as the manual shown in Figure 4) raise the profile of biosecurity and exotic pest threats to the tree nut industry, which increases the chance of early detection and reporting of suspect pests. Responsibility for awareness material lies with industry and government, with

assistance from PHA as appropriate. Any unusual plant pest should be reported immediately to the relevant state/territory agriculture department.

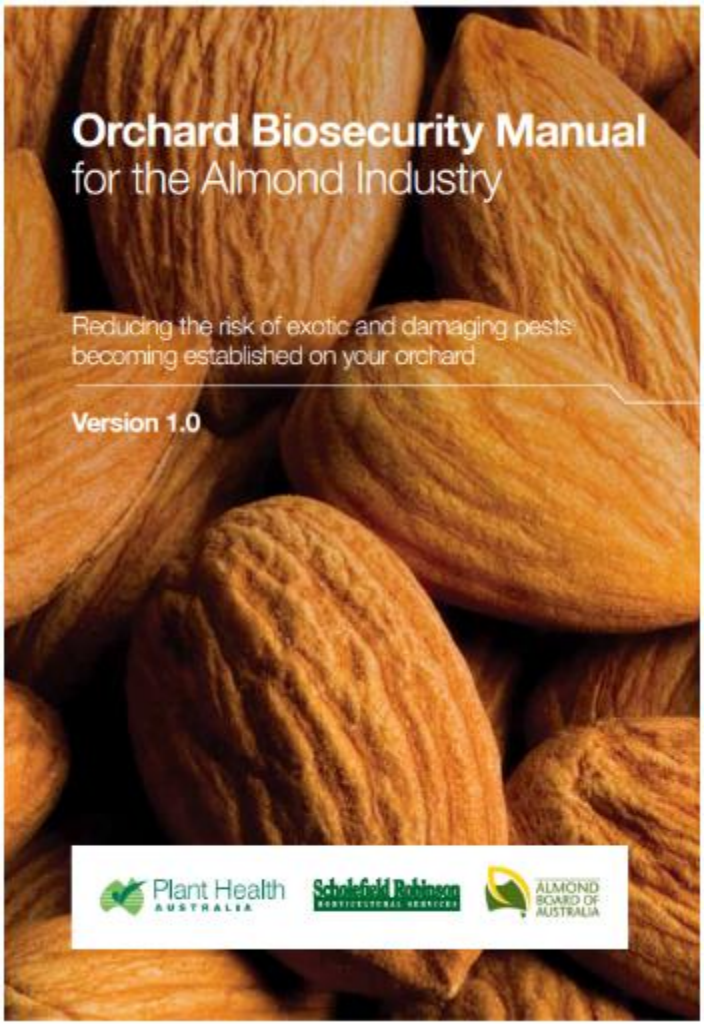


Figure 4. *Examples of awareness material developed for the almond industry*

High priority plant pest threat-related documents

Pests listed in Table 6 have been identified as high priority threats to the tree nut industry by members of the IBG. They have been assessed as having high entry, establishment and spread potentials and/or a high economic impact. This list should provide the basis for the development of awareness material for the industry.

Further information on high priority pests

The websites listed below (Table 11) contain information on pests across most plant industries, including the tree nut industry.

Table 11. *Sources of information on high priority pest threats for the tree nut industry*

Source	Website
Department of Agriculture and Water Resources	**www.agriculture.gov.au**
Pest and Disease Image Library (PaDIL)	**www.padil.gov.au**
DAF Queensland A-Z list of significant plant pests and diseases	**www.daf.qld.gov.au/plants/health-pests-diseases/a-z-significant**
University of California Statewide Integrated Pest Management (IPM) Program	**www.ipm.ucdavis.edu/EXOTIC/exoticpestsmenu.html**
Knowledge Master[28]	**www.extento.hawaii.edu/Kbase/crop/crop.htm**
European and Mediterranean Plant Protection Organization (EPPO)	**www.eppo.int/DATABASES/pqr/pqr.htm**

[28] Developed by University of Hawaii, College of Tropical Agriculture and Human Resources and Hawaii Department of Agriculture

Further information/relevant web sites

A range of government and grower organisation details and websites are provided below (Table 12) for persons seeking further information on tree nut industry biosecurity.

Table 12. *Relevant sources of further biosecurity information for the tree nut industry*

Agency	Website/email	Phone	Address
National			
Almond Board of Australia	**www.australianalmonds.com.au/**	08 8582 2055	PO Box 2246 Berri SA 5343
Australian Macadamia Society	**www.australian-macadamias.org/consumer/en**	1800 262 426	113 Dawson St. Lismore, NSW 2480
Australian Pecan Growers Association	**www.pecangrowers.org.au/**	02 6564 8747	PO Box 590 Lismore, NSW, 2480
Chestnuts Australia	**www.chestnutsaustralia.com.au/**	03 5751 1466	PO Box 472 Myrtleford, Victoria 3737
Department of Agriculture and Water Resources	**www.agriculture.gov.au**	(02) 6272 3933 1800 020 504	GPO Box 858 Canberra, ACT 2601
Hazelnut Growers of Australia Inc	**http://hazelnuts.org.au/static/**	0417 809 172	PO Box 214 Lobethal SA 5241
Pistachio Growers Association	**http://www.pgai.com.au/**	0417 809 172	27 Ludgate Hill Rd Aldgate SA 5154
Plant Health Australia	**www.planthealthaustralia.com.au** **biosecurity@phau.com.au**	(02) 6215 7700	Level 1, 1 Phipps Cl Deakin, ACT 2600
Australian Walnut Industry Association	**www.walnut.net.au/**	0418 664 672	PO BOX 80 Moyhu 3732 Victoria

Agency	Website/email	Phone	Address
New South Wales			
Department of Primary Industries	**www.dpi.nsw.gov.au/biosecurity/plant**	(02) 6391 3535	Locked Bag 21 Orange, NSW 2800
Queensland			
Biosecurity Queensland, a part of the Department of Agriculture and Fisheries, Queensland	**www.daf.qld.gov.au** **callweb@daf.qld.gov.au**	13 25 23[29] 07 3404 6999[30]	80 Ann Street Brisbane, QLD 4000
Northern Territory			
Department of Primary Industry and Fisheries	**www.nt.gov.au/d/Primary_Industry** **info.DPIF@nt.gov.au**	(08) 8999 5511	Berrimah Farm, Makagon Road Berrimah, NT 0828
South Australia			
Primary Industries and Regions SA	**www.pir.sa.gov.au**	(08) 8207 7820	GPO Box 1671 Adelaide, SA 5001
Biosecurity SA-Plant Health	**www.pir.sa.gov.au/biosecuritysa/planthealth** **PIRSA.planthealth@sa.gov.au**	(08) 8207 7820	33 Flemington Street Glenside, SA 5065
Biosecurity SA-Plant Health Market access and Interstate Certification Assurance	**IRSA.planthealthmarketaccess@sa.gov.au**	(08) 8207 7814	
Biosecurity SA-Plant Health Transport manifest lodgement	**pirsa.planthealthmanifest@sa.gov.au**	Fax: (08) 8124 1467	
South Australian Research and Development Institute	**www.sardi.sa.gov.au** **sardi@sa.gov.au**	(08) 8303 9400	2b Hartley Grove Urrbrae, SA 5064
Tasmania			
Department of Primary Industries, Parks, Water and Environment	**www.dpipwe.tas.gov.au** **BPI.Enquiries@dpipwe.tas.gov.au**	1300 368 550	GPO Box 44, Hobart, TAS 7001

[29] Within Qld
[30] Interstate

Agency	Website/email	Phone	Address
Victoria			
Department of Economic Development, Jobs, Transport and Resources	**www.economicdevelopment.vic.gov.au/**	136 186	CPHO Group, Division of Market Access and Regulation, Biosecurity Branch Department of Economic Development, Jobs, Transport and Resources 475 Mickleham Road, Attwood, Victoria 3047
Western Australia			
Department of Agriculture and Food	**www.agric.wa.gov.au** **enquiries@agric.wa.gov.au**	(08) 9368 3333	DAFWA 3 Baron-Hay Court South Perth, WA 6151

Farm biosecurity

Introduction

Plant pests can have a major impact on production if not managed effectively. This includes pests already present in Australia and a number of serious pests of tree nut that Australia does not have.

Farm biosecurity measures can be used to minimise the spread of such pests before their presence is known or after they are identified, and therefore can greatly increase the likelihood that they could be eradicated. This section of the document outlines farm biosecurity and hygiene measures to help reduce the impact of pests on the industry.

The biosecurity and hygiene measures outlined here can be considered as options for each farm's risk management. Many of these measures can be adopted in a way that suits a given farm so that each can have an appropriate level of biosecurity.

Farm biosecurity reporting procedures and hygiene strategies to reduce threats covered in this document are:

- selection and preparation of appropriate plant material
- chemical control measures
- control of vectors
- control of alternative hosts
- neglected farms and volunteer plants
- post-harvest handling and produce transport procedures
- use of warning and information signs
- managing the movement of vehicles and farm equipment
- movement of people
- visiting overseas farms/orchards – what to watch out for when you return
- including farm biosecurity in Industry best management practice and quality assurance schemes
- farm biosecurity checklist

Development of an on farm biosecurity plan tailored to the needs of an individual operation is a good way to integrate best practice biosecurity with day to day operations (**http://www.farmbiosecurity.com.au/planner/**).

Farm biosecurity videos that focus on the biosecurity essentials, demonstrate how to secure your farm against diseases, pests and weeds and provide as excellent resource when completing an on farm biosecurity plan (**http://www.farmbiosecurity.com.au/videos/**).

Selection and preparation of appropriate plant material

Bottom line	Using high health, clean seed material or tissue cultured tree nut plants reduces the pest load and improves farm biosecurity.

Plants and propagation material should not be distributed without screening for pests. Infected planting material is the main source of spread for some serious pests. Material from infected plants may appear healthy, so the outward appearance of planting material cannot be regarded as a reliable indicator of pest status. Soil carried on plants can harbour pathogens or pests, such as fungal spores or nematodes.

Chemical control measures

Bottom line	Appropriate training and advice on safe chemical use should be obtained prior to chemical control of pests.

Chemical control programs may be required during crop growth to control pests or may be required around the farm to control weeds or volunteers that may harbour pests. A planned and effective monitoring and pest management program, prepared in consultation with an IPM consultant and/or your local agriculture department officers, will minimise the impact of pests on your crop.

Farmers, their staff and contractors applying chemical control measures are required by law to complete certain training in an accredited course, depending upon the state in question.

The Australian Pesticides and Veterinary Medicines Authority (APVMA) is the national authority responsible for registration and deregistration of chemicals and can be contacted by phone on (02) 6210 4701. The APVMA Permit Section deals specifically with emergency registrations for chemicals. Further information can be obtained from the APVMA web site (**www.apvma.gov.au**).

Control of vectors

Bottom line	Vectors, such as insects, people and machinery can increase the spread of some pathogens, especially viruses and bacteria.

Many viruses and some bacteria require a vector to provide a means of dispersal. Biological vectors can include insects and mites, nematodes, fungi, birds and people. Non-biological vectors such as machinery/equipment and clothing can also serve as vectors of plant pathogens and nematodes (for example many nematodes and pathogens can be spread in soil moved between properties on vehicles and machinery). The activity and mobility of the vector determines the rate and distance of dispersal. Some insects may not be vectors but can increase the severity or facilitate the spread of the pathogen.

Inspection and cleaning of vehicles, machinery and equipment (such as harvesters, tractors, machinery used for planting and spraying, vehicles transporting inputs and harvested produce, tools used for grafting, etc.) helps to prevent pest spread, as does cleaning of footwear and restricting unnecessary people movements around the farm. Consideration should also be given to the control of known vectors of plant pathogens when new disease incursions are likely. In these cases, management of the vector may enable management of the pathogen.

The use of chemicals to control vectors can have a number of potentially adverse effects on the production and marketing of tree nut including residues on produce that may limit market access, and chemical resistance that may develop in target pests.

IPM practices, such as the use of natural enemies and pheromone traps, can be effective methods of controlling vectors and managing the threat of insecticide resistance. Advice on IPM and control of vectors can be obtained from your local state/territory agriculture department.

Control of alternative hosts

Bottom line	Pest management protocols can be enhanced through the control of alternative hosts.

Control of Weeds

Weed species are significant biosecurity problems in their own right as well as acting as alternative hosts of many agricultural or horticultural pests. Where this is so, weed control practices can significantly contribute to limiting the survival of pests and reducing the potential for incursions.

Some alternative hosts may not be weeds. Details of any alternative hosts will be included in pest specific contingency plans for high priority tree nut pests (see Contingency Plans and Response Management section of this plan on page 86).

Control of ornamental host plants

Ornamental plants present around tree nut cropping areas are also of concern as they can harbour disease inoculum and insect pests, which can then spread to nearby crops. Strategies for the containment or destruction of ornamental plants should be adopted depending on the pest involved. Specific advice should be sought from the relevant state/territory agriculture department.

Neglected farms and volunteer plants

Bottom line	Reduce the ability of pests to spread and establish through the removal of neglected plants.

Neglected farms and volunteer plants potentially pose a high biosecurity risk to the tree nut industry, as they may allow pests to multiply, become established and spread.

Control of derelict farms and feral plants should be proactive to reduce the risk of establishment and spread of new pests, should an incursion occur. If no action is taken with regard to the removal of these plants, the task will get progressively larger until it reaches a level of impossibility.

In general the problem is caused by some members of the community and not by industry. The industry is strongly supportive of the need for this host burden to be removed.

Suspected neglected or volunteer plants should be reported to one of the authorities listed in Table 13. After reporting, appropriate steps may be taken by the relevant authority to ensure the neglected plants do not carry pests or pose a risk to nearby or adjacent farms. Table 13 also provides a summary of the actions that may be carried out in each state under relevant legislation.

Table 13. *Authorities responsible for dealing with neglected, feral or volunteer plants*

State	Authority	Legislation	Actions enabled
NSW	DPI	*Plant Diseases Act 1924*	The *Plant Diseases Act 1924* provides powers to quarantine and requires owners to treat plants harbouring pests or diseases. The Act gives officers the power to destroy plants within neglected or abandoned orchards or nurseries, if they are likely to harbour or spread diseases or pests.
NT	DPIF	*Plant Health Act 2008* *Plant Health Regulations 2011*	There is no provision for control of neglected farms unless a declared pest or disease has been detected on the farm or in the near vicinity and specified action or removal is required by a notice from the Chief Inspector, for plants to be destroyed. Costs incurred may be recovered if conducted by DPIF.
Qld	DAF Qld	*Plant Protection Act 1989* *Plant Protection Regulation 2002*[31]	The Department of Agriculture, Fisheries and Forestry, Queensland has no particular powers on neglected farms, unless they are infested with a declared pest.
SA	PIRSA	*Plant Health Act 2009*	There is no provision under the SA *Plant Health Act 2009* for control of neglected farms unless a declared pest or disease has been detected in the farm or in the near vicinity and specified action or removal is required by Ministerial Notice.
Tas	DPIPWE	*Plant Quarantine Act 1997*	Though there are no specific legislative provisions to deal with neglected farms. Biosecurity Tasmania advise that neglected farms should be reported to the Department of Primary Industries, Parks, Water and Environment, or the State Grower Industry representative. Neglected farms may be removed if they present a risk to adjacent farms by harbouring populations of pests or diseases on the "Annual List of List A and List B Pests and Diseases". Copies of these lists are available on request from Quarantine Services, Tasmania and are provided in the back of the Tasmanian Plant Quarantine Manual. .
Vic	DEDJTR	*Plant Biosecurity Act 2010*	Under the Plant *Biosecurity Act 2010*, if an inspector knows or reasonably suspects that any plant or plant product is affected by any plant pest or disease on any land, and he or she reports it to the Secretary, a notice may be issued requiring that the owner or occupier control, eradicate or destroy the affected plants or plant produce.

[31] From July 2016 both the *Plant Protection Act 1989* and the *Plant Protection Regulation 2002* will be replaced by the *Biosecurity Act 2014* and *Biosecurity Regulation 2016*.

State	Authority	Legislation	Actions enabled
WA	DAFWA	*Plant Diseases Act 1914* *Biosecurity and Agricultural Management Act 2007*[32]	Neglected production plants in Western Australia can be removed or destroyed if required, under order by the Minister.

Growers wishing to remain anonymous when reporting suspected neglected or feral crops may report through their local or national grower association.

Destruction of crop residues

Bottom line	Proper management of crop residues reduces the pest load on your next crop.

The removal of crop and pruning residues from the orchard reduces the over seasoning of pests in the crop and the initial pest load the following season.

Collection and removal of pruned material as well as unharvested nuts and the chipping, mulching or burning of this material are common methods of disposal. The removal of unharvested nuts also reduces vermin populations in the orchard. Approval for burning residues may need to be sought prior to use of this destruction method.

Use of warning and information signs

Bottom line	Warning signs tell visitors to your property that you have biosecurity measures in place so as to minimise the spread of pests.

Place warning and information signs on the entrances and gates of properties (where practicable) to help inform visitors of the biosecurity practices in place, and remind personnel that farm biosecurity is a priority. Signs should also include up-to-date contact details for people to gain further information. Visitors to the area may not be aware of relevant biosecurity protocols.

All people entering the property should have a clear view of any informative signs. Signs should contain simple messages (e.g. do not enter the property without prior approval, use wash down facilities for cleaning vehicles and machinery). An example biosecurity sign is shown in Figure 5.

[32] Will replace *Plant Diseases Act 1914*. Implementation soon to be underway.

Figure 5. *Example biosecurity warning and information sign*

Post-harvest handling and managing the movement of vehicles and farm equipment

Bottom line Pest spread off-property can be reduced through providing appropriate wash-down facilities for machinery and equipment and checking for pest activity on the farm. Produce identification systems provide a mechanism for tracing pests following an incursion.

A high risk of spreading pests comes from the movement of people, machinery and equipment between regions and farms. Vehicles (including cars and farm equipment such as harvest bins and tractors) can carry soil and soil-borne pathogens (especially when muddy) and plant debris may have weed seeds or may carry pests (including pathogens or insects). This risk can be reduced by ensuring plant material and soil that may harbour pests is removed before people, machinery and equipment are moved to other properties or regions.

This section deals only with movements between farms and growing regions. For interstate or international movements of farm equipment and vehicles, contact your state/territory agriculture department (Table 9) or DAWR, respectively.

While it is not always practical to stop these movements on and off your farm, a number of measures can be used to reduce the risk of pest spread by this route. Possible strategies are outlined below:

- visually inspect machinery and equipment (e.g. harvest bins, trucks and any other equipment) for signs of soil or plant material before it comes onto the property.
- clean soil, plant or other debris from equipment or vehicles (especially equipment used on crops directly) prior to entering the property and deny access to any equipment that does not meet your standards.

- use high-pressure wash down facilities (ideally with a concrete or tarmac pad for cleaning vehicles and equipment), not allowing wash down runoff to enter the farm or irrigation sources.
- restrict movements of vehicles and people (where possible) during high-risk periods. This may include avoiding moving vehicles and machinery, particularly when roads are wet and muddy.
- consider assigning certain equipment (including clothing, tools and footwear) to be used in pest infected areas only. This means that the equipment used in infected properties or areas is not reused in clean areas – and *vice versa.*
- maintain effective pest monitoring and management programs. This includes keeping records of pest incursions and the control measures used. Clients receiving the produce should be informed of the produce source and whether the material has come from an area experiencing a pest incursion.
- identification and tracing systems will assist in tracing produce consignments to their source if they are found to be contaminated with an exotic pest. Consignments should be clearly marked with the grower's name or code, and a batch identification mark (date or other code). Growers should maintain a record of the source and destination of each batch, and identify separate growing areas on a property map.
- post-harvest handling and produce transport procedures that minimise the risk of pest movement should be developed further and promoted within the industry.
- provide a designated parking area at the front of the property.
- transport visitors, contractors, employees and government officials using vehicles based permanently on the property.
- cover harvested crops to prevent plant material (especially potential "seed" material) from blowing off during transit to packing facilities or markets.
- up-to-date advice on movement restrictions must always be sought before moving tree nut plant material and products. This can be obtained from the Domestic Quarantine website (www.dqmawg.org.au), or enquiries can be made directly to your local state or territory agriculture agency.

National controls

The Australian Government is responsible for the inspection of machinery and equipment being imported into Australia. Administrative authority for national quarantine is vested in Australian Government Department of Agriculture and Water Resources under the *Biosecurity Act 2015*[33]. Any machinery or equipment being imported into Australia must meet quarantine requirements. If there is any uncertainty, contact Department of Agriculture and Water Resources on (02) 6272 3933 or 1800 020 504, or visit the website at **http://www.agriculture.gov.au**.

[33] During the life of the biosecurity plan the Australian Government will transition from the *Quarantine Act 1908* to the *Biosecurity Act 2015*. The new Biosecurity Act will commence on 16 June 2016, 12 months after royal assent, replacing the *Quarantine Act 1908*.

State controls

Each state has quarantine legislation in place governing the movement of machinery, equipment and other potential sources of pest contamination (Table 9). A summary of the movement restrictions can be found in Table 14 with additional information available in quarantine manuals (Table 9) and on the Domestic Quarantine website (**www.dqmawg.org.au**).

Table 14. *State/territory restrictions on movement of machinery and equipment*

State	Authority	Legislation	Control procedures
NSW	NSW DPI	*Plant Diseases Act 1924* *Noxious Weeds Act 1993* *Noxious Weeds Regulation 2008*	Restrictions apply to movement of machinery and equipment into NSW that may have come into contact with rice pests, Onion smut, Panama disease Tropical race 4, Banana freckle, Red imported fire ants, Lupin anthracnose, Potato cyst nematode, Cucumber green mottle mosaic virus or Grapevine phylloxera. Requirements regarding the inspection and cleaning of machinery for weed seeds are covered by the *Noxious Weeds Act 1993* and *Noxious Weeds Regulation 2008.*
NT	DPIF	*Plant Health Act 2008* *Plant Health Regulations 2011*	A permit is required for the movement of agricultural machinery & equipment and mining and earthmoving machinery & equipment into the NT. Restrictions are in place to control movement of machinery, equipment and persons from gazetted quarantine areas. Contact NT Quarantine on (08) 8999 5511
Qld	DAF Qld	*Plant Protection Act 1989* *Plant Protection Regulation 2002*[34]	Restrictions apply to the entry of machinery and equipment. Contact Biosecurity Queensland through the DAF Queensland Customer Service Centre on (07) 3404 6999.
SA	PIRSA	*Plant Health Act 2009*	Restrictions apply to freedom from soil and plant material for the movement of used agricultural machinery into South Australia to prevent introduction of pests and diseases of interest e.g. Phylloxera or Potato cyst nematodes.
Tas	DPIPWE	*Plant Quarantine Act 1997* *Weed Management Act 1999*	Requirements regarding the inspection and cleaning of machinery coming to Tasmania are covered by the *Plant Quarantine Act 1997* (Section 55), Sections 2.6 to 2.8 and Import Requirement 39 of the *Plant Biosecurity Manual Tasmania*, and the *Weed Management Act 1999*. Machinery and equipment must be free from soil, plant trash, plants, declared weed seeds and other declared diseases or organisms.

[34] From July 2016 both the *Plant Protection Act 1989* and the *Plant Protection Regulation 2002* will be replaced by the *Biosecurity Act 2014* and *Biosecurity Regulation 2016*.

State	Authority	Legislation	Control procedures
Vic	DEDJTR	*Plant Biosecurity Act 2010* *Plant Biosecurity Regulations 2012*	Restrictions apply to movement of machinery and equipment, such as bins, into or within Victoria to prevent spread of pests and diseases of interest e.g. Fire ants, Potato cyst nematodes or Grapevine phylloxera.
WA	DAFWA	*Plant Diseases Act 1914* *Plant Diseases Regulations 1989* *Biosecurity and Agricultural Management Act 2007*[35]	Machinery and equipment entering Western Australia must be presented for inspection and be free from soil and plant material. Additional specific requirements apply for some machinery and equipment. For further information on requirements contact Quarantine Western Australia on (08) 9334 1800 or fax (08) 9334 1880.

Farm/regional activities

It is in the interests of industry to encourage and monitor the management of biosecurity risks at the farm level, as this will reduce the probability of an incursion and increase the probability of early detection. This should in turn reduce the likelihood of a costly incident response, thereby reducing the costs to the industry, governments and the wider community.

Suggested practices for minimising pest spread at the farm level include:

- ensuring that all visitors to the farm report directly to the office on arrival.
- checking that machinery, vehicles, and equipment (e.g. trailers, crates, bins) entering or leaving properties are free of soil and crop debris.
- visually inspecting machinery and equipment before it comes onto the property and denying access to any equipment that does not meet biosecurity standards.
- restricting movements of vehicles and people (if possible) during high risk periods. This may include avoiding moving vehicles and machinery, particularly when roads are wet and muddy.
- wash and disinfect equipment used in high risk areas to avoid transferring pests to other areas of the farm.
- ensuring all visitors and employees are aware of the importance of keeping footwear and clothing (including hats) free from loose dirt and plant matter before entering or leaving the property.
- providing wash down facilities for both machinery and people (e.g. high pressure hose with a concrete or tarmac pad, scrubbing brushes and footbaths).
- providing a designated parking area and transporting visitors, contractors, employees and government officials using vehicles based permanently on the property.
- minimising unnecessary entry of vehicles from outside the farm and movements of vehicles around the farm (especially when the soil is wet).

[35] Will replace *Plant Diseases Act 1914* and *Plant Diseases Regulations 1989*. Implementation soon to be underway.

- reporting all suspected exotic pests to your relevant agriculture department or the Exotic Plant Pest Hotline (1800 084 881).

Movement of people

Bottom line	People can also carry pests, particularly on boots and clothing. Inform people of your biosecurity measures and provide hygiene options such as foot baths to minimise pest spread via visitors.

Movement of people between farms and between regions can also potentially spread pests. Fungal spores, bacteria, insects and weed seeds can be carried onto a property, on boots and clothing (including hats) that have been worn on another farm, especially those covered in soil. While it is not practical to completely stop movements of people on and off your farm, a number of measures can be used to reduce spread of pests by this route. Possible strategies are:

- ensure all visitors to your property report directly to your office or house on arrival.
- ensure all visitors and employees are aware of the importance of keeping footwear and clothing (including hats) free from loose dirt and plant matter before entering or leaving the property.
- supply footwear or footbaths (with a scrubbing brush) containing a strong cleansing solution such as ‘Farm cleanse’ detergent to avoid the spread of soil, mud and pathogens between areas.
- use signs to alert people that biosecurity measures need to be undertaken and to report to the office/house.
- brief staff, contractors and visitors on your farm hygiene measures.
- undertake biosecurity/quarantine training for employees and other personnel.
- be aware if your visitors have recently arrived from overseas.

Visiting overseas farms/orchards – what to watch out for when you return

Bottom line	Production regions overseas may have devastating pests that Australia does not have – before returning, wash your clothes, boots and hair, and declare your visit to quarantine!

When visiting production regions and farms overseas that may have pests not present in Australia, care should be taken not to inadvertently introduce these pests into Australia. Prior to returning from a visit, individuals should thoroughly wash all clothing and footwear used

during the visit as well as their hair, which may carry bacterial and fungal spores. Also, any visits to farms (including orchards) should be declared on re-entry documentation as required.

Pollination services and biosecurity

Bottom line	Encouraging good bee biosecurity practices provides benefits to beekeepers and growers, and protects the honey bee and pollination-dependent industries, such as the Australian tree nut industry

Growers of tree nut require pollination services to maximise the quantity and quality of product grown. However, bringing in beekeepers to satisfy the crops requirement for pollination can result in some unique biosecurity risks.

It is possible that pests can be carried and spread between properties by beekeepers through soil, apiary equipment, vehicles, clothing and boots. This could introduce pests that are damaging to the tree nut industry and the natural environment. It is also possible that through the pollination process, honey bees moving between plants can provide a mechanism for the spread of plant pests within and between the crops grown.

Tree nut producers should expect beekeepers to:

- check the health of any hives brought in to provide pollination services and have an accompanying apiary health certificate
- audit the hives to determine that they meet the required standards to provide sufficient pollination services
- specifically check bees and brood for signs of pests and diseases
- maintain strong hives that are not susceptible to pest attack
- avoid placing hives near abandoned hives, as these are more likely to be diseased
- regularly inspect and record bees for unusual behaviour
- ensure that the beekeeper (and hives) are registered and that they comply with all possible movement restrictions with the state/territory.

Working together to reduce biosecurity threats, tree nut producers and beekeepers should:

- sign a pollination contract, which helps specify the responsibilities of both parties and helps clarify what the grower is hiring and what the beekeeper needs to supply
- discuss with the beekeeper any chemicals that may need to be applied during the pollination period
- investigate the use of bee friendly chemicals, or spray at a time when bees are not foraging (i.e. night)
- ensure a clean water source is available for honey bees

- if possible, minimise the number of people and vehicles that work around, or visit the hives
- ensure that the beekeepers vehicles, equipment, boots and clothing are free from plant material, soil, insects and other pests before entering and leaving farms or handling hives
- check hives when monitoring the farm and report any unexplained decline in bee numbers, crawling or dead bees near hive entrances or any unusual bee behaviour.

For more information about honey bee biosecurity and pollination of agricultural and horticultural crops see **www.beeaware.org.au**.

Including farm biosecurity in Industry Best Management Practice and Quality Assurance schemes

Bottom line	Growing tree nuts following Best Management Practice and Quality Assurance schemes ensures high quality produce and reductions in pest impact and spread.

For farm level protection from pests, the following farm biosecurity (farm hygiene) measures are recommended:

- using disease-free propagation material. All propagation material should be packed in sealed containers and carry identifying marks that allow tracking of the origin of products.
- seeking advice from the state/territory agriculture department before transporting plant material between growing regions or interstate.
- inspecting all incoming vehicles and equipment for signs of contaminated soil or plant material and enforcing biosecurity standards.
- using high pressure wash down facilities associated with a concrete or tarmac pad for cleaning vehicles and equipment, with treatment and disposal of effluent away from plants and irrigation sources.
- disposing of farm waste away from crops or propagating areas.
- undertaking a biosecurity/quarantine education and training program for employees and related personnel.
- having a planned, effective monitoring and pest management program.
- erecting informative signs at the entrance of the property which outline the basic biosecurity requirements for all visitors.
- reporting all suspect diseased plants and pests to the local state/territory agriculture department, for identification.
- minimising vehicle movement around the farm.

- including supplier information with produce consignments and maintaining source and destination records.
- training staff in effective use of relevant chemicals.
- disposing of unwanted plants and reporting neglected crops and volunteer plants to the local state/territory agriculture department.
- managing visitor movement around the farm by using vehicles which remain on the property, and supplying footwear or footbaths.
- keeping public sales and tourist activities separate from the farm area.

Including such measures in Industry Best Management Practice (BMP) and Quality Assurance (QA) schemes will strengthen the ability to rapidly detect, control and eradicate exotic pest incursions in the tree nut industry before extensive damage occurs. BMP and QA schemes that cover some of the above biosecurity measures are listed in Table 15.

Table 15. *Tree nut industry BMP and QA schemes*

Scheme	Key areas of biosecurity relevance
Freshcare Code of Practice	Freshcare is the industry-owned, national, on-farm food safety program for the fresh produce industry. Freshcare links food safety on farm to the quality and food safety programs of the other members of the fresh produce supply chain.
Codex Hazard Analysis Critical Control Point (HACCP)	HACCP certification provides a recognised endorsement of food safety excellence.
GlobalG.A.P	GlobalG.A.P (Good Agricultural Practice) started in Europe to help producers comply with European criteria for: food safety, sustainable production methods, worker and animal welfare, responsible use of water, compound feed and plant propagation materials. Since then the organisation has grown and now represents the interests of more than 100 countries.
Safe Quality Food (SQF) 2000 for packers and processors & SQF 1000 for producers	SQF Codes provide primary producers (SQF 1000) and food manufacturers, retailers, agents and exporters (SQF 2000) with a food safety and quality management certification program that is tailored to their requirements and enables suppliers to meet regulatory, food safety and commercial quality criteria. The SQF Codes are owned and managed by the Food Marketing Institute of the USA.
Nut industry best practice guides	A range of BMP guides are available for the various tree nut industries. There is potential to incorporate best biosecurity practice principles into these documents over the period of this biosecurity plan.

Farm biosecurity checklist

Use this checklist to do a quick biosecurity assessment of your property and see sections of this document for further detail on each point.

Farm biosecurity checklist	Yes	No
Do you have information signs placed at the entry gate to demonstrate your hygiene/biosecurity measures?		
Do you maintain secure boundary fences?		
Do you provide movement controls (people and vehicles) and wash down areas/footbaths to prevent spread of pests onto your property?		
Do you have designated parking for visitors?		
Do you provide on-property transport for visitors?		
Do you check if visiting machinery been cleaned correctly prior to entering your property?		
Do you use high health planting material?		
Do you ensure seed or propagation material is as clean as possible to prevent the spread of soil-borne nematodes and pathogens?		
Do you ensure that you and your staff are adequately trained in the correct use of pesticides?		
Do you provide biosecurity training and awareness for farm staff?		
Do you use quality assurance and/or best management practice systems?		
Have you sought advice from an expert in developing and implementing your farm's biosecurity plan?		
Have you been to an overseas farm, orchard or to a suspect area? Wash your clothes, hat, boots and hair, and declare your international visit to quarantine!		
Do you know where to report anything unusual?		

Development of an on farm biosecurity plan tailored to the needs of an individual operation is a good way to integrate best practice biosecurity with day to day operations (**http://www.farmbiosecurity.com.au/planner/**). Further information is relation to farm biosecurity can be found at the farm biosecurity website (**www.farmbiosecurity.com.au**).

Reporting suspect pests

Any unusual plant pest should be reported immediately to the relevant state/territory agriculture agency through the Exotic Plant Pest Hotline (1800 084 881). Early reporting enhances the chance of effective control and eradication.

Reporting an exotic plant pest carries serious implications and should be done only via the Exotic Plant Pest Hotline. Careless use of information, particularly if a pest has not been confirmed, can result in extreme stress for individuals and communities, and possibly damaging and unwarranted trade restrictions.

If you suspect a new pest, call the Exotic Plant Pest Hotline on 1800 084 881

Calls to the Exotic Plant Pest Hotline will be forwarded to an experienced person in the department of agriculture from the state of origin of the call, who will ask some questions about what you have seen and may arrange to collect a sample. Every report will be taken seriously, checked out and treated confidentially.

In some states and territories, the Exotic Plant Pest Hotline only operates during business hours. Where this is the case, and calls are made out of hours, callers should leave a message including contact details and staff from the department of agriculture will return the call the following business day.

Some tree nut pests are notifiable under each state or territory's quarantine legislation. The complete list of notifiable pests can be downloaded from the PHA website[36]; however, each state's list of notifiable pests are subject to change over time so contacting your local state/territory agricultural agency (details in Table 9) will ensure information is up to date. Landowners and consultants have a legal obligation to notify the relevant state/territory agriculture agency of the presence of those pests within a defined timeframe (Table 16).

Table 16. *Timeframe for reporting of notifiable pests as defined in state/territory legislation*

State/territory	Notifiable pest must be reported within
NSW	24 hours
NT	24 hours
Qld	24 hours
SA	Immediately
Tas	As soon as possible
Vic	Without delay
WA	24 hours

Suspect material should not generally be moved or collected without seeking advice from the relevant state/territory agriculture agency, as incorrect handling of samples could spread the pest or render the samples unsuitable for diagnostic purposes. State/territory agriculture officers will usually be responsible for sampling and identification of pests.

[36] Available from **www.planthealthaustralia.com.au/biosecurity/notifiable-pests**

Preparedness

Pest-specific emergency response and information documents

To help prepare for an incursion response a listing of pest-specific emergency response and information documents that support a response, may be developed. Over time, as more of these documents are produced for pests of the tree nut industry they will be included in this document and made available through the PHA website. This includes the development of pest-specific information and emergency response documents, such as fact sheets, contingency plans, diagnostic protocols and a summary of surveillance programs currently in operation for these high priority pests (see **www.planthealthaustralia.com.au/pidd**). These documents and programs should be developed over time for all medium to high risk pests listed in the TSTs (Appendix 2). Currently, a number of preparedness documents have been developed for pests of the various tree nut industries (**www.planthealthaustralia.com.au/industries/**) and are available for download from the Pest Information Document Database at **www.planthealthaustralia.com.au/pidd**.

Contingency Plans

Contingency Plans provide background information on the pest biology and available control measures to assist with preparedness for incursions of a specific pest into Australia. The contingency plan provides guidelines for steps to be undertaken and considered when developing a Response Plan for that pest. Any Response Plan developed using information in whole or in part from this Contingency Plan must follow procedures as set out in PLANTPLAN and be endorsed by the National Management Group prior to implementation.
As a part of contingency planning, biological and chemical control options are considered as are options for breeding for pest resistance. Through this planning process, it may be discovered that there are gaps in knowledge. Such gaps should be identified and consequently be considered as RD&E needs to be met within the implementation table.

For a list of current contingency plans developed for the tree nut industry see **www.planthealthaustralia.com.au/pidd**.

National Diagnostic Protocols

Diagnostic protocols are documents that contain information about a specific plant pest, or related group of pests, relevant to its diagnosis. National Diagnostic Protocols (NDPs) are diagnostic protocols for the unambiguous taxonomic identification of a pest in a manner consistent with ISPM No. 27 – Diagnostic Protocols for Regulated Pests. NDPs include

diagnostic procedures and data on the pest, its hosts, taxonomic information, detection and identification.

Australia has a coherent and effective system for the development of NDPs for plant pests managed by the Subcommittee on Plant Health Diagnostics (SPHD). NDPs are peer reviewed and verified before being endorsed by SPHD.

Endorsed NDPs are available on the National Plant Biosecurity Diagnostic Network (NPBDN) website (**www.plantbiosecuritydiagnostics.net.au**), together with additional information regarding their development and endorsement.

Diagnostic information for some tree nut pests is also available from the PaDIL website **http://www.padil.gov.au/Sphds/** or through the PHA website **www.planthealthaustralia.com.au/pidd**. For diagnostic information on fruit flies, refer to the Australian Handbook for the Identification of Fruit Flies, available from the PHA website.

For a list of current diagnostic protocols developed for the tree nut industry see: **www.plantbiosecuritydiagnostics.net.au**

Research Development and Extension

Research, Development and Extension – Linking Biosecurity Outcomes to RD&E Priorities

Through the biosecurity planning process, gaps in knowledge or extension of knowledge will have been identified and need to be documented in the implementation table. Some of these gaps will require further Research and Development (e.g. understanding risk pathways, developing surveillance programs or diagnostic protocols, developing tools to facilitate preparedness and response), other gaps will require communication or extension of that knowledge to various target audiences (developing awareness raising materials, undertaking training exercises, running workshops, consideration of broader target audiences).

It is important that the RD&E gaps identified through this plan feed directly into the normal annual RD&E priority setting and strategic planning activities that an industry undertakes. This is fundamental if an industry is to progress biosecurity preparedness and response throughout the life of the Industry Biosecurity Plan.

Reference

Department of Agriculture, Fisheries and Forestry (2011) Import Risk Analysis Handbook 2011. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.

RESPONSE MANAGEMENT

Introduction

Gathering information, developing procedures, and defining roles and responsibilities during an emergency can be extremely difficult. To address this area, PHA are the custodians of the EPPRD and coordinated the development of PLANTPLAN, a national set of incursion response guidelines for the plant sector, detailing the procedures required and the roles and responsibilities of all Parties involved in an incursion response.

The following section provides details of the EPPRD and PLANTPLAN and also includes key contact details and communication procedures that should be used in the event of an incursion in the tree nut industry.

The Emergency Plant Pest Response Deed

PHA is the custodian of the Emergency Plant Pest Response Deed (EPPRD). The EPPRD came into effect on October 26, 2005 and is a formal legally binding agreement between PHA, the Australian Government, all state and territory governments and 32 national plant industry body signatories, including: the Almond Board of Australia, Chestnuts Australia, Hazelnut Growers of Australia Inc., the Australian Macadamia Society, Pistachio Growers' Association and the Australian Walnut Industry Association. At the time of publication, the Australian Pecan Growers Association was not a member of PHA or a signatory to the EPPRD.

The EPPRD has been negotiated between government and industry members of PHA to cover the management and funding arrangements of eradication responses to Emergency Plant Pest (EPP) Incidents, including the potential for owner reimbursement costs for growers. It also formalises the role of plant industries' participation in decision making, as well as their contribution towards the costs related to approved responses.

The ratification of the EPPRD by government and industry members significantly increased Australia's capacity to respond to emergency plant pest incursions. The key advantage of the EPPRD is more timely, effective and efficient response to plant pest incursions, while minimising uncertainty over management and funding arrangements. Other significant benefits include:

- potential liabilities are known and funding mechanisms are agreed in advance
- industry and government are both involved in decision making about mounting and managing an emergency plant pest response from the outset
- reimbursement to growers whose crops or property are directly damaged or destroyed as a result of implementing an approved Response Plan
- a consistent and agreed national approach for managing incursions
- wider commitment to risk mitigation by all parties through the development and implementation of biosecurity strategies and programs
- motivation and rationale to maintain a reserve of trained personnel and technical expertise
- provision of accountability and transparency to all parties.
- Cost Sharing of eligible costs
- an Agreed Limit for Cost Sharing (calculated as 2% of the local value of production for one year of the Affected Industry Party or as defined in Schedule 14 of the EPPRD). The Agreed Limit can be exceeded with the agreement of Affected Parties.

For further information on the EPPRD, including copies of the EPPRD, Fact Sheets or Frequently Asked Questions, visit **www.planthealthaustralia.com.au/epprd** and **www.planthealthaustralia.com.au/epprd-qa/**.

Formal Categorisation of pests for inclusion in the EPPRD

The following section outlines one aspect of the EPPRD - the categorisation of EPPs.

A copy of the EPPRD can be downloaded from the PHA website (**www.planthealthaustralia.com.au/epprd**).

Pest categorisation

The EPPRD outlines a mechanism whereby Industry and Government Parties will contribute to the total cost of a response to an EPP Incident based on agreed Categories. These Categories determine the ratio each party will pay, based on the relative public and private benefits of EPP eradication.

Categorisation of a Plant Pest is carried out to determine the Parties that are Affected and who will therefore be the beneficiaries of an eradication response. It does not indicate its likelihood of eradication or its overall importance i.e. an EPP listed as Category 1 is not deemed to be any more or less important than an EPP listed as Category 4.

Any Plant Pest considered by a Party to meet the definition of an EPP can be put forward for categorisation and inclusion in Schedule 13 of the EPPRD. Pests listed in the HPP threat list (Table 6) may provide a starting point for Industry to prioritise development of Categorisation requests as they have been determined to be of high priority to the Industry. Other pests identified in TSTs or identified via other means as being priority pests, may also be categorised if required. The process for requesting categorisation of a pest is set out in Schedule 3 of the EPPRD and the Guidelines for the Preparation of a Categorisation Request will be available from the PHA website **www.planthealthaustralia.com.au**. This pest categorisation process is only available to signatories of the EPPRD.

http://www.planthealthaustralia.com.au/biosecurity/emergency-plant-pests/pest-categorisation/

PLANTPLAN

Underpinning the EPPRD is PLANTPLAN, the agreed technical response plan for an emergency plant pest incident. It provides nationally consistent guidelines for response procedures, outlining the phases of an incursion (investigation and alert, operational and stand down[37]), as well as the key roles and responsibilities of industry EPPRD signatories and government during each of the phases.

PLANTPLAN also provides a description of the management structures and information flow systems for the handling of a plant pest emergency at national, state/territory and district levels as well as guidelines, SOPs, forms/templates and job cards. Guidance is provided for the operation of control centres, as well as outlining principles for the chain of responsibility, functions of sections, and role descriptions. PLANTPLAN is a general manual for use by all Government and Industry Parties during Plant Pest emergencies. PLANTPLAN incorporates best practice in emergency plant pest responses, and is updated regularly to incorporate new information or address gaps identified by the outcomes of incident reviews.

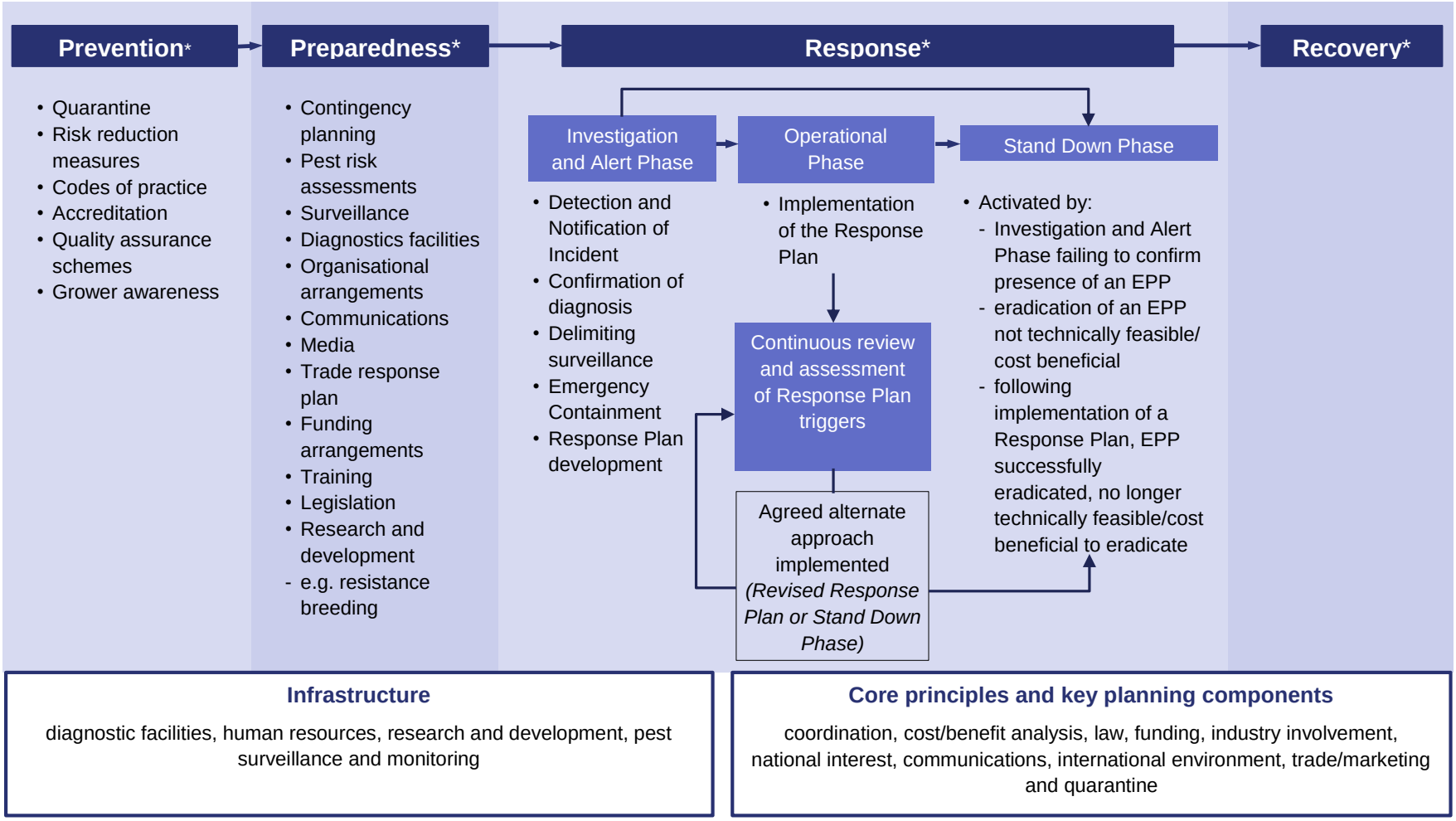
PLANTPLAN is an appendix to the Emergency Plant Pest Response Deed and is endorsed by all signatories. PLANTPLAN is supported by individual industry biosecurity planning that covers industry and pest specific information, risk mitigation activities and contingency plans. It also provides a focus for training personnel in operational response and preparedness

[37] As of December 2014, the inclusion of Transition to Management programs is currently being assessed for inclusion into the EPPRD and PLANTPLAN.

procedures. This ensures that the best possible guidance is provided to plant industries and governments in responding to serious Plant Pests.

The incursion management plan from PLANTPLAN (2014) has been summarised in Figure 6.

For more information about PLANTPLAN visit
www.planthealthaustralia.com.au/biosecurity/incursion-management/plantplan/



* stages of 'all hazards' approach adopted by Emergency Management Australia

Figure 6. *Summary of incursion management for plant industries according to PLANTPLAN (2014)*

How to respond in an incursion

Following the detection of a suspect EPP, the relevant state agency should be immediately notified either directly or through the Exotic Plant Pest Hotline. Within 24 hours of the initial identification, the agency, through the State Chief Plant Health Manager (CPHM), will inform the Australian Chief Plant Protection Office (ACPPO) who will notify all state agencies, relevant industry representatives and PHA (this process is outlined in Figure 7).

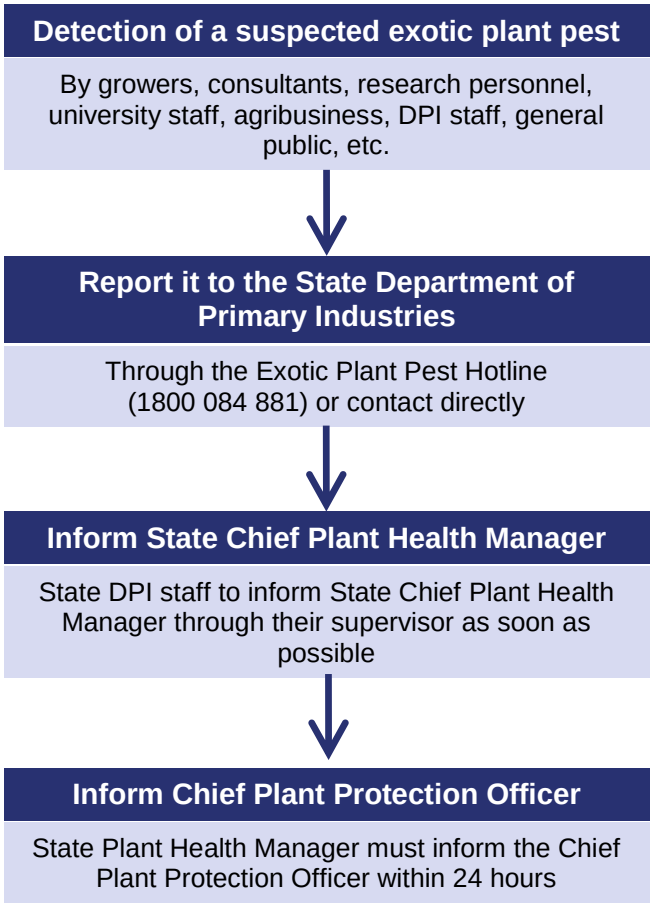


Figure 7. *Suspect exotic plant pest detection reporting flowchart*

Following the detection or reporting of the pest, the relevant state/territory agriculture agency will seek a confirmatory diagnosis from another laboratory, usually within a different jurisdiction. If the pest is suspected to be an EPP (meeting one of the four main criteria within the EPPRD), the general process (as described in PLANTPLAN) is as outlined in Figure 8.

If the pest is considered potentially serious and/or suspected to be an EPP, the relevant state/territory agriculture department will usually adopt precautionary emergency containment measures. These measures, depending on the Plant Pest, may include:

- restriction of operations in the area
- disinfection and withdrawal of people, vehicles and machinery from the area
- restricted access to the area
- control or containment measures.

If an EPP is confirmed, technical and economic considerations are reviewed, and a decision made on whether to eradicate (managed under the EPPRD and a Response Plan) or take another course of action (potentially to contain or do nothing - long term management). Under the EPPRD all decisions are made by Committees with government and industry representation. If the tree nut industry wishes to be represented, they must become signatories to the EPPRD. At the Consultative Committee on Emergency Plant Pests (CCEPP) level, these decisions relate to the technical feasibility of eradication of the EPP in question. From a National Management Group (NMG) perspective, they relate to technical advice from the CCEPP as well as financial considerations.

During the Investigation and Alert Phase (Figure 8), the Affected area will be placed under quarantine until a decision is made on whether to eradicate the pest or not. If a decision has been made to pursue eradication and a Response Plan under the EPPRD is approved by the NMG, efforts enter the Operational Phase (Figure 8). Eradication methods used will vary according to the nature of the EPP involved and infested/infected material will be destroyed where necessary. All on ground response operations are undertaken by the relevant state agricultural department(s) in accord with the approved Response Plan and the relevant state/territory legislation.

In the Stand Down Phase (Figure 8), all operations are wound down. Where a plant pest emergency is not confirmed, those involved will be advised that the threat no longer exists. Where the EPP is successfully eradicated, the situation should begin to return to ‘normal’. Where the EPP is not able to be eradicated, future long term management and control options may be investigated. In all cases, the response is reviewed and any lessons learnt will be used to improve the system for the future.

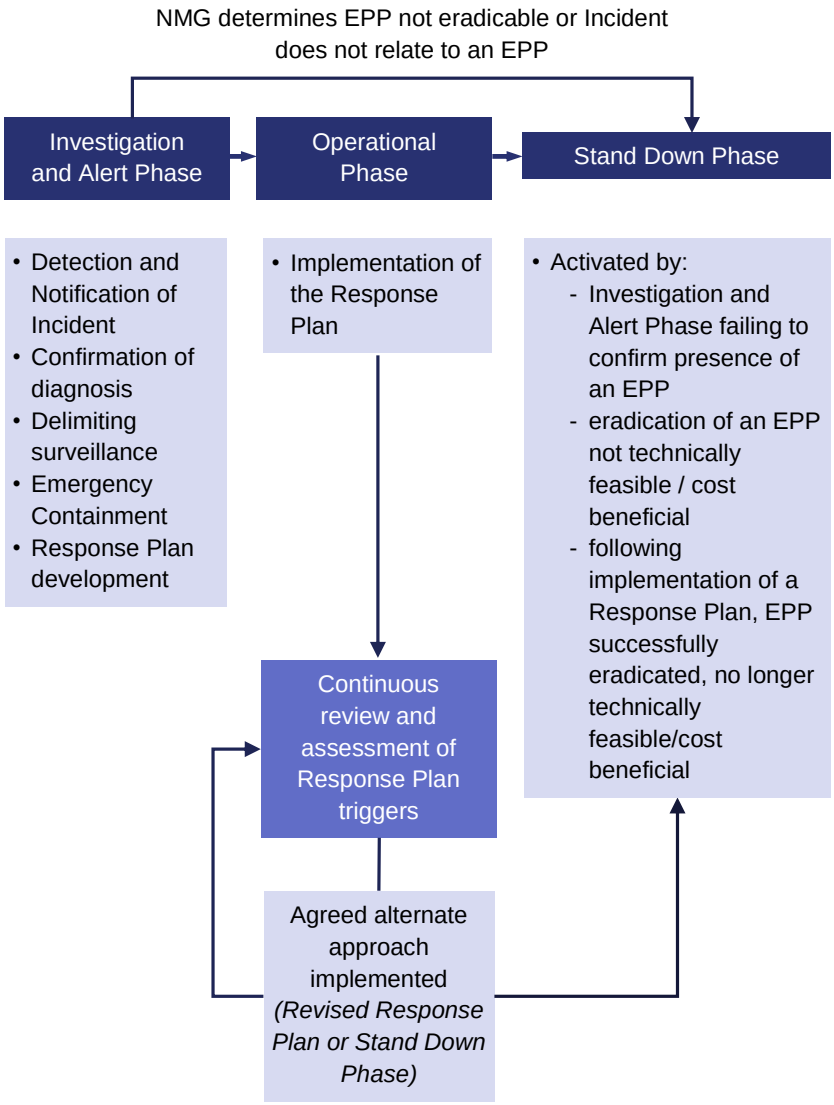


Figure 8. *General decision making and communication chain for a plant pest emergency response*

References

AS/NZS ISO 31000:2009 Risk management - Principles and guidelines. Standards Australia, Sydney, and Standards New Zealand, Wellington.

DAFF (2011) Import Risk Analysis Handbook 2011. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.

FAO (2004) Pest risk analysis for quarantine pests including analysis or environmental risks and living modified organisms. International Standards for Phytosanitary Measures No. 11. Secretariat of the International Plant Protection Convention, Food and Agriculture Organization of the United Nations, Rome.

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National Plant Health Status Report (2011) Plant Health Australia, Canberra ACT. **http://www.planthealthaustralia.com.au/national-programs/national-plant-biosecurity-status-report/**

PLANTPLAN (2014) PLANTPLAN Australian Emergency Plant Pest Response Plan. Version 1. (**www.planthealthaustralia.com.au/plantplan**).

APPENDIX 1: PROFILE OF THE AUSTRALIAN TREE NUT INDUSTRY

Profile of the Australian tree nut industry

The production of tree nuts is a rapidly growing part of the Australian horticulture sector (ABARES 2014). In 2014 the total export value of Australian nut production was approximately $656 million, with predictions that this could increase to $869 million by 2020 (ANIC 2014). Australian nut production is expanding with production set to increase as the existing non-bearing trees mature.

There are seven main tree nuts grown in Australia. Background information on each crop is provided below.

Almonds

The Almond Board of Australia represents the biosecurity interests of almond producers and the industry. They are members of Plant Health Australia and signatories to the Emergency Plant Pest Response Deed (EPPRD).

Almonds (*Prunus dulcis*) are predominantly grown in Victoria, South Australia and New South Wales. There are four major growing regions including Sunraysia (in Vic), the Riverland and Adelaide (in SA) and the Riverina (in NSW).

The Australian almond industry has grown rapidly in the last 15 years from 5900 ha in 2001 to 28,586 ha in 2013. In 2013 over 70,000 tonnes of almond were harvested. This makes the Australian industry the second largest in the world (Almond Board of Australia 2013).

Two varieties, Nonpareil and Caramel, dominate plantings in Australia and together represent approximately 80% of the crop (Almond Board of Australia 2013).

Chestnuts

Chestnuts Australia represents the biosecurity interests of chestnut producers and the industry. They are members of PHA and signatories to the EPPRD.

Chestnuts (*Castanea* species) are thought to have been introduced by early settlers from Europe and China during the Gold Rush era of the 1850's. Commercial plantings did not commence until the 1970's.

Most Australian chestnuts are grown in north eastern Victoria (approximately 75% of production). There are also plantings in other parts of Victoria, NSW, SA, Tasmania and south western WA.

There are approximately 300 growers in the industry, which produce approximately 1500 tonnes each year from 1000 ha of plantings. The industry's production is worth approximately $9 million per annum. By 2020 production is expected to increase to 2000 tonnes worth approximately $11.5 million per annum (Chestnuts Australia 2015; ANIC 2014).

Hazelnuts

Hazelnut Growers of Australia Inc. represent the biosecurity interests of hazelnut producers and the industry. They are members of PHA, and are in the process of becoming signatories to the EPPRD.

Even though hazelnuts (*Corylus* species) were introduced into Australia more than one hundred years ago, they have never been grown on an extensive scale. Significant larger scale plantings have become established in NSW in recent times and may have an impact on production in several years' time as plantings mature. Plantings of hazelnut for nut and truffle production exist in cool climate areas of all states, particularly NSW, ACT, Victoria and Tasmania.

Currently there are 130 hectares of hazelnuts, which produce approximately 70 tonnes per annum, valued at approximately $1 million. The Australian hazelnut industry is expanding and it is expected that in 2020 approximately 200 ha will be producing 150 tonnes and the farm-gate value would be in the order of $17 million (ANIC 2014).

In addition, in 2014 Ferraro commenced planting 2000 hectares with the aim of producing 5000 tonnes by 2025.

Macadamias

The Australian Macadamia Society represents the biosecurity interests of macadamia producers and the industry. They are members of PHA and signatories to the EPPRD.

The Australian macadamia industry is the world's largest producer and exporter of macadamia nuts, surpassing Hawaii in 1997. The industry currently makes up about 30% of global production. The Australian macadamia nut (*Macadamia integrifolia*) is the only Australian native plant species to have become a significant agricultural industry.

Located mainly along the coastal strip of eastern Australia, production stretches from Nambucca Heads in the mid-North of NSW to the Atherton Tableland in QLD. The 2015 production is estimated to be approximately 47,000 tonnes of nut in shell (at 10% moisture) (Australian Macadamia Society 2015). Currently the industry has a farm-gate value of approximately $122 million and there are approximately 18,666 ha dedicated to macadamia with major growth occurring in the Bundaberg region of Queensland. The area planted to macadamia is expected to grow to approximately 20,000 ha by 2020 and have a farm gate value of over $140 million (ANIC 2014).

Pecans

The Australian Pecan Growers Association is the peak body representing Australia's pecan industry. It was formed to represent and support growers and improve pecan production. Australian Pecan Growers Association are not yet members of PHA or signatories to the EPPRD, but have indicated interest in engaging in this process

The Australian pecan nut industry currently produces approximately 3000 tonnes of nut in shell from a production area of 1350 hectares, and has a farm gate value of approximately $14 million. Approximately 75% of the industry is based in Moree NSW, with other plantings in the Hunter Valley, North and Central NSW coast, parts of Queensland and small plantings in SA and WA (ANIC 2014).

Pistachios

The Pistachio Growers' Association represents the biosecurity interests of pistachio producers and the industry. They are members of PHA and signatories to the EPPRD.

Pistachio is the common name for *Pistacia vera*. The tree is native to western Asia and Asia Minor, and evidence has been found in this region that suggests the nuts were being used for food as early as 7,000 B.C.

Currently Australia has approximately 900 ha dedicated to pistachios producing around 1200 tonnes (2 year average) of nut in shell per annum, with a farm-gate value of around $9 million. This area is expected in increase to 1200 ha in 2016. The major growing region is along the Murray River Valley from Waikerie in South Australia to Swan Hill in Victoria. There are also plantings in central west Victoria and Pinnaroo SA, with small plantings in WA (ANIC 2014).

Walnuts

The Australian Walnut Industry Association represents the biosecurity interests of walnut (*Juglans regia*) producers and the industry. They are members of PHA and signatories to the EPPRD.

The Australian walnut industry operates in most states of Australia with the main growing regions including the east coast of Tasmania, the Goulburn Valley and Murray Irrigation Area in Victoria as well as the Riverina in NSW (ANIC 2014).

The industry has grown significantly in recent years due to growth in the establishment of large-scale commercial plantings. As of 2015 there is approximately 3,500 ha currently under walnut cultivation, with a farm gate value of approximately $44 million. In 2015, the production of Australian walnuts was 8,000 tonnes (in-shell) and production is expected to increase dramatically in the next five years as new orchards mature and begin bearing. By 2020 it is anticipated that the production will be 13,000 tonnes.

References

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Australian Macadamia Society (2015) Media Release: 2015 Australian macadamia crop estimated at 47,000 tonnes in-shell. Available from: **www.australian-macadamias.org/industry/item/602-issue-one**.

Chestnuts Australia (2015) Australian chestnut industry five year strategic investment plan 2015 - 2020.

APPENDIX 2: THREAT SUMMARY TABLES

Tree nut industry threat summary tables

The information provided in the TSTs (Table 17 to Table 30) is an overview of exotic plant pest threats to the tree nut industry. Summarised information on entry, establishment and spread potentials and economic consequences of establishment are provided where available. Pests under official control[38] or eradication may be included in these tables where appropriate. However, tree nut pests that are endemic but regionalised within Australia are not covered by IBPs, but may be assessed in state biosecurity plans. Assessments may change given more detailed research, and will be reviewed with the biosecurity plan every 5 years.

Full descriptions of the risk rating terms can be found on page 33. An explanation of the method used for calculating the overall risk can be found on the PHA website[39]. Additional information on a number of the pests listed in the TSTs has already been prepared, further information on these documents can be found on page 83.

[38] Official control defined in ISPM No. 5 as the active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests

[39] Available from **www.planthealthaustralia.com.au/biosecurity/risk-mitigation**

Almonds

Invertebrates

Table 17. *Almond invertebrate threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
ACARI (Mites e.g. spider and gall mites)								
Amphitetranychus viennensis (syn. *Tetranychus viennensis*)	Hawthorn spider mite	Rosaceae including: almond, apple, peach, pear, apricot, plum, hawthorn, cherry, sweet cherry and raspberry	Leaves, bark, flowers	LOW[40]	MEDIUM	HIGH[41]	LOW[42]	VERY LOW
Eriophyes insidiosus	-	*Prunus* spp., including almonds	Nuts, Leaves	LOW[43]	MEDIUM	HIGH	MEDIUM[44]	LOW
Tetranychus pacificus	Pacific spider mite	Walnut, cotton, melon, soybean, common bean, stone fruit, Japanese plum, grapevine, almond	Leaves	MEDIUM[45]	MEDIUM[46]	HIGH[47]	LOW[48]	LOW

[40] Occurs in China, Georgia, Japan, Russia, Turkey, Ukraine and other European countries. Could possibly enter on fruit (Biosecurity New Zealand 2009). See BICON for relevant import conditions.
[41] Due to large areas planted to almonds in continuous plantings, which would allow the rapid spread of the pest.
[42] Feeding causes yellowing of foliage (Biosecurity New Zealand 2009). Treatments for this mite likely to be similar to other mites.
[43] Could enter on plant material. Currently occurs in North America.
[44] Vector of the exotic Peach American mosaic virus (Closterovirus), which is reported to affect *Prunus* spp. including almonds.
[45] Hitchhiker on other imported material.
[46] Wide range of host species available and climate is likely to be suitable.
[47] Dispersal by movement of infested plant material; wind dispersal.
[48] Doesn't affect nuts.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Tetranychus turkestani	Strawberry spider mite	Almond, cotton, roses, peppers, sword lily, soybean, oleander, peach, maize	Leaves	MEDIUM[49]	MEDIUM[50]	HIGH[47]	LOW	LOW
COLEOPTERA (Beetles and weevils)								
Capnodis carbonaria	Almond flathead root borer	*Prunus* spp., including almonds	Trunk and roots	LOW[51]	UNKNOWN	UNKNOWN	UNKNOWN[52]	UNKNOWN
Capnodis tenebrionis	Peach flathead borer	*Prunus* spp., including almonds	Trunk and roots	LOW[53]	UNKNOWN	UNKNOWN	UNKNOWN[54]	UNKNOWN
Naupactus xanthographus	South American fruit tree weevil	Citrus, apple, olive, avocado, apricot, almond, grape	Larvae damage the roots and adults damage foliage	MEDIUM[55]	MEDIUM	MEDIUM[56]	HIGH[57]	MEDIUM

[49] Hitchhiker on other imported material.
[50] Wide range of host species available and climate is likely to be suitable.
[51] Limited quantities of timber imported therefore low risk of entry.
[52] Reported from almond orchards in Turkey (Bolu and Ozgen 2011). This species is a wood borer that damages the trunk and roots.
[53] Mediterranean species (Lichou et al., 2008). Limited quantities of timber imported therefore low risk of entry.
[54] Most papers look at other stone fruit species. Soler et al., (2014) suggests that almonds are susceptible to this pest (especially under drought conditions). Impact on almond is likely to be similar to other *Capnodis* spp.
[55] Native to southern South America, adults can spread with fruit and nuts.
[56] Adults cannot fly (CABI 2015 D).
[57] Larvae feeding causes foliage to wilt.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Trogoderma granarium	Khapra beetle	Stored products including: grain, nuts (including almonds, pecan, pistachio, walnut), acorns, and stored foodstuffs, etc. Also associated with walnut, pistachio and pecan orchards where it feeds on fallen nuts (Stibick 2007).	Stored product	HIGH[58]	HIGH	HIGH[59]	HIGH[60]	HIGH
HEMIPTERA (Stink bugs, aphids, mealybugs, scale, whiteflies and hoppers)								
Asymmetrasca decedens	Leaf hopper	Prunus spp. (including almonds), citrus, cotton and other plants	Leaves	LOW[61]	UNKNOWN	UNKNOWN	LOW[62]	UNKNOWN
Brachycaudus amygdalinus	Almond leaf curl aphid; Short tailed almond aphid	Almond, Peach, Sweet Cherry, European pear	Leaves	UNKNOWN	UNKNOWN[63]	UNKNOWN	UNKNOWN[64]	UNKNOWN
Cacopsylla pruni	Psyllid	*Prunus* spp. (including almonds)	Leaves	UNKNOWN[65]	UNKNOWN	UNKNOWN	UNKNOWN[66]	UNKNOWN
Cacopsylla pyri	Pear psylla; European pear sucker	Mostly pear. Also reported from peach. Possibly a chance feeder on almond[67]	Leaves	UNKNOWN[68]	UNKNOWN	UNKNOWN	UNKNOWN[69]	UNKNOWN
Cacopsylla pyricola (Syn. *Psylla pyricola*)	Pear sucker; pear psyllid	Mostly pear. Vectors Peach yellow leafroll phytoplasma (the cause of Almond brownline and decline)[70] so presumably also affects *Prunus* spp. Including almond	Leaves	UNKNOWN[71]	UNKNOWN	UNKNOWN	UNKNOWN[69]	UNKNOWN

[59] Spread with infested grain and foodstuffs.
[60] Impact likely to be high. Although Sulfuryl fluoride is reported to control this pest (Eliopoulos 2013).
[61] Mediterranean species (Vacante and Gerson 2012).
[62] Vectors of European Stone Fruit Yellows (USDA APHIS 2012). Would have limited impact without the pathogen.
[63] Climate likely to be suitable for establishment given overseas distribution.
[64] Pest of almonds in Syria and other Mediterranean countries, such as Lebanon (Almatni and Khalil 2008). Not reported in the literature as a vector of almond diseases.
[65] Species occurs in Europe and central Asia (Ciancio and Mukerji 2008).
[66] Vectors of European Stone Fruit Yellows (USDA APHIS 2012).
[67] See: Uyemoto et al., (1999).
[68] Occurs in North America, Europe and parts of Asia (including Syria, Turkey, Iran, Georgia, China, Armenia and Azerbaijan).
[69] Vector of pear decline (Etropolska et al., 2011).
[70] See: Adaskaveg et al., (2014).
[71] Occurs in North America, Europe and parts of Asia (including China, Iran, Israel, Japan, Lebanon, and Turkey).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Chinavia hilaris (syn. *Acrosternum hilare; Pentatoma hilaris; Chinavia hilare; Nezara hilaris*)	Green stink bug; Pistachio bug	Polyphagous including hazelnut, black walnut, pistachio, almond hawthorn, ash, lucerne, *Robinia* spp., *Prunus* spp., legumes	Leaves, nuts	LOW[72]	MEDIUM	MEDIUM[73]	HIGH[74]	MEDIUM
Ferrisia gilli	Gill's mealybug	Grape, pistachio, almond, persimmon	Branches, rachises, nuts, petioles, leaves	UNKNOWN[75]	UNKNOWN	UNKNOWN	UNKNOWN[76]	UNKNOWN
Fieberiella florii	Privet leaf hopper	Polyphagous, including *privet*, *prunus* spp. (including almond), apple and possibly hazelnut (as it has the broadest host range of vectors of Apple proliferation, which is reported to affect hazelnut)	Leaves	UNKNOWN[77]	UNKNOWN	UNKNOWN	UNKNOWN[78]	UNKNOWN
Homalodisca vitripennis (syn. *Homalodisca coagulata*)	Glassy winged sharpshooter	Feeds on >100 plants including: almond, macadamia, pistachio, walnut, avocado, citrus, Eucalypts, grapes, ash, oleander, blackberry, bottlebrush, bougainvillea, camellia, acacia, chrysanthemum and other ornamentals	Leaves. Vector of the strain of the bacterium *Xylella fastidiosa* causing leaf scorch	MEDIUM[79]	HIGH[80]	HIGH[81]	UNKNOWN[82]	HIGH-NEGLIGIBLE
Hyalopterus amygdali	Mealy peach aphid	Almond, peach, apricot, nectarine	Leaves	UNKNOWN[83]	UNKNOWN	UNKNOWN	UNKNOWN[84]	UNKNOWN
Leptoglossus clypealis	Leaf footed bug	Pistachio, almond, juniper, aromatic sumac (*Rhus aromatica*)	Nuts (kernels and epicarp)	LOW[85]	MEDIUM	MEDIUM	HIGH-MEDIUM[86]	MEDIUM-LOW

[72] Occurs in North America, Asia and Iran.
[73] Capable of long distance dispersal to find hosts (Gomez and Mizel 2013a).
[74] Causes kernels to wrinkle, and become discoloured. Feeding site may have a black spot (Pickel et al., 2015). Therefore, causes down grades.
[75] Recently reported Californian species (Haviland et al., 2006).
[76] Newly described. Causes damage in California. Nuts become covered in honeydew and sooty mould (Haviland et al., 2006). Not reported in the literature as a vector of almond diseases but can vector Grapevine leafroll associated virus strain 3 (Haviland et al., 2013).
[77] Occurs in North America, Europe (USDA APHIS 2012).
[78] Vector of Apple proliferation (USDA APHIS 2012).
[79] Native to South-eastern USA and northern Mexico, has spread to other parts of the USA, French Polynesia and Hawaii (Mizell et al., 2008). Could spread on nursery stock from overseas.
[80] Numerous alternative hosts; recent history of spread in USA, especially on nursery stock.
[81] Strong fliers, egg masses could be spread with nursery stock over large areas.
[82] Vector of *Xylella fastidiosa* diseases. Feeding doesn't cause physical signs of damage but the insects secrete a white liquid while feeding that covers the leaves and ground below the infected plant.
[83] European species.
[84] Feeds on Almonds, peach, and other *Prunus* spp.
[85] North American species that is found in the southern USA and Mexico (Wang and Millar 2000).
[86] Infrequent pest of almonds. Feeding on young nuts can cause abortion of the kernel. Feeding at later stages can cause kernels to distort and wrinkle (Zalom et al., 2015).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Leptoglossus occidentalis	Western conifer seed bug	Pistachio, almond, various pines (including Radiata pine)	Nuts (kernels and epicarp)	LOW[87]	MEDIUM[88]	MEDIUM	HIGH-MEDIUM[86]	MEDIUM-LOW
Leptoglossus zonatus	Western leaf footed bug	Pistachio, citrus, guava, avocado, pomegranate, melons, cotton, sorghum, corn, tomato, cucurbits, eggplant, almond	Nuts (kernels and epicarp)	LOW[89]	MEDIUM	MEDIUM	HIGH-MEDIUM[90]	MEDIUM-LOW
Nysius raphanus	False chinch bug	Almond, pistachio, pomegranate, citrus, grasses	Above ground plant parts	MEDIUM[91]	MEDIUM[92]	MEDIUM	MEDIUM[93]	LOW
Pterochloroides persicae	Black peach aphid	Almond, quince, apple, apricot, peach, plum	Leaves	LOW[94]	MEDIUM[95]	MEDIUM	UNKNOWN[96]	MEDIUM-NEGLIGIBLE
HYMENOPTERA (Ants, bees and wasps)								
Eurytoma amygdali	Almond seed wasp	Almond	Nuts	LOW[97]	MEDIUM[98]	MEDIUM[99]	UNKNOWN[100]	MEDIUM-NEGLIGIBLE
LEPIDOPTERA (Butterflies and moths)								
Amyelois transitella	Navel orange worm	*Citrus* spp., walnut, pistachio, almond, grapevine	Leaves, nuts	MEDIUM[101]	HIGH[102]	HIGH[103]	HIGH[104]	MEDIUM

[87] Occurs in North America, Europe and Japan.
[88] Spreading in Europe, first detected in 1999 now widespread (Hizal and Inan 2012).
[89] Occurs from the south west of the United States to northern South America.
[90] Periodic pest of almonds (Ingels and Haviland 2015).
[91] North American species.
[92] Hosts widespread.
[93] Heavy infestations are reported to cause death of young almond and pistachio trees in the United States (Haviland and Bentley 2010).
[94] Occurs in the Mediterranean basin and into south western Asia to India (CABI date of publication unknown A).
[95] Climate likely to be suitable for establishment given overseas distribution.
[96] Pest of almonds in Syria and other Mediterranean countries, such as Lebanon (Almatni and Khalil 2008).
[97] Occurs in south Eastern Europe and the Middle East.
[98] Climate likely to be suitable for its establishment.
[99] Could spread within Australia.
[100] Larvae feed inside nuts (Kouloussis 2008).
[101] Has been intercepted on citrus imports from California.
[102] Lays eggs on "mummy" almonds that stay on tree after harvest (Phelan and Baker 1987).
[103] Strong dispersal capability; small insects with high reproductive output.
[104] Major pest of almonds in California (Burks et al., 2008).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Anarsia lineatella	Peach twig borer	Almonds, apricots, peaches, plums,	Leaves, growing shoots, nuts	LOW[105]	HIGH-MEDIUM	HIGH-MEDIUM	HIGH[106]	MEDIUM
Carposina sasakii	Peach fruit moth	Mostly Rosaceae including almond, peach, pear	Nuts	UNKNOWN[107]	UNKNOWN	UNKNOWN	UNKNOWN [108]	UNKNOWN
Choristoneura rosaceana	Oblique banded leafroller	Wide host range including: *Prunus* spp. (including almond), pistachio, hazelnut, maple, pear, raspberry, blueberry	Leaves and nuts	LOW[109]	MEDIUM[110]	MEDIUM	HIGH-MEDIUM[111]	MEDIUM-LOW
Cydia latiferreana	Filbertworm	Chestnuts, hazelnut (*Corylus*), beeches, almond, pomegranate, *Quercus*	Nuts	LOW[112]	MEDIUM[113]	MEDIUM[114]	UNKNOWN[115]	MEDIUM-NEGLIGIBLE
Euproctis chrysorrhoea	Brown-tail moth	Wide host range including: oak, hawthorn, almond, rose, willow, elm	Leaves, nut and inflorescences	UNKNOWN[116]	UNKNOWN	UNKNOWN	NEGLIGIBLE[117]	UNKNOWN
Euzophera semifuneralis	American plum borer	Wide host range including: walnut, almonds, plum, cherry, olive, oak, pomegranate	Trunk, branches	LOW[118]	MEDIUM	MEDIUM-LOW	LOW[119]	VERY LOW-NEGLIGIBLE
Malacosoma californicum	Western tent caterpillar	Reported on oak, willow, poplar, birch, alder, hazelnut, ash, apple, almond, apricot, cherry, plum	Leaves	UNKNOWN[120]	UNKNOWN	UNKNOWN	LOW[121]	UNKNOWN

[105] Originally Mediterranean species but now occurs in North America, Europe, northern Africa and southern Asia to China.
[106] Second most important pest of almonds in California. Damage by peach twig borer also provides entry for aflatoxin-producing fungi.
[107] Reported from China, Japan and far eastern Russia (CABI 2015 A).
[108] Larvae are internal feeders on a range of fruit and nuts, including almond (CABI 2015 A).
[109] North American species.
[110] 1-2 generations per year (CABI and EPPO date of publication unknown C).
[111] Larvae feed on developing nuts and damage the kernel (Zalom et al., 2014).
[112] North American species, which occurs from Canada to Mexico. Fruit, nuts and plant material can carry pest.
[113] Widespread in USA.
[114] Moths are weak fliers and will be limited in Australia by available hosts (no endemic *Corylus* spp. as in North America).

[116] Widespread in the Northern Hemisphere.
[117] Larvae feed on above ground plant parts and also produce webbing that covers the plant. Larvae can cause allergic reactions (rashes) in some people.
[118] Native and widespread in North America. This species has also been reported in Turkey (Atay and Ozturk 2010).
[119] Larvae burrow under the bark.
[120] North American species (Swiecki and Bernhardt 2006).
[121] Little information about this pest's impact on nuts other than recording them as hosts. Larvae feed on foliage and build "tents" of silk (Swiecki and Bernhardt 2006).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Malacosoma neustria	Common lackey	Almond, apple, plum, pear, oak and hazelnut	Leaves	UNKNOWN[122]	UNKNOWN	UNKNOWN	LOW[123]	UNKNOWN
Saturnia pyri (Syn. *Bombyx pyri*)	Great peacock moth	Hazelnut, walnut, *Prunus* spp. (including almond), willow, maple, beech, Rubus, poplar, apple	Leaves	MEDIUM-LOW[124]	MEDIUM-LOW	MEDIUM	VERY LOW[125]	NEGLIGIBLE
Schizura concinna	Redhumped caterpillar	Wide host range including: walnut, almond, liquidambar, plum, apple, apricot, birch, cottonwood, cherry, pear, prune)	Leaves	LOW[126]	MEDIUM-LOW	MEDIUM	LOW[127]	VERY LOW-NEGLIGIBLE
Synanthedon exitiosa	Peachtree borer	*Prunus* spp. including almond, peach, apricot, plum, etc.	Trunk, large roots, stem[128]	UNKNOWN[129]	UNKNOWN[130]	UNKNOWN	UNKNOWN[131]	UNKNOWN
Yponomeuta padella	Cherry ermine moth; small ermine moth	Rosacea including almond, hawthorn, cherry	Leaves	UNKNOWN[132]	UNKNOWN	UNKNOWN	UNKNOWN[133]	UNKNOWN

[122] Europe, Asia and North Africa.
[123] Larvae defoliate trees and build silken "tents". Less of a problem in Sicily now than in the past (Liotta and Maniglia 1994).
[124] This species occurs in Europe, northern Africa and the Middle East.
[125] Larvae feed on the leaves of a range of trees. Generally, only a minor pest overseas.
[126] North American species.
[127] Occasional pest. Can sometimes cause total defoliation of young plants.
[128] Larvae only fed on live cambium and their feeding creates tunnels in the cambium.
[129] North American species.
[130] Single generation per year.
[131] Larvae bore into crown and trunk and feed on the cambia, especially near graft unions. Damage girdles and kills host. In the United States damage is often only on the peach root stock not the almond scion (Zalom et al., 2009).
[132] Occurs in Europe and North America. Can spread with nursery stock.
[133] Larvae cause defoliation of host plants.

Pathogens and nematodes

Table 18. *Almond pathogen and nematode threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
BACTERIA (including mycoplasma-like organisms and phytoplasmas)								
***Candidatus* phytoplasma prunorum**	European stone fruit yellows	Apricot, plum, cherry, almond, hazelnut	Whole tree, Symptoms in leaves.	MEDIUM-LOW[134]	MEDIUM-LOW[135]	MEDIUM[136]	HIGH-MEDIUM[137]	MEDIUM-VERY LOW
***Candidatus* phytoplasma phoenicium**	Almond witches' broom	Almond, peach	Whole tree, Symptoms in leaves.	MEDIUM-LOW[138]	MEDIUM-LOW	MEDIUM[139]	HIGH-MEDIUM[140]	MEDIUM-VERY LOW
Clover proliferation group phytoplasma (16SrVI - *Candidatus* phytoplasma trifolii related strains)	Shoot proliferation	Almond, peach	Shoots symptomatic	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Peach yellow leafroll phytoplasma	Almond brown line and decline	Almond, peach	Whole tree. Causes stunting, leaf, bark and nut symptoms	MEDIUM-LOW	MEDIUM-LOW	MEDIUM[141]	UNKNOWN[142]	MEDIUM-NEGLIGIBLE

[134] Occurs in Europe, Asia (Azerbaijan and Turkey) and in Africa (Tunisia) (USDA APHIS 2012).
[135] Vectored by *Cacopsylla pruni* and *Asymmetrasca decedens* (USDA APHIS 2012). Both exotic.
[136] Vector dependent.
[137] Causes decline of tree and yield reductions.
[138] Currently only reported from Iran and Lebanon (Verdin et al., 2003).
[139] Transmitted with propagation material, vectors unknown.
[140] Causes severe witches broom symptoms with no flowers or fruit produced on infected tree. Trees decline and die following infection (Verdin et al., 2003).
[141] Graft transmittible. Psyllids may also act as vectors but this has not been confirmed.
[142] Affects almonds grown on plum rootstock (Marianna 2624 root stock was specified by Uyemoto et al., (2008); Teviotdale et al., (2002)), causing yellow canopies, line of dead cells at union, small leaves and bark splits (disease called Almond brownline and decline).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Peach yellow leafroll phytoplasma	Almond kernel shrivel	Almond, peach	Whole tree. Causes stunting, leaf, bark and nut symptoms	MEDIUM-LOW	MEDIUM-LOW	MEDIUM[143]	UNKNOWN[144]	MEDIUM-NEGLIGIBLE
Pseudomonas amygdali	Hyperplastic canker	Almond	Branches and twigs	MEDIUM-LOW[145]	MEDIUM	MEDIUM	MEDIUM[146]	LOW-VERY LOW
Stolbur (16SrXII-A) group phytoplasmas	Little leaf	Almond, cherry, peach, plum	Leaves	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
X-disease phytoplasma (suggested scientific name: *Candidatus* phytoplasma pruni)	Peach X-disease	*Prunus* spp. including: almond	Leaves	MEDIUM-LOW[147]	LOW	LOW[148]	LOW[149]	NEGLIGIBLE
Xylella fastidiosa* subsp. *fastidiosa (Ratings with vector)	Almond leaf scorch	Grape, almond, maple[150]	Leaves symptomatic, damages whole plant	MEDIUM[151]	HIGH	HIGH[152]	HIGH[153]	HIGH
Xylella fastidiosa* subsp. *fastidiosa (Ratings without vector)	Almond leaf scorch	Grape, almond, maple[150]	Leaves symptomatic, damages whole plant	LOW[151]	HIGH	LOW[154]	HIGH[153]	MEDIUM

[143] Graft transmittible. Psyllids may also act as vectors but this has not been confirmed.
[144] Affects almonds grown on peach rootstock the pathogen causes delayed bud burst, stunted growth, pale leaves, kernels shrivelled (disease called Almond kernel shrivel) (Teviotdale et al., 2002).
[145] Occurs in Greece, Afghanistan and Turkey (Teviotdale et al., 2002).
[146] Causes cankers on the twigs and branches and causes decline of the tree (Teviotdale et al., 2002).
[147] Only present in Canada and the United States (CABI and EPPO date of publication unknown F).
[148] Vector dependent.
[149] On peach it can kill young trees (CABI and EPPO date of publication unknown F). Almonds in California that tested positive to the pathogen did not show symptoms (Teviotdale et al., 2002).
[150] See: Balbalian (2012).
[151] Disease occurs in North and South America, Asia and reported from Italy (EPPO and CABI (date of publication unknown B); Cariddi et al., 2014).
[152] Rapid spread if vectors present. Glassy winged sharpshooter (*Homalodisca vitripennis* (syn. *Homalodisca coagulata*)) is the main vector however there are several other species that can vector the bacteria overseas (Mizell et al., 2015). The Glassy winged sharpshooter is currently not present in Australia.
[153] This sub species causes leaf scorch of almond (Cariddi et al., 2014). Infections cause leaves to yellow, usually beginning on one branch before affecting the whole tree. Infected trees may be stunted, have reduced production but will usually survive several years after infection.
[154] Spread with cuttings but Australian planting material is tested via a virus tested a clean budwood scheme.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Xylella fastidiosa* subsp. *multiplex (Ratings with vector)	Almond leaf scorch	Pecan, almond, crape myrtle, elm, gingko, oak, mulberry, peach, plum, sweetgum and sycamore[155]	Leaves symptomatic, damages whole plant	MEDIUM[151]	HIGH	HIGH[152]	HIGH[153]	HIGH
Xylella fastidiosa* subsp. *multiplex (Ratings without vector)	Almond leaf scorch	Pecan, almond, crape myrtle, elm, gingko, oak, mulberry, peach, plum, sweetgum and sycamore[155]	Leaves symptomatic, damages whole plant	LOW[151]	HIGH	LOW[154]	HIGH[153]	MEDIUM
Xylella fastidiosa* subsp. *piercei (Ratings with vector)	Almond leaf scorch	Grape, almond, maple, lucerne[156]	Leaves symptomatic, damages whole plant	MEDIUM[151]	HIGH	HIGH[152]	HIGH[153]	HIGH
Xylella fastidiosa* subsp. *piercei (Ratings without vector)	Almond leaf scorch	Grape, almond, maple, lucerne[156]	Leaves symptomatic, damages whole plant	LOW[151]	HIGH	LOW	HIGH[153]	MEDIUM
FUNGI								
Armillaria mellea	Armillaria root rot	Very broad host range including: *Acacia* spp., *Acer* spp., kiwifruit, European alder, birches, cedar, cypress, citrus, fig, ash, olive, fir, pecan, chestnut, hazel, walnut, almond, *Prunus* spp., ornamental apple, privet, *Eucalyptus* spp., pine, oak, blackcurrant, mulberry, rose, grapevine and blueberry	Roots and collar region	LOW[157]	LOW	MEDIUM	MEDIUM[158]	VERY LOW
Armillaria tabescens	Clitocybe root rot	Wide host range including: hickory, pecan, almond, citrus, oak, Rosaceous species, ornamental trees and shrubs and fruit crops	Roots and collar region	LOW	LOW	MEDIUM	LOW[159]	NEGLIGIBLE

[155] See: Balbalian (2012); Cariddi et al., (2014).
[156] See: Schaad et al., (2004).
[157] The old records of this fungus in Australia are now all assumed to be the native *Armillaria, A. luteobubalina*.
[158] Would be very difficult to eradicate and be difficult to manage (in same way as *Phytophthora* spp.) Would have a significant impact on infected trees.
[159] Reported in Greek almond orchards (Tsopelas and Tjamos 1997).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Collophora hispanica		Almond	Wood of the trunk and branches	UNKNOWN	UNKNOWN[160]	UNKNOWN	UNKNOWN[161]	UNKNOWN
Diplodia olivarum		Almond, carob, olive	Wood of the trunk and branches	NEGLIGIBLE[162]	UNKNOWN[163]	UNKNOWN	UNKNOWN[161]	UNKNOWN
Phaeoacremonium amygdalinum		Almond	Wood of the trunk and branches	MEDIUM[164]	MEDIUM[160]	MEDIUM	MEDIUM[161]	LOW
Phaeoacremonium iranianum		Almond, grapevine	Wood of the trunk and branches	MEDIUM	MEDIUM[165]	MEDIUM	MEDIUM[161]	LOW
Phymatotrichopsis omnivora	Texas root rot	Broad range of plants including over 2000 hosts. These include cotton, pecan, walnut, pistachio, almond, macadamia, hazelnut, okra, peanut, sugar beet, legumes, fig, apple, *Prunus* spp., poplars, elms, willows and grapevine	Whole plant as a result or root damage	LOW[166]	MEDIUM	MEDIUM[167]	HIGH [168]	MEDIUM
Polystigma amygdalinum	Almond leaf blotch	*Prunus* spp. including almond	Leaves	LOW[169]	HIGH-MEDIUM	HIGH-MEDIUM	HIGH-MEDIUM[170]	MEDIUM-LOW
Polystigma fulvum (Syn. *Polystigma ochraceum*)	Red leaf blotch	*Prunus* spp. including almond	Leaves	LOW[171]	HIGH-MEDIUM	HIGH-MEDIUM	HIGH-MEDIUM[172]	MEDIUM-LOW

[160] Occurs on the island of Mallorca in the Mediterranean Sea (Gramaje et al., 2012).
[161] Causes severe decline and wood decay of almonds (Gramaje et al., 2012).
[162] Could enter on imported wood infected by the pathogen.
[163] Present in the Mediterranean. Therefore, similar climate to Australia.
[164] Could enter on symptomless propagation material (e.g. cuttings).
[165] Occurs on the island of Mallorca in the Mediterranean Sea (Gramaje et al., 2012), British Columbia (Urbez-Torres et al., 2014) and in South Africa (White et al., 2011).
[166] Present in North America. Soil-borne pathogen. But could enter on a range of commodities due to wide host range.
[167] Spread with soil, plant debris, etc.
[168] Kills infected plants.
[169] Occurs in the Mediterranean
[170] Economically important pathogen of almonds (Cannon 1996).
[171] Occurs in Iran, Spain, Belgium, Bulgaria, Greece, Israel, Italy, Lebanon, Palestine, Romania and Tunisia (Teviotdale et al., 2002).
[172] Major leaf pathogen in Iran (Banihashemi 1990). Causes leaf spots.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Polystigma rubrum	Leaf blotch; Red pit; Red leaf spot	*Prunus* spp. including almond	Leaves	LOW	HIGH-MEDIUM	HIGH-MEDIUM	HIGH-MEDIUM[173]	MEDIUM-LOW
Rhizopus circinans[174]	Hull Rot	Almond	Hull, Leaves, Branches	LOW	HIGH-MEDIUM	HIGH-MEDIUM	HIGH-MEDIUM[175]	MEDIUM-LOW
Verticillium dahliae (exotic defoliating strains)[176]	Verticillium wilt	Various including: cotton, olive, pistachio, chestnut, almond, pecan, walnut	Whole plant	MEDIUM	HIGH[177]	HIGH[178]	UNKNOWN[179]	HIGH-NEGLIGIBLE
NEMATODES								
Criconemoides curvatum	Ring Nematodes	Walnuts, almond, peach, carnation	Roots	LOW[180]	MEDIUM	MEDIUM	UNKNOWN[181]	MEDIUM-NEGLIGIBLE
Criconemoides xenoplax	Ring Nematodes	Walnuts, almond, peach	Roots	LOW[180]	MEDIUM	MEDIUM	UNKNOWN[181]	MEDIUM-NEGLIGIBLE
Longidorus attenuatus	Needle nematode	Wide host range including: barley, cabbage, potato, ryegrass, *Prunus* spp. (including almond), lucerne	Roots	LOW[182]	MEDIUM	MEDIUM[183]	HIGH-NEGLIGIBLE[184]	MEDIUM-NEGLIGIBLE

[173] Causes leaf blotches.
[174] Unknown which species of *Rhizopus* are causing hull rot in Australia. There is a project underway to examine this.
[175] Causes hull lesions similar damage to other *Rhizopus* spp. that are already present in Australia. Impact is therefore likely to be similar to the endemic species and therefore be a significant issue. However, may be able to be managed in a similar way to the endemic species causing hull rots.
[176] Non-defoliating strains of *Verticillium dahliae* occur in Australia. The defoliating strain VCG 1A is known to occur in Australia and is currently under review.
[177] Defoliating strain has a higher temperature requirement than non-defoliating strains.
[178] Soil, plant debris, etc. can spread the pathogen.
[179] Limited information on impact other than being listed as a susceptible host (McCain 1981).
[180] Found in South America, North America, Asia, Africa and Europe (Bridge and Starr 2007).
[181] Reported to be damaging to almond (Bridge and Starr 2007).
[182] European species could enter on infested soil.
[183] Can be spread with soil.
[184] Vector of Tomato blackring virus (CABI and EPPO date of publication unknown D). Impact depends on root stock. If using a resistant root stock impact would be Negligible if susceptible would have a Medium-High impact

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
VIRUSES AND VIROIDS								
***Peach American mosaic virus* (*Closterovirus*)**	Peach mosaic	*Prunus* spp., including almonds	Whole plant, leaves, flowers and nuts show symptoms	UNKNOWN[185]	UNKNOWN	UNKNOWN	UNKNOWN[186]	UNKNOWN
***Peach mosaic virus* (Trichovirus)**	Peach mosaic virus	Peach, apricot, almond, plum	Symptomless	UNKNOWN	UNKNOWN	UNKNOWN	NEGLIGIBLE[187]	UNKNOWN
***Peach rosette mosaic virus* (Nepovirus)**	Peach rosette mosaic virus	Peach, almond, grapes	Whole plant, causes leaf symptoms	UNKNOWN	UNKNOWN	UNKNOWN[188]	UNKNOWN[189]	UNKNOWN
***Plum pox virus* (*Potyvirus*) - Dideron strain**	Sharka	*Prunus* spp., including almonds	Symptoms appear on leaves and nuts	MEDIUM[190]	HIGH[191]	HIGH[192]	NEGLIGIBLE[193]	NEGLIGIBLE
***Tomato blackring virus* (*Nepovirus*)**	Enation	*Prunus* spp., including almond, grapes and a range of other hosts	Leaves	UNKNOWN[194]	UNKNOWN[195]	UNKNOWN	UNKNOWN[196]	UNKNOWN
***Tomato ringspot virus* (*Nepovirus*)**	Peach yellow bud mosaic virus	*Prunus* spp., including almond	Leaves and nuts	LOW-MEDIUM[197]	MEDIUM [198]	MEDIUM[199]	LOW[200]	LOW

[185] Could enter on graft material or mite vector (*Eriophyes insidiosus*). Only known to occur in North America (EPPO Date of publication unknown B).
[186] Almonds generally show milder symptoms to peaches and plums. Virus causes mild leaf symptoms (discolouration and distortion), nut symptoms and reduced yield and nut quality (EPPO Date of publication unknown B).
[187] Almonds can be symptomless hosts of this virus.
[188] Vectored by *Xiphinema americanum* (CABI and EPPO date of publication unknown E), which occurs in Australia.
[189] Reported from almonds in nurseries in Turkey. Infected plants showed leaf symptoms (Azery and Cycek 1997).
[190] Widespread overseas has been reported in northern Africa, Europe, Asia, North America and parts of South America.
[191] Hosts and vectors present in Australia.
[192] Vectored by aphids in a non-persistent manner. Vectors include: Green citrus aphid (*Aphis spiraecola*) and Green peach aphid (*Myzus persicae*) which are present in Australia. Virus can also be spread with infected budwood.
[193] Although this virus can cause significant impacts on stone fruit (Biosecurity Australia 2010), almonds show few if any symptoms (Rubio et al., 2003).
[194] Occurs in Europe, India, Japan, Turkey, Canada (CABI and EPPO date of publication unknown D).
[195] Vectored by nematodes in the *Longidorus* genus including: *L. attenuatus* (exotic) and *L. elongatus* (in Tasmania see: APPD) (CABI and EPPO date of publication unknown D).
[196] Can cause economic damage to peach (CABI and EPPO date of publication unknown D). The virus causes Enation of almond.
[197] Reported on almonds in California (Teviotdale et al., 2002).
[198] Graft transmittible and vectored by Dagger nematodes such as *Xiphinema americanum* (which has been reported in Australia (Qld, NSW, SA, Victoria (see APPD)) (Teviotdale et al., 2002).
[199] Vector dependent.
[200] Virus causes leaf symptoms, nut set is reduced and the hulls of infected nuts are thicker than normal (Teviotdale et al., 2002).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
UNKNOWN AGENTS								
Unknown	Almond stem pitting	Almond	Leaves, shoots, stems, branches, graft union and trunk	UNKNOWN[201]	UNKNOWN[202]	UNKNOWN	HIGH[203]	UNKNOWN
Unknown - bacteria suspected	Foamy canker	Almond, apricot, peach, citrus	Branches and trunk	UNKNOWN[204]	UNKNOWN	UNKNOWN	HIGH[205]	UNKNOWN

[201] Disease has been reported in Italy (Teviotdale et al., 2002).
[202] Graft transmittible but causal agent is unknown (Teviotdale et al., 2002).
[203] Causes leaf symptoms, weeping of shoots, stem pitting and shortening of internodes. Graft unions also affected with necrosis and stem pitting, young trees may break at the graft union. 17-74% yield losses reported in Italy. (Teviotdale et al., 2002).
[204] Only occurs in California (Teviotdale et al., 2002).
[205] Gum flows from cankers and can form puddles on the ground. Kills individual branches or whole plant (Teviotdale et al., 2002).

Chestnuts

Invertebrates

Table 19. *Chestnut invertebrate threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
ACARI (Mites e.g. spider and gall mites)								
Eotetranychus carpini (Syn. *Tetranychus carpinis; Eutetranychus carpini; Schizotetranychus carpin*)	Yellow mite; Yellow vine mite	Polyphagous including raspberry, chestnut, hazelnut, grapevine and plum	Nuts, leaves, old and young shoots	MEDIUM[206]	MEDIUM	HIGH-MEDIUM	MEDIUM[207]	LOW
Tetranychus canadensis	Canadian spider mite; four spotted spider mite	Wide range of plants including: chestnut, beech, ash, cotton, barley, apple, poplar, pear, rose, rye, elm and maize.	Leaves	UNKNOWN[208]	MEDIUM[209]	HIGH[210]	MEDIUM	MEDIUM-NEGLIGIBLE
COLEOPTERA (Beetles and weevils)								
Conotrachelus carinifer	Nut curculio	Oak, chestnut	Nuts	LOW[211]	MEDIUM	MEDIUM	HIGH[212]	MEDIUM

[206] European species, also occurs in Turkey and the USA (NSW DPI 2013).
[207] Affects leaves. However, chestnuts do not currently use insecticides to control endemic insect pests. If insecticidal management is needed it would have an impact on the management of the orchard as additional inputs would be required for the control of the pest.
[208] Occurs in Canada, Hungary, Poland and the USA (Bolland et al., 1998).
[209] Wide range of host species available and climate is likely to be suitable.
[210] Dispersal by movement of infested plant material; wind dispersal.
[211] Species occurs on the eastern coast of the United States. Could spread with the movement of fresh nuts infested with larvae.
[212] Larvae feed inside nut. Mostly affect acorn but reported on chestnut in Georgia (Payne 1972). Quality issues due to feeding damage.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Curculio caryatrypes	Larger chestnut weevil	Chinquapin, American and Chinese chestnuts	Nuts	LOW[213]	MEDIUM	MEDIUM[214]	HIGH [215]	MEDIUM
Curculio auriger	Small chestnut weevil	*Castanea* spp.	Nuts	LOW[216]	MEDIUM	MEDIUM	HIGH[217]	MEDIUM
Curculio elephas	Chestnut weevils	Chestnuts and oak	Nuts	LOW[218]	MEDIUM	MEDIUM	HIGH[219]	MEDIUM
Curculio proboscideus	Large chestnut weevil	*Castanea* spp.	Nuts	LOW[220]	MEDIUM	MEDIUM	HIGH[221]	MEDIUM
Curculio rectus	Black oak acorn weevils	Chestnut and oak	Nuts	LOW[222]	MEDIUM	MEDIUM	HIGH[223]	MEDIUM
Curculio sayi	Lesser Chestnut Weevil	Chinquapin, American and Chinese chestnuts	Nuts	LOW[224]	MEDIUM	MEDIUM	HIGH[225]	MEDIUM
Melolontha melolontha	White grub cockchafer	Wide range of hosts including: hazelnut, chestnut, strawberry, apple, pasture crops, oak, raspberry, potato, dandelion, turf grasses and grape	Leaves (by adults), roots (by larvae)	LOW-NEGLIGIBLE[226]	MEDIUM	MEDIUM[227]	HIGH[228]	MEDIUM-VERY LOW

[213] Native to North America, where is can cause significant damage. Could spread with the movement of fresh nuts infested with larvae. Entry potential is low as long as fresh material is not imported. Would likely increase if fresh imports are permitted.
[214] Spread potential is limited by the distribution of chestnut plantings.
[215] Larvae feed inside nut and cause nuts to fall from the tree. Significant pests in the central-east of the USA. Significant quality issues due to feeding damage.
[216] North American Species (Brooks and Cotton 1929). Could spread with the movement of fresh nuts infested with larvae.
[217] Larvae feed inside nut. Therefore, quality issues.
[218] Occurs in central and southern Europe and North Africa. Could spread with the movement of fresh nuts infested with larvae.
[219] Adults are minor leaf feeders; larvae bore into nuts (Alford 2014). Larvae cause nut quality issues.
[220] North American Species (Brooks and Cotton 1929). Could spread with the movement of fresh nuts infested with larvae.
[221] Larvae feed inside nut and cause nuts to fall from the tree. Larvae feeding would cause quality issues.
[222] North American species from the eastern USA. Could spread with the movement of fresh nuts infested with larvae.
[223] Larvae feed inside nut. Larvae feeding would cause quality issues.
[224] North American Species. Could spread with the movement of fresh nuts infested with larvae.
[225] Larvae feed inside nut and cause nuts to fall from the tree. Significant pests in the central-east of the USA. One of the most damaging species of North American chestnuts due to quality issues.
[226] Occurs in much of Europe and in Turkey, India and China.
[227] Due to wide host range.
[228] Reported to feed on Chestnut leaves in Bulgaria (Ovcharvo et al., 2007).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Otiorhynchus armadillo	Armadillo weevil	Alders, camellia, nut trees (including chestnut and hazelnut), beech, ivy, holly, juniper, bay, olive, spruce, Pittosporum, plum, azalea, Rubus, willow, elder and yew	Leaves (by adults), roots (by larvae)	UNKNOWN[229]	UNKNOWN	UNKNOWN	UNKNOWN[230]	UNKNOWN
Scolytus intricatus	European oak bark beetle	Birch, oak, rowan, chestnut, hazelnut, beech, poplar	Woody stems	UNKNOWN[231]	MEDIUM[232]	MEDIUM	UNKNOWN [233]	UNKNOWN
Xyleborus dispar	Pear blight beetle; European shothole borer; ambrosia beetle	Wide host range that includes eucalypts and deciduous trees including: hazelnut, chestnut, apple, apricot, peach, nectarine, pear, cherry, plum, oak, maple, birch, poplar and alder	Stems, branches	MEDIUM[234]	MEDIUM	MEDIUM[235]	MEDIUM[236]	LOW
HEMIPTERA (Stink bugs, aphids, mealybugs, scale, whiteflies and hoppers)								
Alebra albostriella	Leafhoppers	Oak (*Quercus cerris, Q. petraea*), chestnut[237]	Leaves	LOW[238]	LOW	LOW	LOW[239]	NEGLIGIBLE
Alebra viridis	Leafhoppers	Oak (*Quercus cerris, Q. petraea*), chestnut[237]	Leaves	LOW[238]	LOW	LOW	LOW[239]	NEGLIGIBLE

[229] This species occurs in Europe from the Mediterranean to Sweden (in a glass house) (Borisch 1997).
[230] Adults feed on leaves, larvae are root feeders.
[231] Occurs in Europe, northern Africa, Iran and Turkey.
[232] Could establish in Australia due to host range.
[233] Adults feed on leaves and twigs of various host plants (CABI 2014 B).
[234] Occurs in Europe, North America, and parts of Asia. The movement of infested woody material could introduce the pest.
[235] Adult females fly readily and flight is one of the main means of movement and dispersal to previously uninfected areas. Movement of infested plant material will also allow spread to occur
[236] Larvae are borers that are more likely to attach stressed trees. Damage to trees can also lead to disease infection.
[237] See: Demichelis and Bosco (1995).
[238] European species.
[239] Reported to affect the leaves of infected trees (Demichelis and Bosco 1995).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
HYMENOPTERA (Ants, bees and wasps)								
Dryocosmus kuriphilus	Oriental chestnut gall wasp	European chestnut (*Castanea sativa*), Japanese chestnut (*Castanea crenata*), American chestnut (*Castanea dentata*), Chinese chestnut (*Castanea mollissima*) and their hybrids. It infests also *Castanea seguinii* in China	Buds	MEDIUM[240]	MEDIUM[241]	MEDIUM[242]	HIGH-EXTREME[243]	HIGH-MEDIUM
LEPIDOPTERA (Butterflies and moths)								
Cydia fagiglandana	Beech seed moth	Chestnut (*Castanea* spp.), beech (*Fagus* spp.), oak (*Quercus* spp.)	Nuts	LOW[244]	MEDIUM[245]	MEDIUM[246]	MEDIUM[247]	LOW
Cydia latiferreana	Filbertworm	Chestnuts, hazelnut, beeches, almond, pomegranate, oak	nuts	LOW[248]	MEDIUM[249]	MEDIUM[250]	UNKNOWN	MEDIUM-NEGLIGIBLE
Cydia splendana	Chestnut tortrix moth; Chestnut codling moth	Walnut, chestnut, beech, oak	Nut	UNKNOWN[251]	UNKNOWN	UNKNOWN	HIGH[252]	UNKNOWN

[240] Present in Italy, China, Japan, Korea, USA (EPPO 2005). Originally native to Asia (Rieske 2007). Spread on budwood. Imported budwood goes through quarantine. Illegal imports a potential pathway for entry into Australia.
[241] Overseas distribution suggests this could establish in Australia.
[242] Spread occurs by the movement of infected shoots and locally by adult flight (EPPO 2005).
[243] Attacks buds forming galls. This reduces nut numbers and yield reductions of 50-70% can result. Heavy infestations can cause decline and tree death (EPPO 2005). Causing immense damage in the United States and Europe where introduced via bud wood. No known control measures to date in commercial orchards.
[244] European species also occurs in central Asia. Not importing fresh chestnuts, therefore low entry potential
[245] Single generation per year (Gilligan and Epstein 2014 B).
[246] Hosts present in Australia.
[247] Larvae feed inside nuts (Gilligan and Epstein 2014 B). Chestnut leaf roller (*Pammene fasciana*), along with Chestnut codling moth (*Cydia splendana*) and Beech seed moth (*Cydia fagiglandana*) are significant pests of chestnuts in Greece (Avtzis 2012).
[248] North American species, which occurs from Canada to Mexico. Fruit, nuts and plant material can carry pest.
[249] Widespread in USA.
[250] Moths are weak fliers and will be limited in Australia by available hosts (no endemic Corylus spp. as in North America).
[251] Native over much of Europe, also occurs in Japan, Algeria.
[252] Chestnut leaf roller (*Pammene fasciana*), along with Chestnut codling moth (*Cydia splendana*) and Beech seed moth (*Cydia fagiglandana*) are significant pests of chestnuts in Greece (Avtzis 2012). This species causes significant impacts in Spain and Italy, but would likely be easier to manage than *Curculio* spp. weevils using Pheromone traps etc.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Lymantria dispar	Gypsy moth (Asian and European strains)	Extremely polyphagous including chestnut, hazelnut, pecan, pistachio, walnut, *Prunus* spp. (not almonds), *Pinus* spp., maples, oaks, elms, box elder, birches, red gum, corn, apple, *Rubus* spp., blueberry, spruce and pear	Leaves	HIGH-MEDIUM[253]	MEDIUM[254]	HIGH	HIGH[255]	HIGH-MEDIUM
Lymantria mathura	Rosy gypsy moth; Pink gypsy moth	Chestnut, walnut, beech, apple, oak, willow, elm, lime trees (*Tilia* spp.)	Leaves	HIGH-MEDIUM[256]	MEDIUM	HIGH	UNKNOWN[257]	HIGH-NEGLIGIBLE
Orgyia antiqua	European tussock moth	Hazelnut, chestnut, dog rose, hops, apple, willow, blueberry, oak	Leaves	UNKNOWN[258]	UNKNOWN	UNKNOWN	UNKNOWN[259]	UNKNOWN
Pammene fasciana	Chestnut leaf roller	Chestnut, maple, beech	Leaves, nuts	LOW[260]	MEDIUM	MEDIUM	HIGH[261]	MEDIUM
Thaumetopoea processionea	Oak processionary moth	Oak, birches, chestnut, hazelnut, pines, hawthorn	Leaves	LOW[262]	MEDIUM	MEDIUM	UNKNOWN[263]	MEDIUM-NEGLIGIBLE

[253] Egg masses are often laid on cars, boats, shipping containers, etc. that are then spread through trade.
[254] Australian climatic conditions along the east coast, Victoria, Tasmania and regions of South Australia.
[255] Larvae defoliate host plants.
[256] Occurs in China, Korea, Russia (Far East), Can spread with trade like Gypsy moth (*L. dispar*) (OPPO/EPPO 2005).
[257] In Asia outbreaks occur every 4 years and cause significant defoliation of host plants (OPPO/EPPO 2005).
[258] Occurs in Europe, China and North America.
[259] Larvae defoliate host plants.
[260] This species occurs in Europe and Asia.
[261] Larvae feed on leaves and nuts. Chestnut leaf roller (*Pammene fasciana*), along with Chestnut codling moth (*Cydia splendana*) and Beech seed moth (*Cydia fagiglandana*) are significant pests of chestnuts in Greece (Avtzis 2012).
[262] Occurs in Europe and the Middle East.
[263] Larvae defoliate trees and have irritating hairs (FAO 2009).

Pathogens and nematodes

Table 20. *Chestnut pathogen and nematode threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
FUNGI								
Armillaria mellea	Armillaria root rot	Very broad host range including Acacia spp., Acer spp., kiwifruit, European alder, birches, cedar, cypress, citrus, fig, ash, olive, fir, pecan, chestnut, hazel, walnut, almond, *Prunus* spp., ornamental apple, privet, *Eucalyptus* spp., pine, oak, blackcurrant, mulberry, rose, grapevine and blueberry	Roots and collar region	LOW[264]	LOW	MEDIUM	MEDIUM[265]	VERY LOW
Cryphonectria parasitica	Chestnut blight	Chestnut (*Castanea* spp.), some oaks and eucalyptus	Branches, trunk, bark	MEDIUM[266]	HIGH	MEDIUM	EXTREME-HIGH[267]	HIGH-MEDIUM
Rugonectria castaneicola *(Syn. Rugonectria sinica, Neonectria castaneicola)*	Stem canker	Japanese chestnut (*Castanea crenata*), Veitch's fir (*Abies veitchii*), Hawthorn-leaf maple (*Acer crataegifolium*), *Quercus* spp. (including *Q. acutissima, Q. robur* and its hybrids)	Stem, trunk	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN

[264] The old records of this fungus in Australia are now all assumed to be the native *A. luteobubalina*.
[265] Causes tree death on other hosts.
[266] Localised incursion in Victoria. Spread by rain splash, wind, insects and grafting material (SPHDS 2011). Currently under eradication.
[267] Causes cankers which may girdle and kill infected branches. On grafted trees the union is often affected (SPHDS 2011). Would have significant impact on how orchards are managed and would affect market access (both imports and exports).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Verticillium dahliae (exotic defoliating strains)[268]	Verticillium wilt	Various including: cotton, olive, pistachio, chestnut, almond, pecan, walnut	Whole plant	MEDIUM	HIGH[269]	HIGH[270]	UNKNOWN[271]	HIGH-NEGLIGIBLE
OOMYCETES								
Phytophthora ramorum	Sudden oak death	Broad host range across genera from families including hazelnut, chestnut, oak trees, Arbutus, *Lithocarpus* spp., fir, maple plants in Ericaceae family, Eucalyptus, beech, macadamia, bay laurel, magnolia and yew. The known host range continues to expand with more research.	Epicormic shoots, leaves	MEDIUM	HIGH	HIGH	HIGH[272]	HIGH

[268] Non-defoliating strains of *Verticillium dahliae* occur in Australia. The defoliating strain VCG 1A is known to occur in Australia and is currently under review.
[269] Defoliating strain has a higher temperature requirement than non-defoliating strains.
[270] Soil, plant debris, etc. can spread the pathogen.
[271] Limited information on impact other than being listed as a host (EFSA 2014).
[272] Causes leaf symptoms on chestnut. Symptoms restricted to epicormic shoots and juvenile leaves (Denman et al., 2005).

Hazelnuts

Invertebrates

Table 21. *Hazelnut invertebrate threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
ACARI (Mites e.g. spider and gall mites)								
Cecidophyopsis vermiformis	Big bud mite	*Corylus* spp.	Buds	LOW[273]	LOW	MEDIUM-LOW[274]	HIGH[275]	LOW
Eotetranychus carpini (Syn. *Tetranychus carpinis; Eutetranychus carpini; Schizotetranychus carpin*)	Yellow mite; Yellow vine mite	Polyphagous including raspberry, chestnut, hazelnut, grapevine and plum	Nuts, leaves, old and young shoots	MEDIUM[276]	MEDIUM	HIGH-MEDIUM	MEDIUM[277]	LOW
COLEOPTERA (Beetles and weevils)								
Curculio nucum	Hazelnut weevil; nut weevil	Hazelnut	Nut	LOW[278]	MEDIUM	MEDIUM	HIGH[279]	MEDIUM

[273] Most likely to enter in buds of planting material (particularly material illegally entering Australia). This is the most widespread mite pest of hazelnuts and occurs in Europe, Asia, New Zealand and the United States of America. It is usually associated with *Phytoptus avellanae* (which is reported from Tasmania) (Webber 2007).
[274] Spread with host plants between regions.
[275] Causes buds to become deformed and swollen ("big buds"). High (up to 90%) bud losses reported overseas (Webber 2007).
[276] European species, also occurs in Turkey and the USA (NSW DPI 2013).
[277] Affects leaves.
[278] European species. Australia imports some kernels and nuts in-shell (but this is fumigated). Generally don't see field pests on imported material but can see stored insect pests. Therefore low entry potential.
[279] Larvae feed inside nut. Considered to be one of the major hazelnut pests causing high yield losses in Europe and Turkey (Moraglio et al., 2012).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Megaplatypus mutatus (Syn. *Platypus mutatus, P. sulcatus*)	Ambrosia beetle	Wide range of woody trees including: Hazelnut (*Corylus avellana*), walnut, maple, Citrus, Eucalyptus, ash, laurel, Magnolia, apple, plane tree (*Platanus* spp.), Poplar, peach, Avocado, pear, oak, willow, lime tree (*Tilia* spp.), elm, sour cherry	Trunk	MEDIUM [280]	MEDIUM-LOW	MEDIUM-LOW	UNKNOWN[281]	MEDIUM-NEGLIGIBLE
Melolontha melolontha	White grub cockchafer	Wide range of hosts including: hazelnut, chestnut, strawberry, apple, pasture crops, oak, raspberry, potato, dandelion, turf grasses and grape.	Roots (larvae), leaves (adults)	LOW[282]	MEDIUM	MEDIUM[283]	UNKNOWN[284]	MEDIUM-NEGLIGIBLE
Oberea linearis	Hazelnut and Walnut Twig Borer	Hazelnut and walnut	Shoots	LOW [285]	UNKNOWN	UNKNOWN	MEDIUM[286]	UNKNOWN
Otiorhynchus armadillo	Armadillo weevil	Alders, camellia, nut trees (including: chestnut and hazelnut), beech, ivy, holly, juniper, bay, olive, spruce, Pittosporum, plum, azalea, Rubus, willow, elder and yew	Leaves (by adults), roots (by larvae)	UNKNOWN[287]	UNKNOWN	UNKNOWN	UNKNOWN[288]	UNKNOWN

[280] Native and widespread in South America. Has been reported in Italy.
[281] Reported to be damaging to hazelnut in Italy (Allegro and Griffo 2008).
[282] Occurs in much of Europe and in Turkey, India and China.
[283] Due to wide host range.
[284] Adults are reported to feed on the leaves of hazelnut (Schneider 1980).
[285] European species.
[286] Larvae feed and develop in shoots.
[287] This species occurs in Europe from the Mediterranean to Sweden (in a glass house) (Borisch 1997).
[288] Adults feed on leaves, larvae are root feeders.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Xyleborus dispar	Pear blight beetle; European shothole borer; ambrosia beetle	Wide host range that includes eucalypts and deciduous trees including: hazelnut, chestnut, apple, apricot, peach, nectarine, pear, cherry, plum, oak, maple, birch, poplar and alder	Stems, branches	MEDIUM[289]	MEDIUM	MEDIUM[290]	MEDIUM[291]	LOW
HEMIPTERA (Stink bugs, aphids, mealybugs, scale, whiteflies and hoppers)								
Alebra coryli	Leafhoppers	Hazelnut[292]	Leaves	LOW[293]	LOW	LOW	LOW[294]	NEGLIGIBLE
Chinavia hilaris (syn. *Acrosternum hilare; Pentatoma hilaris; Chinavia hilare; Nezara hilaris*)	Green stink bug; Pistachio bug	Polyphagous including hazelnut, black walnut, pistachio, almond, hawthorn, ash, lucerne, *Robinia* spp., *Prunus* spp., legumes	Leaves, nuts	LOW[295]	MEDIUM	MEDIUM[296]	HIGH[297]	MEDIUM
Corylobium avellanae	Large hazelnut aphid	*Corylus* spp.	Shoots, twigs	LOW[298]	LOW	LOW	MEDIUM[299]	VERY LOW

[289] Occurs in Europe, North America, and parts of Asia. The movement of infested woody material could introduce the pest.
[290] Adult females fly readily and flight is one of the main means of movement and dispersal to previously uninfected areas. Movement of infested plant material will also allow spread to occur
[291] Larvae are borers that are more likely to attach stressed trees. Damage to trees can also lead to disease infection.
[292] See: Demichelis and Bosco (1995).
[293] European species.
[294] Reported to affect the leaves of infected trees (Demichelis and Bosco 1995).
[295] Occurs in North America, Asia and Iran.
[296] Capable of long distance dispersal to find hosts (Gomez and Mizel 2013a).
[297] Causes distortions to nuts and fruit (Gomez and Mizel 2013a).
[298] Species is reported from the United States and Europe.
[299] Causes sooty mould and reduced production. Mostly seen on husks (Walton et al., 2009).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Fieberiella florii	Privet leaf hopper	Polyphagous, including *privet*, *prunus spp.* (including almond), apple and possibly hazelnut (as it has the broadest host range of vectors of Apple proliferation, which is reported to affect hazelnut)	Leaves	UNKNOWN[300]	UNKNOWN	UNKNOWN	UNKNOWN[301]	UNKNOWN
Gonocerus acuteangulatus	Box bug	Hazelnuts, box (*Buxus* spp.)	Leaves, nuts	UNKNOWN[302]	UNKNOWN	UNKNOWN	UNKNOWN[303]	UNKNOWN
Halyomorpha halys	Brown marmorated stink bug	Feeds and reproduces on a wide range of plants including: hazelnut, pecan, walnut, cotton, sweetcorn, soybeans, maple, oak, fig, cotton, grapes, cherry, peach, and vegetable crops	Nuts	HIGH[304]	HIGH[305]	HIGH[306]	HIGH[307]	HIGH
Palomena prasina	Green shield bug	Polyphagous including hazelnut	Leaves, nuts	LOW	MEDIUM	LOW[308]	HIGH-MEDIUM[309]	LOW-VERY LOW

[300] Occurs in North America, Europe (USDA APHIS 2012).
[301] Vector of apple proliferation (USDA APHIS 2012).
[302] Occurs in the Mediterranean, Europe and central Asia.
[303] Enzymes in the bug's saliva which is injected into nuts while feeding can cause quality reductions (Vaccino et al., 2008).
[304] Was recently (late 1990s) introduced from China into North America, where it is spreading rapidly (Kamminga et al., 2014).
[305] Given the rapid establishment of this species in the United States.
[306] Given the rapid spread of this species in the United States.
[307] On hazelnuts in the USA this species causes blank nuts, shrivelled kernels or "corking" damage. Damage depends on the timing of feeding, with experiments showing up to 30% of nuts can be affected (shrivelled, corked or blank) due to feeding by this insect (Hedstrom 2014).
[308] Only one generation per year.
[309] Feed on foliage and nut clusters leading to nut drop and distortion. Hazelnuts become small and light brown. Kernels are shrunken and have a bitter taste. Common pest in hazelnut orchards in Turkey (Saruhan et al., 2010).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
LEPIDOPTERA (Butterflies and moths)								
Archips podana	Great brown twist moth, Large fruit tree tortrix, Fruit-tree tortrix	Highly polyphagous including European alder, Hazelnut, oaks (including *Q. robur* and *Q. ilex*), European honeysuckle, Japanese spindletree, blueberry, clover, beech, currant, spruce, quince, apple, cherry, plum, pear, rugosa rose, raspberry and blackberry	Leaves, inflorescence and nuts	LOW	HIGH	HIGH	MEDIUM	LOW
Archips rosana	European leaf roller; Filbert leaf roller, Rose leaf roller	Polyphagous including raspberry, hazelnut, blackberry, blackcurrant, rose, plum, apple, European pear, conifer and poplar	Leaves, growing points, inflorescence, and nuts	LOW[310]	MEDIUM	MEDIUM	LOW	VERY LOW
Choristoneura rosaceana	Oblique banded leafroller	Wide host range including: *Prunus* spp. (including almond), pistachio, hazelnut, maple, pear, raspberry, blueberry	Leaves	LOW[311]	MEDIUM[312]	MEDIUM	LOW[313]	VERY LOW
Cosmia trapezina	Dun-bar moth	Polyphagous including *Rubus* spp., *Ribes* spp. apple, pear, maple, hazelnut, oak, birch and willow	Leaves	UNKNOWN[314]	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN

[310] Occurs in Europe and North America.
[311] North American species.
[312] 1-2 generations per year (CABI and EPPO date of publication unknown C).
[313] Leaf damage reported on hazelnut (CABI and EPPO date of publication unknown C).
[314] Occurs in Europe and Asia.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Cydia latiferreana	Filbertworm	Chestnuts, hazelnut (*Corylus*), beeches, almond, pomegranate, Quercus	Nuts	LOW[315]	MEDIUM[316]	MEDIUM[317]	HIGH[318]	MEDIUM
Gypsonoma dealbana	-	Hazelnut, hawthorn, poplar, willow, oak	Leaves, buds, catkins, shoots	LOW[319]	MEDIUM	MEDIUM	MEDIUM[320]	LOW
Hyphantria cunea	American white moth, Fall web worm; mulberry moth	Wide host range including: maple, alder, ash, pecan, walnut and hazelnut, Rosaceae species (including apple, plum, pear and cherry), persimmon, poplar, willow, sycamore and mulberry	Leaves	LOW[321]	MEDIUM[322]	MEDIUM	UNKNOWN[323]	MEDIUM-NEGLIGIBLE
Lymantria dispar	Gypsy moth (Asian and European strains)	Extremely polyphagous including: chestnut, hazelnut, pecan, pistachio, walnut, *Prunus* spp. (not almonds), *Pinus* spp., maples, oaks, elms, box elder, birches, red gum, corn, apple, *Rubus* spp., blueberry, spruce and pear	Leaves	HIGH-MEDIUM[324]	MEDIUM[325]	HIGH	HIGH[326]	HIGH-MEDIUM

[315] North American species, which occurs from Canada to Mexico. Fruit, nuts and plant material can carry pest.
[316] Widespread in USA.
[317] Moths are weak fliers and will be limited in Australia by available hosts (no endemic Corylus spp. as in North America).
[318] Eggs laid very close to nut clusters. Larvae feed inside nuts. At maturity, they chew out of nut and pupate in the soil. Considered to be a key pest in Oregon in the United States, where it is managed by pyrethroid sprays (Hedstrom et al., 2012).
[319] European species.
[320] Larvae damage leaves, buds, catkins, shoots.
[321] Widespread in Europe, Asia and North America.
[322] Entered Europe from North America after World War 2.
[323] Larvae defoliate trees (typically at the end of branches) and build silk "tents" (Sourakov and Paris 2010).
[324] Range expansion of invading populations is primarily facilitated by long-range movement by humans. Egg masses are often laid on cars, trucks, trains or boats, on logs, or containers that are inadvertently moved by humans).
[325] Australian climatic conditions along the east coast, Victoria, Tasmania and regions of South Australia.
[326] Spread by natural and human assisted means.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Lymantria monacha	Nun moth	Wide range of hosts including fruit trees and confers such as hazelnut, *Pinus* spp., spruce, fir, oak, birch, beech and larch	Leaves	MEDIUM[327]	MEDIUM	HIGH	HIGH[328]	MEDIUM
Malacosoma californicum	Western tent caterpillar	Reported on oak, willow, poplar, birch, alder, hazelnut, ash, apple, almond, apricot, cherry, plum	Leaves	UNKNOWN[329]	UNKNOWN	UNKNOWN	UNKNOWN[330]	UNKNOWN
Malacosoma neustria	Common lackey	Almond, apple, plum, pear, oak and hazelnut	Leaves	UNKNOWN[331]	UNKNOWN	UNKNOWN	LOW[332]	UNKNOWN
Operophtera brumata	Winter moth	Wide host range including: oak, hazelnut, apple, maple, poplars, stone fruit, pears, elms, other deciduous tree species	Leaves and nut	LOW[333]	MEDIUM	MEDIUM[334]	HIGH-MEDIUM[335]	MEDIUM-LOW
Orgyia antiqua	European tussock moth	Hazelnut, chestnut, dog rose, hops, apple, willow, blueberry, oak	Leaves	LOW[336]	MEDIUM	MEDIUM-LOW	MEDIUM-LOW[337]	LOW-NEGLIGIBLE

[327] Occurs in Europe, central and eastern Asia (Michigan State University 2010). Most often found on forest products, shipping containers, cargo and ships' structures; adults are strong fliers, and attracted to light.
[328] Defoliation by larvae can kill trees, causes economic loss.
[329] North American species (Swiecki and Bernhardt 2006).
[330] Little information about this pest's impact on nuts other than recording them as hosts. Larvae feed on foliage and build "tents" of silk (Swiecki and Bernhardt 2006).
[331] Occurs in Europe, Asia and North Africa.
[332] Larvae defoliate trees and build silken "tents".
[333] Occurs in Europe, parts of western Asia and North Africa and North America.
[334] Females do not have fully developed wings and cannot fly.
[335] Defoliating insect.
[336] Occurs in Europe, China and North America.
[337] Larvae defoliate host plants.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Orthosia cerasi	Common quaker	Birches, hornbeam, hazelnut, hawthorn, beech, apple, poplar, willow and elm	Leaves, inflorescence and nut	LOW[338]	MEDIUM	MEDIUM	HIGH-MEDIUM[339]	MEDIUM-LOW
Phalera bucephala	Buff-tip moth	*Rubus* spp., rose, oak, hazelnut, elm and beech	Leaves	LOW[340]	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Saturnia pyri (syn. *Bombyx pyri*)	Great peacock moth	Hazelnut, walnut, *Prunus* spp. (including almond), willow, maple, beech, Rubus, poplar, apple	Leaves	LOW[341]	LOW	LOW	LOW[342]	NEGLIGIBLE
Thaumetopoea processionea	Oak processionary moth	Oak, birches, chestnut, hazelnut, pines, hawthorn	Leaves	LOW[343]	MEDIUM	MEDIUM	LOW-MEDIUM[344]	LOW-VERY LOW

[338] European and western Asian species.
[339] Larvae defoliate host plants.
[340] European species.
[341] This species occurs in Europe, northern Africa and the Middle East.
[342] Larvae feed on the leaves of a range of trees. Generally, only a minor pest overseas.
[343] Occurs in Europe and the Middle East.
[344] Larvae defoliate trees and have irritating hairs (FAO 2009).

Pathogens and nematodes

Table 22. *Hazelnut pathogen and nematode threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
BACTERIA (including mycoplasma-like organisms and phytoplasmas)								
***Candidatus* phytoplasma asteris**	Aster yellows	Numerous plant hosts from many families, including Roseaceae, Solanaceae, Ericaceae, Malvaceae, Salicaceae, Papaveraceae, Anacardiaceae, Fabaceae, Myrtaceae, Euphorbiaceae, Iridaceae, Cucurbitaceae, Apiaceae, Primulaceae, Rutaceae, Asteraceae, Aceraceae, Ulmaceae, Liliaceae, Betulaceae. (including: Hazelnut)	Whole plant – symptoms appear on above ground parts	LOW	LOW	UNKNOWN[345]	MEDIUM[346]	VERY LOW-NEGLIGIBLE
***Candidatus* phytoplasma mali**	Hazelnut yellows, apple proliferation	Apple, pear cherry, plum, apricot and hazelnut	Above ground parts - causes yellowing and decline	MEDIUM[347]	MEDIUM-LOW[348]	HIGH-LOW	MEDIUM[349]	LOW-VERY LOW
***Candidatus* phytoplasma prunorum**	European stone fruit yellows	Apricot, plum, cherry, almond, hazelnut	Whole tree, Symptoms in leaves	MEDIUM-LOW[350]	MEDIUM-LOW[351]	MEDIUM	UNKNOWN	MEDIUM-NEGLIGIBLE

[345] Spread by leafhopper vectors including: *Euscelis*, *Euscelidius*, and *Macrosteles* spp. Literature search couldn't identify the vector on hazelnuts.
[346] Causes stunting and leaf yellowing of hazelnut (Cieślińska and Kowalik 2011).
[347] European species (USDA APHIS 2012).
[348] Vectored by *Cacopsylla melanoneura* (hosts are mostly Rosacea (USDA APHIS 2012)), *Cacopsylla picta* (monophagous on *Malus* spp. (Jarausch et al., 2011)) and *Fieberiella florii* (polyphagous) (USDA APHIS 2012).
[349] Reported on hazelnuts in Italy showing yellowing and decline (Marcone et al., 1996).
[350] Occurs in Europe, Asia (Azerbaijan and Turkey) and in Africa (Tunisia) (USDA APHIS 2012).
[351] Vectored by *Cacopsylla pruni* and *Asymmetrasca decedens* (USDA APHIS 2012). Both exotic.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
***Candidatus* phytoplasma pyri**	Pear decline	Pear, hazelnut, quince, apple, plum	Above ground parts - causes yellowing and decline	MEDIUM[352]	MEDIUM-LOW[353]	HIGH-LOW	MEDIUM[354]	LOW-VERY LOW
Pseudomonas avellanae (Syn. *P. syringae* pv. *avellanae*)	Bacterial canker	Hazelnut	Twigs and branches	LOW	LOW	LOW[355]	HIGH[356]	LOW
FUNGI								
Anguillosporella coryli	Hazelnut leaf spot	*Corylus* spp.	Leaves	LOW	LOW	LOW	MEDIUM-LOW[357]	VERY LOW-NEGLIGIBLE
Anguillosporella vermiformis	Hazelnut leaf spot	*Corylus* spp.	Leaves	LOW	LOW	LOW	MEDIUM-LOW[357]	VERY LOW-NEGLIGIBLE
Anisogramma anomala	Eastern filbert blight	Hazelnut, *Corylus* spp. (particularly *C. avellana*)	Branches, stems	MEDIUM	MEDIUM	HIGH-MEDIUM	EXTREME[358]	HIGH
Armillaria gallica (Syn. *A. lutea*)	Root rot	Wide host range including: blackberry, raspberry, gooseberry, rose, currant, pine, oak, spruce, hazelnut and grapevine	Roots	LOW-NEGLIGIBLE[359]	LOW	MEDIUM	MEDIUM	VERY LOW-NEGLIGIBLE
Armillaria mellea	Armillaria root rot	Very broad host range including *Acacia* spp., *Acer* spp., kiwifruit, European alder, birches, cedar, cypress, citrus, fig, ash, olive, fir, pecan, chestnut, hazel, walnut, almond, *Prunus* spp., ornamental apple, privet, *Eucalyptus* spp., pine, oak, blackcurrant, mulberry, rose, grapevine and blueberry	Roots and collar region	LOW[360]	LOW	MEDIUM	MEDIUM[361]	VERY LOW

[352] European species that has been introduced into North America (Etropolska et al., 2011).
[353] Vectored by *Cacopsylla pyri, C. pyricola* and *C. pyrisuga* (Etropolska et al., 2011). These vectors are exotic and mostly affect *Pryus* spp.
[354] Reported on hazelnuts in Italy showing yellowing and decline (Marcone et al., 1996).
[355] Spread with propagative material and over short distances by rain or irrigation water (Teviotdale et al., 2002).
[356] Causes necrosis of the infected limb (Teviotdale et al., 2002).
[357] Little known other than it causes leaf spot on hazelnuts (Teviotdale et al., 2002).
[358] Based on impacts in the United States where it is a devastating disease of hazelnut and managed using resistant varieties (Sathuvalli et al., 2012).
[359] Occurs in Europe, Asia and North America, spread with soil.
[360] The old records of this fungus in Australia are now all assumed to be the native *Armillaria, A. luteobubalina*.
[361] Causes tree death on other hosts.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Armillaria solidipes, (Syn. *A. ostoyae*)	Root rot	Wide host range including: blackberry, raspberry, gooseberry, rose, currant, pine, oak, spruce, hazelnut and grapevine[362]	Roots	LOW-NEGLIGIBLE[363]	LOW	MEDIUM	MEDIUM	VERY LOW-NEGLIGIBLE
Asteroma coryli	Hazelnut leaf spot	*Corylus* spp.	Leaves	LOW	LOW	LOW	MEDIUM-LOW[364]	VERY LOW-NEGLIGIBLE
Cercospora corylina	Hazelnut leaf spot	*Corylus* spp.	Leaves	LOW	LOW	LOW	MEDIUM-LOW[357]	LOW
Cryptosporiopsis tarraconensis	Borro sec	Hazelnut	Flowers	LOW[365]	LOW	LOW	HIGH[366]	MEDIUM
Cytospora corylicola	Cytospora canker	*Corylus* spp.	Trunk	LOW[367]	UNKNOWN[368]	UNKNOWN	UNKNOW[369]	UNKNOWN
Fomitiporia mediterranea	White heart rot	Maple, grape, hazelnut, olive, oak, *Robina* spp., crepe myrtle (*Lagerstroemia* spp.), Laurel, privet	Above ground parts	LOW[370]	LOW	LOW	LOW[371]	NEGLIGIBLE
Mamianiella coryli	Hazelnut leaf spot	*Corylus* spp.	Leaves	LOW	LOW	LOW	MEDIUM-LOW[357]	VERY LOW-NEGLIGIBLE
Microsphaera coryli (Syn. *Erysiphe corylicola*)	Powdery mildew	*Corylus* spp.	Leaves	LOW	MEDIUM	HIGH-MEDIUM[372]	MEDIUM[373]	LOW
Phyllactinia guttata	Powdery mildew	Hazelnut, Pistachio, kiwi, alder, dogwood, oak, Contorted hazelnut (*Corylus avellana*)	Leaves, nuts	LOW	MEDIUM	MEDIUM	HIGH[374]	MEDIUM

[362] Reported on hazelnut (see: Biosecurity Australia 2011).
[363] Occurs in Europe and North America.
[364] Little known other than it causes leaf spot on hazelnuts (Pscheidt and Stone 2001).
[365] Occurs in Europe, first reported in Spain (Teviotdale et al., 2002).
[366] Causes buds to dry (Teviotdale et al., 2002).
[367] Widespread overseas, not known to occur in Australia.
[368] Warm summers and low soil organic matter favour disease (Lamichhane et al., 2014).
[369] Secondary invader of damaged tissue, causes cankers (Lamichhane et al., 2014).
[370] Occurs in Mediterranean basin and parts of central Europe.
[371] Causes rot of wood and chlorosis of leaves (CABI 2012).
[372] Fast spread within groves, but slow spread between regions, due to distribution of host plants in the environment.
[373] Pathogen is reported to cause Powdery mildew of hazelnuts. If it established there would be increased production/management costs.
[374] Affects hazelnuts (Teviotdale et al., 2002).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Phyllosticta coryli	Hazelnut leaf spot	*Corylus* spp.	Leaves	LOW	LOW[375]	MEDIUM[376]	MEDIUM	VERY LOW
Phymatotrichopsis omnivora	Texas root rot	Broad range of plants including: over 2000 hosts. These include cotton, pecan, walnut, pistachio, almond, macadamia, hazelnut, okra, peanut, sugar beet, legumes, fig, apple, *Prunus* spp., poplars, elms, willows and grapevine	Whole plant as a result or root damage	LOW[377]	MEDIUM	MEDIUM[378]	MEDIUM[379]	LOW
Piggotia coryli (Syn. *Gloeosporium coryli, Labrella coryli, Monostichella coryli*)	Anthracnose	Hazelnut	Leaves, inflorescences and nuts	MEDIUM[380]	MEDIUM	HIGH-MEDIUM	HIGH[381]	MEDIUM
Pucciniastrum coryli	Hazelnut rust	Uredinial and Telial state on *Corylus* spp. (including hazelnut and filbert), Spermogomial and Aecial state on fir, specifically: *Abies firma, A. homolepis* and *A. veitchii* (Yun 2010).	Leaves and shoots	MEDIUM[382]	HIGH-MEDIUM	HIGH	HIGH-MEDIUM[383]	HIGH-LOW
Ramularia coryli	Hazelnut leaf spot	*Corylus* spp.	Leaves	MEDIUM	MEDIUM	MEDIUM	LOW[384]	VERY LOW
Ramularia endophylla (syn. *Mycosphaerella punctiformis*)	Kernel mould	Hazelnut, oak, maple, and lime tree (*Tilia* spp.)	Kernels and leaves	MEDIUM	MEDIUM	MEDIUM	HIGH-MEDIUM[385]	MEDIUM-LOW

[375] Widespread throughout the USA (Horst 2013).
[376] Spreads rapidly one established (Sun et al., 2013).
[377] Present in North America. Soil-borne.
[378] Spread with soil, plant debris, etc.
[379] Kills infected plants.
[380] Common in North America. Also present in Korea and Europe (Teviotdale et al., 2002).
[381] Causes leaf spots, bud rot and catkin necrosis.
[382] Only known from Japan, far eastern Russia and China (Yun 2010).
[383] Causes leaf symptoms (Yun 2010).
[384] Listed by the American Phytopathological Society as a pest of hazelnut. See: **www.apsnet.org/publications/commonnames/Pages/Hazelnut.aspx** for further information.
[385] Causes kernels to become mouldy and covered in mycelia (DeFrancesco 2006). However, pathogenicity has not been proved.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Septoria ostryae	Kernel mould and leaf spot	Hazelnut (*Corylus* spp.), alder (*Alnus* spp.), hornbeam (*Carpinus* spp.) and hop-hornbeam (*Ostrya* spp.)	Kernels and leaves	MEDIUM[386]	LOW	MEDIUM-LOW	LOW[387]	VERY LOW-NEGLIGIBLE
Taphrina coryli	Hazelnut leaf blister	Corylus spp.	Leaves	LOW	LOW	MEDIUM	LOW	NEGLIGIBLE
OOMYCETES								
Phytophthora ramorum	Sudden oak death	Broad host range across genera from families including hazelnut, chestnut, oak trees, Arbutus, *Lithocarpus* spp., fir, maple plants in Ericaceae family, Eucalyptus, beech, macadamia, bay laurel, magnolia and yew. The known host range continues to expand with more research.	Stems, branches, shoots, leaves	MEDIUM	HIGH	HIGH	MEDIUM[388]	MEDIUM
VIRUSES AND VIROIDS								
***Tulare apple mosaic virus* (*Ilarvirus*)**	Tulare apple mosaic virus	Apple and hazelnut	Leaves	UNKNOWN[389]	UNKNOWN	UNKNOWN[390]	UNKNOWN[391]	UNKNOWN
UNKNOWN								
Unknown	Filbert Stunt Syndrome	Hazelnut	Leaves, Branches, Roots	LOW[392]	UNKNOWN	UNKNOWN[393]	UNKNOWN[394]	UNKNOWN

[386] North American species (Olsen et al., 2013).
[387] Causes kernel decay. Losses typically 0.5-1% can be up to 10% in some orchards (Teviotdale et al., 2002; Olsen et al., 2013).
[388] Hazelnut is described by Moralejo et al., (2009) as being slightly susceptible to sudden oak death.
[389] Only reported once in France (Teviotdale et al., 2002).
[390] Vector unknown.
[391] Only reported once worldwide on apples and hazelnut in France (Teviotdale et al., 2002).
[392] Reported from Oregon in the USA (Teviotdale et al., 2002).
[393] Spread by grafting (including root grafting within orchards) (Teviotdale et al., 2002).
[394] Usually only affect isolated plants. Leaves dull and are small (1/8 normal size), plants stunt and die back occurs (Teviotdale et al., 2002).

Macadamias

Invertebrates

Table 23. *Macadamia invertebrate threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
COLEOPTERA (Beetles and weevils)								
Hypothenemus obscurus	Tropical nut borer	Macadamia, Brazil nuts	Nuts	MEDIUM[395]	HIGH	HIGH[396]	HIGH[397]	HIGH
Xylosandrus compactus	Black twig borer	Wide host range including coffee, tea, avocado, macadamia, litchi, eucalypts	Branches	LOW[398]	MEDIUM	HIGH	MEDIUM[399]	LOW
Xylosandrus crassiusculus	Asian ambrosia beetle	Wide host range including macadamia, pecan, elms, koa (*Acacia koa*), aspen, beech, cherry, oak	Branches	LOW[400]	MEDIUM[401]	HIGH	MEDIUM[402]	LOW

[395] The risk of accidental introduction of *H. obscurus* is quite high for macadamia if unhusked or unprocessed nuts are exported. Australia imports 500 tonnes of nut in shell form South Africa, where this species is also found (Greco and Wright 2012). There are conditions on importation of nuts, see BICON for relevant import conditions.
[396] Adults are able to fly up to several hundred metres and to infest an entire orchard quickly.
[397] Major pest in Hawaii. Damage can exceed 30% in Hawaii. Nuts with low moisture levels (e.g. nuts that have been on the ground for a week) are at greatest risk of attack (Delate et al., 1994).
[398] Wide spread overseas. Occurs in Fiji, Papua New Guinea, Hawaii, Italy, Brazil, USA, parts of Asia and much of Africa.
[399] Bores into twigs and branches causing damage (Greco and Wright 2012).
[400] Transport of infested seedlings, saplings or cut branches. *X. crassiusculus* usually attacks stems of small diameter (not more than 5 cm diameter), but is sometimes found in larger timber, especially if fresh. Hence it may also be transported in crates or other packing material).
[401] Wide host range. Adult female beetles will fly readily.
[402] Bores into twigs and branches causing damage.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
HEMIPTERA (Stink bugs, aphids, mealybugs, scale, whiteflies and hoppers)								
Bathycoelia natalicola	Two-spotted Stink Bug	Macadamia	Nuts, Leaves	LOW[403]	MEDIUM	MEDIUM	HIGH-MEDIUM[404]	MEDIUM-LOW
Bathycoelia rodhaini	Yellow-spotted stink bug	Macadamia	Nuts	LOW[405]	MEDIUM	MEDIUM	MEDIUM[406]	LOW
Dorisiana viridis	Cicada	Roots (nymphs) and above ground parts	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN[407]	UNKNOWN
Helopeltis theivora	Tea mosquito	Tea, cashew, macadamia	Leaves	UNKNOWN[408]	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Homalodisca vitripennis (Syn. *Homalodisca coagulata*)	Glassy winged sharpshooter	Feeds on >100 plants including: almond, macadamia, pistachio, walnut, avocado, citrus, Eucalypts, grapes, ash, oleander, blackberry, bottlebrush, bougainvillea, camellia, acacia, chrysanthemum and other ornamentals	Leaves Vector of the bacterium *Xylella fastidiosa*	MEDIUM[409]	HIGH[410]	HIGH[411]	UNKNOWN[412]	HIGH-NEGLIGIBLE
Pseudotheraptus wayi	Coconut bug	Macadamia, coconut, avocado, mango	Growing points, inflorescence, nuts	LOW[413]	HIGH-MEDIUM	HIGH	HIGH[414]	MEDIUM

[403] South African species. Could potentially enter as hitchhiker with fruit, nuts or plant imports.
[404] Main stink bug pest of macadamia in South Africa (Schoeman 2013). Stinkbugs cause flower drop during bloom, nut drop before shell hardening and damaged kernels from before to after shell hardening).
[405] South African species. Could potentially enter as hitchhiker with fruit, nuts or plant imports.
[406] Causes significant damage to macadamia in South Africa (Froneman and de Villiers 1990).
[407] Reported to affect macadamia in Brazil. Infested trees showed leaf yellowing and leaves fell from the tree. Damage similar to that caused by *Psaltoda* cicadas on macadamia in Queensland (Santos-Cividanes et al., 2013).
[408] Present in Sri Lanka, Indonesia, Indo-China and India.
[409] Native to south-eastern USA and northern Mexico, has spread to other parts of the USA, French Polynesia and Hawaii (Mizell et al., 2008). Could spread on nursery stock from overseas.
[410] Numerous alternative hosts; recent history of spread in USA, especially on nursery stock.
[411] Strong fliers, egg masses could be spread with nursery stock over large areas.
[412] Vector of *Xylella fastidiosa* diseases. Feeding doesn't cause physical signs of damage but the insects secrete a white liquid while feeding that covers the leaves and ground below the infected plant.
[413] African species occurring in South Africa, Kenya and Tanzania.
[414] Causes significant drop of flowers and young nuts in South Africa. Kernels become necrotic and deformed (CABI 2015 C).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Sophonia orientalis	Two-spotted leafhopper	Wide host range including: macadamia, coffee, banana, taro, guava, mango	Leaves	LOW[415]	MEDIUM[416]	MEDIUM	LOW[417]	VERY LOW
LEPIDOPTERA (Butterflies and moths)								
Cryptoblabes gnidiella	Honeydew moth	Macadamia, citrus, grapes, loquat, avocado	Nuts	MEDIUM[418]	MEDIUM[419]	HIGH	LOW[420]	VERY LOW
Cryptophlebia illepida	Koa seedworm	Macadamia, mango, litchi, Koa (*Acacia koa*)	Nuts	LOW	MEDIUM	MEDIUM	LOW[421]	VERY LOW
Thaumatotibia leucotreta	False codling moth	Wide host range including: walnut, macadamia, citrus, grains, cotton, pineapple, oak	Nuts	LOW[422]	MEDIUM[423]	MEDIUM	MEDIUM[424]	VERY LOW
THYSANOPTERA (Thrips)								
***Scirtothrips aurantii* (exotic biotypes)[425]**	South African citrus thrips	Polyphagous across more than 50 plant species including lemon, navel orange, mango, asparagus, grevillea, acacia, tea, cotton, macadamia, banana, castor bean, grapevine, pomegranate, silky oak, groundnut, glory lily and macadamia	Nuts, leaves, growing points	HIGH	HIGH[426]	MEDIUM	UNKNOWN	HIGH-NEGLIGIBLE

[415] Occurs in Taiwan, China, Pakistan, Japan and Hawaii (Aguin-Pombo et al., 2007). All life stages can be readily moved on vegetative plant materials. The small size and concealed nature of *S. rufofascia* eggs make their detection on imported plant material very difficult.
[416] Very wide host range, short life cycle. The small size and concealed nature of *S. rufofascia* eggs make their detection on imported plant material very difficult. Therefore, the risk of introduction is fairly high.
[417] Pest of Macadamia in Hawaii (Aguin-Pombo et al., 2007).
[418] Eggs are laid on fruit, nuts and leaves and larvae attack nuts. Could enter on a range of imported fruit or vegetables. Pest occurs in northern Africa, Mediterranean Europe, Asia, South America, and New Zealand
[419] *C. gnidiella* is a polyphagous pest of numerous crops including fruit and vegetables.
[420] In Israel, combined losses of macadamia nuts as a result of *C. gnidiella*, Carob moth (*Ectomyelois ceratoniae*) (an emerging species) and False codling moth (*Thaumatotibia leucotreta*) (an exotic species) amounted to 30% (Wysoki, 1986).
[421] Reported to be a pest in Hawaii, together with the and closely related Macadamia nut borer (*Cryptophlebia ombrodelta*) (an Australian species) (Jones 1994).
[422] Transported on fruit (but has been detected in California on South African Citrus imports.
[423] Wide host range but is a warm-climate species so is more likely to do well in Qld and NSW.
[424] Burrow into the husk and into the shell to feed on the kernel. Has caused yield losses of 30+% in Israel and South Africa (USDA APHIS PPQ 2010).
[425] Currently only reported in Australia on Mother of millions (*Bryophyllum delagoense*) (see: **www.daf.qld.gov.au/plants/health-pests-diseases/a-z-significant/south-african-citrus-thrips**).
[426] Numerous alternative hosts

Pathogens and nematodes

Table 24. *Macadamia pathogen and nematode threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
BACTERIA (including mycoplasma-like organisms and phytoplasmas)								
Xylella fastidiosa (Ratings with vector)	Leaf scorch	Various including macadamia[427]	Leaves symptomatic, damages whole plant	MEDIUM[428]	HIGH	HIGH[429]	UNKNOWN[427]	HIGH-NEGLIGIBLE
Xylella fastidiosa (Ratings without vector)	Leaf scorch	Various including macadamia[427]	Leaves symptomatic, damages whole plant	LOW[430]	HIGH	LOW[431]	UNKNOWN[427]	LOW-NEGLIGIBLE
FUNGI								
Phymatotrichopsis omnivora	Texas root rot	Broad range of plants including over 2000 hosts. These include cotton, pecan, walnut, pistachio, almond, macadamia, hazelnut, okra, peanut, sugar beet, legumes, fig, apple, *Prunus* spp., poplars, elms, willows and grapevine	Whole plant as a result or root damage	LOW[432]	MEDIUM	MEDIUM[433]	HIGH[434]	MEDIUM

[427] Moreira-Carmona et al., (2003) lists macadamia as a host of Xylella fastidiosa but the strain is not specified in their paper.
[428] Disease occurs in North and South America, Asia and reported from Italy (EPPO and CABI, date of publication unknown B)
[429] Rapid spread if vectors present. Glassy winged sharpshooter (*Homalodisca vitripennis* (syn. *Homalodisca coagulata*)) is the main vector however there are several other species that can vector the bacteria overseas (Mizell et al., 2015). The Glassy winged sharpshooter is currently not present in Australia.
[430] Lower risk of entry without vector, however illegal importation of budwood could introduce pathogens.
[431] Spread with cuttings, so spread possible without vector. Budwood schemes can minimise spread of budwood transmitted diseases.
[432] Present in North America. Soil-borne.
[433] Spread with soil, plant debris, etc.
[434] Kills infected plants.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
OOMYCETES								
Phytophthora ramorum	Sudden oak death	Broad host range across genera from families including hazelnut, chestnut, oak trees, Arbutus, *Lithocarpus* spp., fir, maple plants in Ericaceae family, Eucalyptus, beech, macadamia, bay laurel, magnolia and yew. The known host range continues to expand with more research.	Stems, branches, shoots, leaves	MEDIUM	HIGH	HIGH	HIGH[435]	HIGH

[435] *Macadamia tetraphylla* has been shown to be susceptible (Ireland et al., 2012).

Pecans

Invertebrates

Table 25. *Pecan invertebrate threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
ACARI (Mites e.g. spider and gall mites)								
Eotetranychus hicoriae	Pecan leaf scorch mite	Pecan	Foliage	LOW[436]	MEDIUM-LOW[437]	MEDIUM	HIGH[438]	MEDIUM-LOW
COLEOPTERA (Beetles and weevils)								
Curculio caryae	Pecan weevil	Hickories, pecan, walnut	Nuts	LOW[439]	LOW[440]	MEDIUM[441]	HIGH[442]	LOW

[436] This species occurs in the United States.
[437] Limited host range restricts establishment, however if it enters the main production area it would spread rapidly.
[438] Feeding by mites destroys leaf tissue. Leaves/leaflets turn brown and drop. Experience in the United States shows this to be a difficult pest to manage.
[439] Most likely source would be from fresh nuts infested with larvae. Adults could enter on second-hand machinery. Nut in-shell that comes into the country is treated, therefore minimal risk of entry through legal pathways.
[440] Adults must find suitable hosts for oviposition.
[441] Each female will oviposit in approximately 30 nuts during her 3 to 4 week life. Adults do not fly far and natural spread of infestations occurs over distances of a mile or less. Dispersal in USA to western areas has not yet happened.
[442] Feeding activity of adult weevils before nuts enter the gel stage can cause nut drop. After shell hardening, males only feed on the shuck which does not cause nut drop. Nut losses caused by adult feeding are small compared to those caused by egg laying.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Trogoderma granarium	Khapra beetle	Stored products including: grain, nuts (including almonds, pecan, pistachio, walnut), acorns, and stored foodstuffs, etc. Also associated with walnut, pistachio and pecan orchards where it feeds on fallen nuts (Stibick 2007).	Stored product	HIGH[443]	HIGH	HIGH[444]	HIGH	HIGH
Xylosandrus crassiusculus	Asian ambrosia beetle	Wide host range including macadamia, pecan, elms, koa (*Acacia koa*), aspen, beech, cherry, oak	Branches	LOW[445]	MEDIUM[446]	HIGH	UNKNOWN[447]	MEDIUM-NEGLIGIBLE
HEMIPTERA (Stink bugs, aphids, mealybugs, scale, whiteflies and hoppers)								
Chromaphis juglandicola	Walnut aphid	Walnut, pecan	Leaves	LOW[448]	MEDIUM	MEDIUM	LOW[449]	VERY LOW
Euschistus servus	Brown stink bug	Various including pecan, peach, maize, sorghum, cotton and soybean	Leaves, nuts	LOW[450]	MEDIUM	MEDIUM	HIGH[451]	MEDIUM
Halyomorpha halys	Brown marmorated stink bug	Wide host range with over 100 species reported as hosts including: hazelnut, pecan, walnut, cotton, sweetcorn, soybeans, maple, oak, fig, cotton, grapes, cherry, peach, and vegetable crops	Nuts	HIGH[452]	HIGH[453]	HIGH[453]	UNKNOWN[454]	HIGH-NEGLIGIBLE

[443] Can enter with contaminated foodstuffs, grains, etc.
[444] Spread with infested grain and foodstuffs.
[445] Transport of infested seedlings, saplings or cut branches. *X. crassiusculus* usually attacks stems of small diameter (not more than 5 cm diameter), but is sometimes found in larger timber, especially if fresh. Hence it may also be transported in crates or other packing material.
[446] Wide host range. Adult female beetles will fly readily.
[447] Bores into twigs and branches causing damage. Pecans particularly affected in Florida (Atkinson et al., 2000).
[448] Occurs in Europe and North America.
[449] Reported to cause damage to pecan, however walnut is this species main host (CABI date of publication unknown B).
[450] Currently only occurs in North America (Gomez and Mizell 2013b).
[451] Feeding damage the nuts causing black spots to appear on the kernel (Gomez and Mizell 2013b).
[452] Was recently (late 1990s) introduced from China into North America, where it is spreading rapidly (Kamminga et al., 2014).
[453] Rapid establishment of this species in the United States.
[454] Pecan is reported as a host of this pest. No information on its economic impact (USDA APIS 2010). However, communication with United States researchers (Lenny Wells – 2, October 2015) suggest that this species is beginning to become an issue in some parts of the United States.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Melanocallis caryaefoliae	Black pecan aphid	Pecan, *Carya* spp.	Leaves	LOW[455]	MEDIUM[456]	MEDIUM[457]	HIGH[458]	MEDIUM
Monellia caryella	Black margined aphid; Little hickory aphid	Pecan, hickory	Leaves	LOW[459]	MEDIUM	MEDIUM	HIGH[460]	MEDIUM
Monelliopsis pecanis	Yellow pecan aphid	Pecan	Leaves	LOW[455]	MEDIUM	MEDIUM	HIGH[461]	MEDIUM
LEPIDOPTERA (Butterflies and moths)								
Acrobasis nuxvorella	Pecan nut casebearer	Pecan, walnut	Nuts	LOW	MEDIUM	MEDIUM	HIGH[462]	MEDIUM
Cydia caryana	Hickory shuckworm	Pecan, walnut	Nuts (From early development to maturity)	LOW[463]	HIGH[464]	MEDIUM[465]	HIGH[466]	MEDIUM
Hyphantria cunea	American white moth, Fall web worm; mulberry moth	Wide host range including: maple, alder, ash, pecan, walnut and hazelnut, Roseacous species (including apple, plum, pear and cherry), persimmon, poplar, willow, sycamore and mulberry	Leaves	LOW[467]	MEDIUM[468]	MEDIUM	UNKNOWN[469]	MEDIUM-NEGLIGIBLE

[455] North American species.
[456] Limited hosts in Australia would limit establishment.
[457] 85% of the industry is concentrated in a single area. Therefore, establishment could occur if the insect enter the area.
[458] Feeds on pecan leaves. Feeding causes yellow patches to appear on the leaves, these areas die and the leaf falls from the tree. High populations can cause defoliation. Insecticides are not currently used on pecan in Australia, therefore the introduction of insect pests would have a significant impact on the management of orchards and associated costs. Found to be a difficult pest to manage in the United States.
[459] Present in the USA and reported from Israel (Mansour 1993).
[460] Feeds on pecan leaves, secretes honeydew causing sooty mould.
[461] Feeds on pecan leaves, secretes honeydew causing sooty mould. Significant pest in the United States.
[462] Significant in United States. In Kansas 6-20.5% yield loss was observed in an unmanaged field.
[463] North American species.
[464] Expanded range during 1990's in North America.
[465] The number of generations per year will vary from two to five depending on location.
[466] Prior to shell hardening, larval feeding within the nut causes premature nut drop.
[467] Widespread in Europe, Asia and North America.
[468] Entered Europe from North America after World War 2.
[469] Larvae defoliate trees (typically at the end of branches) and build silk "tents" (Sourakov and Paris 2010).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Lymantria dispar	Gypsy moth (Asian and European strains)	Extremely polyphagous including chestnut, hazelnut, pecan, pistachio, walnut, Prunus spp. (not almonds), *Pinus* spp., maples, oaks, elms, box elder, birches, red gum, corn, apple, *Rubus* spp., blueberry, spruce and pear	Leaves	HIGH-MEDIUM[470]	MEDIUM[471]	HIGH	UNKNOWN	HIGH-NEGLIGIBLE

[470] Egg masses are often laid on cars, boats, shipping containers, etc. that are then spread through trade.
[471] Australian climatic conditions along the east coast, Victoria, Tasmania and regions of South Australia.

Pathogens and nematodes

Table 26. *Pecan pathogen and nematode threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
BACTERIA (including mycoplasma-like organisms and phytoplasmas)								
Bunch disease phytoplasma	Bunch disease	Pecan	Terminals and suckers	MEDIUM-LOW[472]	MEDIUM-LOW	MEDIUM-LOW[473]	LOW[474]	LOW-NEGLIGIBLE
Xylella fastidiosa* subsp. *multiplex (Ratings with vector)	Pecan bacterial leaf scorch	Pecan, almond, crape myrtle, elm, gingko, oak, mulberry, peach, plum, sweetgum and sycamore[475]	Leaves symptomatic, damages whole plant	MEDIUM[476]	HIGH	HIGH[477]	HIGH[478]	HIGH
Xylella fastidiosa* subsp. *multiplex (Ratings without vector)	Pecan bacterial leaf scorch	Pecan, almond, crape myrtle, elm, gingko, oak, mulberry, peach, plum, sweetgum and sycamore[475]	Leaves symptomatic, damages whole plant	LOW[479]	HIGH	LOW[480]	HIGH[478]	MEDIUM

[472] Graft transmittible (Teviotdale et al., 2002).
[473] Graft transmittible. There is likely to be a leafhopper vector but this hasn't been identified to date (Teviotdale et al., 2002).
[474] Symptoms similar to zinc deficiency, witches broom type symptoms, trees may be asymptomatic or only show symptoms in a single terminal (Teviotdale et al., 2002).
[475] See: Balbalian (2012); Cariddi et al., (2014).
[476] Disease occurs in North and South America, Asia and reported from Italy (EPPO and CABI (date of publication unknown B); Cariddi et al., 2014).
[477] Rapid spread if vectors present. Glassy winged sharpshooter (*Homalodisca vitripennis* (syn. *Homalodisca coagulata*)) is the main vector however there are several other species that can vector the bacteria overseas (Mizell et al., 2015). The Glassy winged sharpshooter is currently not present in Australia.
[478] This species causes Pecan bacterial leaf scorch (See: Balbalian 2012; Cariddi et al., 2014). Infections cause defoliation, reduced yields and retards growth (Melanson and Sanderlin 2015).
[479] Disease occurs in North and South America, Asia and reported from Italy (EPPO and CABI (date of publication unknown B); Cariddi et al., 2014).
[480] This species causes Pecan bacterial leaf scorch (See: Balbalian 2012; Cariddi et al., 2014).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
FUNGI								
Armillaria mellea	Armillaria root rot	Very broad host range including: *Acacia* spp., *Acer* spp., kiwifruit, European alder, birches, cedar, cypress, citrus, fig, ash, olive, fir, pecan, chestnut, hazel, walnut, almond, *Prunus* spp., ornamental apple, privet, *Eucalyptus* spp., pine, oak, blackcurrant, mulberry, rose, grapevine and blueberry	Roots and collar region	LOW[481]	LOW	MEDIUM	MEDIUM[482]	VERY LOW
Armillaria tabescens	Clitocybe root rot	Wide host range including: hickory, pecan, almond, citrus, oak, Rosaceous species, ornamental trees and shrubs and fruit crops	Roots and collar region	LOW	LOW	MEDIUM	LOW[483]	NEGLIGIBLE
Ceratobasidium noxium (Syn. *Koleroga noxia*)	Thread blight	Pecan, coffee, citrus, mango, apple, pear, rose	Leaves and shoots	LOW[484]	MEDIUM	MEDIUM	MEDIUM-LOW[485]	LOW-VERY LOW
Elsinoe randii	Nursery Blight; Pecan anthracnose	Pecan	Leaves, shoots	LOW[486]	UNKNOWN	UNKNOWN	UNKNOWN[487]	UNKNOWN
Fusicladium effusum (Syn. *Cladosproium caryigenum*)	Pecan scab	Pecan, hickory and other *Carya* spp.	Nuts and leaves	LOW[488]	HIGH-MEDIUM	HIGH-MEDIUM	EXTREME-HIGH[489]	HIGH-MEDIUM
Gnomonia caryae	Vein spot; Liver Spot	Pecan	Leaves	LOW[490]	MEDIUM	MEDIUM	MEDIUM[491]	LOW
Gnomonia dispora	Gnomonia Leaf Spot	Pecan	Leaves	LOW[490]	MEDIUM	MEDIUM	MEDIUM[491]	LOW

[481] The old records of this fungus in Australia are now all assumed to be the native *Armillaria, A. luteobubalina*.
[482] Causes tree death on other hosts.
[483] Reported from the roots of pecan, causes stunting of above-ground plant parts (Takacs et al., 1970).
[484] Wide spread in the Americas. Also reported from parts of Africa, Asia and some pacific islands.
[485] Affects leaves and shoots, causes necrosis and leaf drop (Teviotdale et al., 2002).
[486] Disease occurs in North America and South America.
[487] Important nursery disease of pecans in the south-eastern US, especially in wet years (Horst 2012).
[488] Occurs in South Africa, North America (Mexico, USA, and Canada), South America (Argentina and Brazil) and New Zealand.
[489] Causes significant yield losses and nut quality in susceptible cultivars. Considered to be the most significant disease issue of pecans (Seyran et al., 2010; Bock et al., 2015).
[490] North American species (Teviotdale et al., 2002).
[491] Minor foliar disease (Teviotdale et al., 2002).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Grovesinia moricola (Syn. *G. pyramidalis*)	Zonate leaf spot	Wide host range including: pecan, walnut, soursop, avocado, maple, grapes	Leaves	LOW[492]	MEDIUM-LOW	MEDIUM	LOW[493]	VERY LOW
Gnomonia nerviseda	Vein spot	Pecan	Leaves	LOW[494]	MEDIUM	MEDIUM	MEDIUM[495]	LOW
Mycosphaerella caryigena	Downy spot	Pecan	Leaves	LOW[496]	MEDIUM	MEDIUM	LOW[497]	VERY LOW
Mycosphaerella dendroides	Leaf Blotch	Pecan, hickory	Leaves	LOW[498]	MEDIUM	MEDIUM	LOW[499]	VERY LOW
Ophiognomonia clavigignenti-juglandacearum (*Syn. Sirococcus clavigignenti-juglandacearum)*	Butternut canker	Walnuts (including *Juglans cinerea, J. nigra and J. regina*) and *Carya* spp. (including pecan)[500]	Stems and branches	LOW[501]	MEDIUM	MEDIUM[502]	UNKNOWN[503]	MEDIUM-NEGLIGIBLE
Passalora halstedii (*Syn. Cercospora halstedii).*	Leaf Blotch	Pecan, hickory	Leaves	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Phymatotrichopsis omnivora	Texas root rot	Broad range of plants including over 2000 hosts. These include cotton, pecan, walnut, pistachio, almond, macadamia, hazelnut, okra, peanut, sugar beet, legumes, fig, apple, *Prunus* spp., poplars, elms, willows and grapevine	Whole plant as a result or root damage	MEDIUM[504]	MEDIUM	MEDIUM[505]	HIGH[506]	MEDIUM

[492] Pathogen occurs in North America (USA) and South America (Brazil - recent detection Bezerra et al., 2008).
[493] Causes leaf spots and defoliation. Wet periods in summer favour disease development on pecan in the United States (Teviotdale et al., 2002).
[494] Only reported from the south eastern United States (Teviotdale et al., 2002).
[495] Causes leaf symptoms that can resemble pecan scab leaf symptoms. Up to 70% defoliation can result from infections (Teviotdale et al., 2002).
[496] Occurs in the United States (Teviotdale et al., 2002). Overwinters on fallen leaves.
[497] Causes leaf spots and early leaf drop (Teviotdale et al., 2002).
[498] Occurs in North America on pecan and hickory (Horst 2012).
[499] Causes yellow then brown leaf spots, minor disease (Teviotdale et al., 2002).
[500] See: Broders and Bolland (2011); Broders et al., (2015).
[501] North American species.
[502] Spread rapidly in the United States, birds and insects may assist in vectoring the pathogen (Ostry and Moore 2007).
[503] Reported to affect *Carya* spp. (Broders et al., 2015).
[504] Present in North America. Soil-borne.
[505] Spread with soil, plant debris, etc.
[506] Significant disease of pecan in Mexico. Symptoms vary from 90% defoliation to tree death (Gaxiola et al., 2014).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Septoria caryae	Leaf spot	Pecan and other *Carya* spp.	Leaves	LOW[507]	LOW	MEDIUM	UNKNOWN[508]	LOW-NEGLIGIBLE
Verticillium dahliae (exotic defoliating strains)[509]	Verticillium wilt	Various including: cotton, olive, pistachio, chestnut, almond, pecan, walnut	Whole plant	MEDIUM	HIGH[510]	HIGH[511]	UNKNOWN[512]	HIGH-NEGLIGIBLE
NEMATODES								
Meliodogyne partityla	Pecan root knot nematode	Pecan, walnut, hickory	Roots	LOW[513]	LOW	LOW[514]	UNKNOWN[515]	LOW-NEGLIGIBLE

[507] North American species.
[508] Limited information on this species.
[509] Non-defoliating strains of *Verticillium dahliae* occur in Australia. The defoliating strain VCG 1A is known to occur in Australia and is currently under review.
[510] Defoliating strain has a higher temperature requirement than non-defoliating strains.
[511] Soil, plant debris, etc. can spread the pathogen.
[512] Limited information on impact other than being listed as a susceptible host (McCain 1981).
[513] Reported from South Africa and the USA (Brito et al., 2006).
[514] Spread through the movement of infected soil.
[515] Causes stunted growth and dead branches of seedlings and in older trees causes yellowing of the foliage, stunted growth and death of branches in the upper canopy. Roots also show symptoms such as galls (Brito et al., 2006).

Pistachios

Invertebrates

Table 27. *Pistachio invertebrate threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
COLEOPTERA (Beetles and weevils)								
Capnodis cariosa	Pistachio root beetle	Pistachio	Trunk and roots. Also feeds on leaves	LOW	UNKNOWN	UNKNOWN	HIGH[516]	UNKNOWN
Chaetoptelius vestitus	Pistachio twig borer beetle	Pistachio	Branches	LOW[517]	UNKNOWN	UNKNOWN	HIGH[518]	UNKNOWN
Trogoderma granarium	Khapra beetle	Stored products including: grain, nuts (including almonds, pecan, pistachio, walnut), acorns, and stored foodstuffs, etc. Also associated with walnut, pistachio and pecan orchards where it feeds on fallen nuts (Stibick 2007)	Stored product	HIGH[519]	HIGH	HIGH[520]	HIGH[521]	HIGH

[516] Pistachios reported to be affected in Turkey (Karadag et al., 2006). Causes significant damage in Iran (Mahrnejad 2001). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[517] Mediterranean species.
[518] Larvae feed inside stems causing nuts to drop and therefore reduced yields (Chebouti-Meziou et al., 2011). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[519] Can enter with contaminated foodstuffs, grains, etc.
[520] Spread with infested grain and foodstuffs.
[521] Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
HEMIPTERA (Stink bugs, aphids, mealybugs, scale, whiteflies and hoppers)								
Acrosternum heegeri	Pistachio bug; pistachio green stink bugs	Pistachio	Leaves, nuts	LOW	MEDIUM	MEDIUM	HIGH[522]	MEDIUM
Acrosternum millierei	Pistachio bug; pistachio green stink bugs	Pistachio	Leaves, nuts	LOW[523]	MEDIUM	MEDIUM	HIGH[524]	MEDIUM
Agonoscena pistaciae	Common pistachio psylla	Pistachio	Leaves, young buds	LOW[525]	MEDIUM	MEDIUM[526]	HIGH[527]	MEDIUM
Anapulvinaria pistaciae	Pistachio cushion scale	Pistachio	Leaves, shoots	LOW	MEDIUM	MEDIUM	HIGH[528]	MEDIUM
Apodiphus amygdali	Pistachio bug	Pistachio, apple, apricot, pear	Leaves, nuts	LOW	MEDIUM	MEDIUM	HIGH[529]	MEDIUM
Brachynema germari	Pistachio bug	Pistachio	Leaves, nuts	LOW	MEDIUM	MEDIUM	HIGH[529]	MEDIUM
Brachynema segetum	Pistachio bug	Pistachio	Leaves, nuts	LOW	MEDIUM	MEDIUM	HIGH[529]	MEDIUM
Campylomma lindbergi	Mirid	Pistachio	Leaves, nuts	LOW	MEDIUM	MEDIUM	HIGH[530]	MEDIUM

[522] One of several species reported to attach pistachio nuts and cause kernel damage in Iran (Mehrnejad 2001).
[523] Most reports are from Iran (e.g. Mehrnejad 2001). Field pest, not likely to enter with nuts. Plant material quarantine requirements mean low entry potential.
[524] Causes distortions to nuts and fruit. One of several species reported to attach pistachio nuts and cause kernel damage in Iran (Mehrnejad 2001). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[525] Most likely pathway would be as eggs on illegal planting material.
[526] Only survives on *Pistacia* spp. so host location will be a limiting factor.
[527] Serious pest of pistachio in Iran (Reza et al., 2009; Mehrnejad 2014). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[528] Reported as a pest of pistachio in Iraq (Abu 1970). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[529] One of several species reported to attack pistachio nuts and cause kernel damage in Iran (Mehrnejad 2001). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[530] In Turkey it has been reported to cause leaves to become wrinkled, curled, etc. (Yanik and Yucel 2001). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Chinavia hilaris (Syn. *Acrosternum hilare; Pentatoma hilaris; Chinavia hilare; Nezara hilaris*)	Green stink bug; Pistachio bug	Polyphagous including hazelnut, black walnut, pistachio, almond, hawthorn, ash, Lucerne, *Robinia* spp., Prunus, legumes	Leaves, nuts	LOW[531]	MEDIUM	MEDIUM[532]	EXTREME-HIGH[533]	HIGH-MEDIUM
Chlorochroa sayi	Say's stink bug	Pistachio	Leaves, nuts	LOW[534]	MEDIUM	MEDIUM	HIGH[535]	MEDIUM
Chlorochroa uhleri	Uhler's stink bug	Pistachio	Leaves, nuts	LOW[536]	MEDIUM	MEDIUM	HIGH[537]	MEDIUM
Ferrisia gilli	Gill's mealybug	Pistachio, almond	Branches, rachises, nuts, petioles, leaves	UNKNOWN[538]	UNKNOWN	UNKNOWN	HIGH[539]	UNKNOWN
Homalodisca vitripennis (Syn. *Homalodisca coagulata*)	Glassy winged sharpshooter	Feeds on >100 plants including: almond, macadamia, pistachio, walnut, avocado, citrus, Eucalypts, grapes, ash, oleander, blackberry, bottlebrush, bougainvillea, camellia, acacia, chrysanthemum and other ornamentals	Leaves Vector of the bacterium *Xylella fastidiosa*	MEDIUM[540]	HIGH[541]	HIGH[542]	UNKNOWN[543]	HIGH-NEGLIGIBLE

[531] Occurs in North America, Asia and Iran.
[532] Capable of long distance dispersal to find hosts (Gomez and Mizel 2013a).
[533] Significant pest in the United States. Depending on time of feeding damage can range from lesions to kernel narcosis and aborted nuts (Haviland et al., 2014). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[534] Pest occurs in the United States.
[535] Feeding by this species resulted in significant nut drop in the 1980s in Arizona (Arthur 1985). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[536] Pest occurs in the United States.
[537] Feeds on leaves, stems and fruits/nuts. Nut damage causes reduced yields (Daane et al., 2003). Also pest in the United States (Haviland et al., 2014). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[538] Recently reported Californian species (Haviland et al., 2006).
[539] Newly described. Causes damage in California. Nuts become covered in honeydew and sooty mould (Haviland et al., 2006). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[540] Native to south-eastern USA and northern Mexico has spread to other parts of the USA, French Polynesia and Hawaii (Mizell et al., 2008). Could potentially spread on nursery stock from overseas. See BICON for relevant import conditions.
[541] Numerous alternative hosts; recent history of spread in USA, especially on nursery stock.
[542] Strong fliers, egg masses could be spread with nursery stock over large areas.
[543] Vector of *Xylella fastidiosa* diseases. Feeding doesn't cause physical signs of damage but the insects secrete a white liquid while feeding that covers the leaves and ground below the infected plant. Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Leptoglossus clypealis	Leaf footed bug	Pistachio, almond, juniper, aromatic sumac (*Rhus aromatica*)	Nuts (kernels and epicarp)	LOW[544]	MEDIUM	MEDIUM	EXTREME-HIGH[545]	HIGH-MEDIUM
Leptoglossus occidentalis	Western conifer seed bug	Pistachio, almond, various pines (including Radiata pine)	Nuts (kernels and epicarp)	LOW[546]	MEDIUM[547]	MEDIUM	EXTREME-HIGH[548]	HIGH-MEDIUM
Leptoglossus zonatus	Western leaf footed bug	Pistachio, citrus, guava, avocado, pomegranate, melons, cotton, sorghum, corn, tomato, cucurbits, eggplant, almond	Nuts (kernels and epicarp)	LOW[549]	MEDIUM	MEDIUM	EXTREME-HIGH[550]	HIGH-MEDIUM
Lygaeus equestris	Black and red bug	Various including: pistachio, milkweed (*Vincetoxicum hirundinaria*)	Nuts	UNKNOWN[551]	UNKNOWN	UNKNOWN	UNKNOWN[552]	UNKNOWN
Megagonoscena viridis	Leaf roller pistachio psyllid	Pistachio	Leaves	LOW	MEDIUM	MEDIUM	HIGH[553]	MEDIUM
Neurocolpus longirostrus	California buckeye bug	Buckeye (*Aesculus califonica*), coffee berry (*Rhamnus* spp.), pistachio	Nuts	UNKNOWN[554]	UNKNOWN	UNKNOWN	HIGH[555]	UNKNOWN

[544] North American species that is found in the southern USA and Mexico (Wang and Millar 2000).
[545] Feeding causes epicarp lesions and kernel necrosis and nut abortion (Haviland et al., 2014). Losses of up to 30% reported in the USA (Wang and Millar 2000). One of the biggest issues in the United States (along with Navel orange worm). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[546] Occurs in North America, Europe and Japan.
[547] Spreading in Europe, first detected in 1999 now widespread (Hizal and Inan 2012).
[548] Feeding causes epicarp lesions and kernel necrosis (Haviland et al., 2014). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[549] Occurs from the south west of the United States to northern South America.
[550] Feeding causes epicarp lesions and kernel necrosis (Haviland et al., 2014). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[551] Occurs in Europe, Turkey, and Iran.
[552] Reported on pistachio in Turkey by Yanik and Yucel (2001) but at low levels. Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[553] Pest of pistachio in Iran where is causes young leaves to roll and distort (Mehrnejad 2014). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[554] North American species.
[555] Can damage the epicarp of nuts and reports of up to 30-35% of nuts being affected have been reported in the United States on pistachio near buckeye plants (Holtz 2002). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Nysius raphanus	False chinch bug	Almond, pistachio, pomegranate, citrus, grasses	Above ground plant parts	MEDIUM[556]	MEDIUM[557]	MEDIUM	HIGH[558]	MEDIUM
Spilostethus pandurus	Pistachio red bug	Pistachio, couch grass (*Agropyron repens),* lamb's quarters (*Chenopodium alba*), camelthorn (*Alhagi pseudalhagi*)	Leaves	UNKNOWN	UNKNOWN	UNKNOWN	HIGH[559]	UNKNOWN
Thyanta pallidovirens	Red shouldered stink bug	Feeds on a range of plants including pistachio, Lucerne, pea, lentil, tomato	Leaves, flowers	UNKNOWN[560]	UNKNOWN	UNKNOWN	HIGH[561]	UNKNOWN
HYMENOPTERA (Ants, bees and wasps)								
Megastigmus pistaciae	Pistachio seed chalcid	Pistachio, other *Pistacia* spp. and pepper trees (*Schinus* spp.)	Nuts	MEDIUM[562]	MEDIUM	MEDIUM[563]	HIGH[564]	MEDIUM
LEPIDOPTERA (Butterflies and moths)								
Amyelois transitella	Navel orange worm	*Citrus* spp., walnut, pistachio, almond, grapevine	Nuts, leaves	MEDIUM[565]	HIGH[566]	HIGH[567]	HIGH[568]	HIGH

[556] North American species.
[557] Hosts widespread.
[558] Heavy infestations are reported to cause death of young almond and pistachio trees in the United States (Haviland and Bentley 2010). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[559] Reported on pistachio in Iran (Zeinodini et al., 2013). Limited information on its impact on production. Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[560] Occurs in the USA. Could be spread on plant material.
[561] Pest of pistachios in the United States (Haviland et al., 2014). Causes lesions on the exocarp of pistachio (McPherson and McPherson 2000).Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[562] Occurs in North Africa and Mediterranean and Middle East and in North America (California) (Rice and Michailides 1988).
[563] Dispersal by adult females (up to 40 km) (European strain has wingless females).
[564] Pest of Pistachio in North America (Rice and Michailides 1988). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[565] Has been intercepted on citrus imports from California.
[566] Lays eggs on "mummy" almonds that stay on tree after harvest (Phelan and Baker 1987).
[567] Strong dispersal capability; small insects with high reproductive output.
[568] Major pest of pistachio in California (Burks et al., 2008). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Choristoneura rosaceana	Oblique banded leafroller	Wide host range including: *Prunus* spp. (including almond), pistachio, hazelnut, maple, pear, raspberry, blueberry	Leaves, nut clusters	LOW[569]	MEDIUM[570]	MEDIUM	HIGH[571]	MEDIUM
Kermania pistaciella	Pistachio twig borer	Pistachio	Twigs, flower clusters, nuts	LOW[572]	MEDIUM[573]	MEDIUM	HIGH-MEDIUM[574]	MEDIUM-LOW
Lymantria dispar	Gypsy moth (Asian and European strains)	Extremely polyphagous including chestnut, hazelnut, pecan, pistachio, walnut, *Prunus* spp. (not almonds), *Pinus* spp., maples, oaks, elms, box elder, birches, red gum, maize, apple, *Rubus* spp., blueberry, spruce and pear	Leaves	HIGH-MEDIUM[575]	MEDIUM[576]	HIGH[577]	HIGH[578]	HIGH-MEDIUM

[569] North American species.
[570] 1-2 generations per year (CABI and EPPO date of publication unknown A).
[571] Has become a very important pest of pistachio in California since the late 1980s (Rice et al., 1988). Feeding damage occurs directly on developing nut clusters and leaves. Leaf infestations can result in defoliation prior to nut maturity and harvest. Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[572] Currently only in Turkey, Iran.
[573] Overwinters in twigs, most likely pathway would be as larvae inside illegal planting material).
[574] Larvae feed on flower clusters causing them to drop from the tree. The larvae then bore into the twigs (Mehrnejad 2010). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.
[575] Range expansion of invading populations is primarily facilitated by long-range movement by humans. Egg masses are often laid on cars, trucks, trains or boats, on logs, or containers that are inadvertently moved by humans.
[576] Australian climatic conditions along the east coast, Victoria, Tasmania and regions of South Australia.
[577] Spread by natural and human assisted means.
[578] Has caused serious defoliation in pistachio in Kyrgyzstan (Orozumbekov et al., 2003). Currently Australia doesn't use insecticides to manage crops therefore high impact on marketability of product, management practices, etc.

Pathogens and nematodes

Table 28. *Pistachio pathogen and nematode threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
BACTERIA (including mycoplasma-like organisms and phytoplasmas)								
Rhodococcus fascians	Pistachio bushy top syndrome	Pistachio	Whole plant	NEGLIGIBLE[579]	UNKNOWN	UNKNOWN	HIGH[580]	VERY LOW
FUNGI								
Cytospora terebinthi	Gum canker	Pistachio (*Pistacia vera*) and *Pistacia khinjuk*	Trunk, branches	LOW[581]	MEDIUM	MEDIUM	UNKNOWN[582]	MEDIUM-NEGLIGIBLE
Phyllactinia guttata	Powdery mildew	Hazelnut, pistachio, kiwi, alder, dogwood, oak, Contorted hazelnut (*Corylus avellana*)	Leaves, nuts	LOW	MEDIUM	MEDIUM	HIGH	MEDIUM
Phymatotrichopsis omnivora	Texas root rot	Broad range of plants including over 2000 hosts. These include cotton, pecan, walnut, pistachio, almond, macadamia, hazelnut, okra, peanut, sugar beet, legumes, fig, apple, *Prunus* spp., poplars, elms, willows and grapevine	Whole plant as a result or root damage	LOW[583]	MEDIUM	MEDIUM[584]	HIGH[585]	MEDIUM

[579] Only reported from a single nursery.
[580] Only reported from plants grown on "UNB1" rootstocks from one nursery in the United States. Causes stunting and bushy growth (Stamler et al., 2014).
[581] Occurs in Iran (Fotouhifar 2010), Italy and Portugal (Teviotdale et al., 2002).
[582] Causes small cankers that exude gum. Disease leads to blight and dieback of branches (Teviotdale et al., 2002).
[583] Present in North America. Soil-born.
[584] Spread with soil, plant debris, etc.
[585] Kills infected plants.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Pileolaria pistaciae	Asian pistachio rust	Pistachio	Leaves	LOW[586]	LOW	HIGH	MEDIUM[587]	VERY LOW
Pileolaria terebinthi (Syn. *Uromyces terebinthi*)	Pistachio rust	Pistachio	Leaves	LOW[588]	LOW[589]	HIGH[590]	HIGH-MEDIUM[591]	LOW-VERY LOW
Pseudocercospora pistacina	Leaf spot	Pistachio	Leaves	LOW[592]	MEDIUM	MEDIUM	HIGH	MEDIUM
Septoria pistaciae	Septoria leaf spot	Pistachio	Leaves	LOW[592]	MEDIUM	MEDIUM	HIGH[593]	MEDIUM
Septoria pistaciarum	Septoria leaf spot	Pistachio	Leaves	LOW[594]	MEDIUM	MEDIUM	HIGH[593]	MEDIUM
Verticillium dahliae (exotic defoliating strains)[595]	Verticillium wilt	Various including: cotton, olive, pistachio, chestnut, almond, pecan, walnut	Whole plant	MEDIUM	HIGH[596]	HIGH[597]	HIGH[598]	HIGH
UNKNOWN								
Unknown	Peter's scorch	Pistachio	Leaves	VERY LOW[599]	UNKNOWN	UNKNOWN	UNKNOWN[600]	UNKNOWN

[586] Occurs in eastern Asia (CABI 2014 A). Could enter on grafting material or plant debris. Pathway is regulated, see BICON for relevant import conditions.
[587] Causes leaf symptoms.
[588] Occurs in Mediterranean Europe and northern Africa, western Asia and northern India to China. Could enter on grafting material or plant debris (Chalkley (date of publication unknown)).
[589] Only affects *Pistachio* spp. therefore limited hosts for establishment.
[590] Windborne spores.
[591] Pathogen causes defoliation which can result in significant yield losses. Losses of up to 60% have been reported overseas (Chalkley (date of publication unknown)).
[592] Occurs in the Mediterranean and Middle East (Teviotdale et al., 2002).
[593] Causes serious leaf and nut spots of pistachio in Turkey, leading to 3-100% yield loss in epidemic years (Crous et al., 2013).
[594] Occurs in the Mediterranean and Middle East and USA (Teviotdale et al., 2002).
[595] Non-defoliating strains of *Verticillium dahliae* occur in Australia. The defoliating strain VCG 1A is known to occur in Australia and is currently under review.
[596] Defoliating strain has a higher temperature requirement than non-defoliating strains.
[597] Soil, plant debris, etc. can spread the pathogen.
[598] Reported on pistachio in Iran (Hadizadeh and Banihashemi 2007). In the United States infections cause the rapid death of branches and/or the entire tree (Michailides and Teviotdale 2014).
[599] Reported in Arizona and California (Michailides 2005).
[600] Affects mostly male plants, especially of the cultivar "Peters". Causes leaf lesions that further develop to give the tree a scorched appearance. Infected trees defoliate sooner than healthy trees (Michailides 2005).

Walnuts

Invertebrates

Table 29. *Walnut invertebrate threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
ACARI (Mites e.g. spider and gall mites)								
Tetranychus pacificus	Pacific spider mite	Walnut, cotton, melon, soybean, common bean, stone fruit, Japanese plum, grapevine, almond	Leaves	MEDIUM[601]	MEDIUM[602]	HIGH[603]	UNKNOWN	MEDIUM-NEGLIGIBLE
COLEOPTERA (Beetles and weevils)								
Aeolesthes sarta	City longhorned borer; Uzbek longhorn beetle	Elm, popular, willow, plane tree, apple, walnut. Also affects maple, oak, locust	Branches	NEGLIGIBLE[604]	MEDIUM[605]	MEDIUM[606]	MEDIUM[607]	NEGLIGIBLE
Chrysobothris mali	Pacific flatheaded borer	Apple, walnut, hickory, popular, oak, willow, elm	Shoots	UNKNOWN[608]	UNKNOWN	UNKNOWN	LOW[609]	UNKNOWN

[601] Hitchhiker on other imported material.
[602] Wide range of host species available and climate is likely to be suitable.
[603] Dispersal by movement of infested plant material; wind dispersal.
[604] Infested wood is the most likely pathway for introduction. Since there is at present little international trade in the wood of host plants of *A. sarta*, the risk of entry is negligible.
[605] Occurs from India to the middle east (EPPO date unknown A).
[606] The natural spread of this insect is slow. Adults are not strong fliers. The species can be transported via untreated wood products. (EPPO date unknown A). See BICON for relevant import conditions.
[607] *A. sarta* is one of the most important pests of many forest, ornamental and deciduous fruit trees in Kyrgyzstan, Uzbekistan, Afghanistan, India (Western Himalayas), Iran, Kyrgyzstan (south), Pakistan (north), Tajikistan, Turkmenistan, and Uzbekistan. Adult females lay eggs on healthy and diseased trees. Larvae tunnel into branches. Branch and tree dieback are often observed (EPPO date of publication unknown A).
[608] North American species, occurs in the USA and southern Canada.
[609] Attracted to diseased or injured limbs. Larvae bore tunnels under the bark and into the tree. Feeding may girdle and kill young trees. Infested branches on older trees often die.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Curculio caryae	Pecan weevil	Hickories, pecan, walnut	Nuts	LOW[610]	MEDIUM[611]	MEDIUM	UNKNOWN[612]	MEDIUM-NEGLIGIBLE
Megaplatypus mutatus (Syn. *Platypus mutatus, P. sulcatus*)	Ambrosia beetle	Wide range of woody trees including: hazelnut (*Corylus avellana*), walnut, maple, Citrus, Eucalyptus, ash, laurel, Magnolia, apple, plane tree (*Platanus* spp.), Poplar, peach, Avocado, pear, oak, willow, lime tree (*Tilia* spp.), elm, sour cherry	Trunk, branches	MEDIUM[613]	LOW-MEDIUM	LOW-MEDIUM	MEDIUM[614]	LOW-VERY LOW
Oberea linearis	Hazelnut and Walnut Twig Borer	Hazelnut and walnut	Shoots	LOW[615]	UNKNOWN	UNKNOWN	UNKNOWN[616]	UNKNOWN
Pityophthorus juglandis	Walnut twig beetle	Black walnut and other *Juglans* spp.	Twigs and branches	LOW[617]	MEDIUM	MEDIUM	UNKNOWN[618]	MEDIUM-NEGLIGIBLE
Trogoderma granarium	Khapra beetle	Stored products including: grain, nuts (including almonds, pecan, pistachio, walnut), acorns, and stored foodstuffs, etc. Also associated with walnut, pistachio and pecan orchards where it feeds on fallen nuts (Stibick 2007)	Stored product	HIGH[619]	HIGH	HIGH[620]	HIGH[621]	HIGH

[610] Most likely source would be from fresh nuts infested with larvae. Adults could enter on second-hand machinery. See BICON for relevant import conditions.
[611] Adults must find suitable hosts for oviposition.
[612] There are reports of this species affecting walnuts when planed near infected pecans (Harris et al., 2010).
[613] Native and widespread in South America. Has been reported in Italy.
[614] Walnut is reported as being severely affected by this defoliating pest in Italy (Alfaro et al., 2007).
[615] European species.
[616] Larvae feed and develop in shoots.
[617] Beetle is found in USA and Mexico and has recently been introduced into Italy (Montecchio and Faccoli 2014).
[618] Vectors Thousand cankers disease of walnut (*Geosmithia morbida*) (Montecchio and Faccoli 2014). Disease more damaging than the vector on its own.
[619] Can enter with contaminated foodstuffs, grains, etc.
[620] Spread with infested grain and foodstuffs.
[621] Would require fumigation to control, currently do not fumigate walnuts.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
DIPTERA (Flies and midges)								
Rhagoletis completa	Walnut husk fly	Walnuts including *Juglans nigra, J. californica and J. hindsii*. Also peaches[622]	Husks, nut	MEDIUM[623]	MEDIUM[624]	MEDIUM[625]	HIGH[626]	MEDIUM
Rhagoletis suavis	Walnut husk fly	Walnuts including *Juglans ailanthifolia, J. cinerea, J. nigra* and *J. regia*. Also peaches[627]	Husks, nut	MEDIUM[628]	MEDIUM[629]	MEDIUM[630]	HIGH[631]	MEDIUM
HEMIPTERA (Stink bugs, aphids, mealybugs, scale, whiteflies and hoppers)								
Chromaphis juglandicola	Walnut aphid	Walnut, pecan	Leaves	LOW[632]	MEDIUM	MEDIUM	LOW[633]	VERY LOW
Epidiaspis leperii	Italian pear scale	Walnut, apple, olive, plum	Nuts, stems, whole plant	LOW[634]	MEDIUM[635]	MEDIUM[636]	LOW[637]	VERY LOW

[622] See: CABI and EPPO (date of publication unknown C).
[623] Pest occurs in Italy, Switzerland Mexico and the USA (CABI and EPPO date of publication unknown C). Could spread with nuts, seed and nursery stock being imported and there is also a risk of transport of puparia in soil or packaging or on machinery. See BICON for relevant import conditions related to these pathways.
[624] In Europe it is considered a quarantine risk for temperate regions. In Australia, there is limited temporal and spatial availability of fruiting walnuts. However, could establish well in the main growing regions.
[625] Adult flight and movement of fruit/nuts are main means of spread. Restricted to *Juglans* spp. and peach.
[626] Serious pest of walnuts in California. Up to 90% of nuts on susceptible varieties can be affected. Control required repeated insecticide applications (Van Steenwyk et al., 2014). Introduced to Europe in the 1990s and it is now a significant pest of walnuts in Europe. Feeding damage by larvae make nuts unmarketable and losses of up to 50% have been reported in Slovenia (Miklavc et al., 2009).
[627] See: CABI and EPPO (date of publication unknown C).
[628] Pest occurs in the USA (CABI and EPPO date of publication unknown C). Could spread with nuts, seed and nursery stock being imported and there is also a risk of transport of puparia in soil or packaging or on machinery. See BICON for relevant import conditions related to these pathways.
[629] In Europe it is considered a quarantine risk for temperate regions. In Australia, there is limited temporal and spatial availability of fruiting walnuts. However, could establish well in the main growing regions.
[630] Adult flight and movement of fruit/nuts are main means of spread. Restricted to *Juglans* spp. and peach.
[631] Similar damage to *R. completa*.
[632] Occurs in Europe and North America
[633] Aphid feeding can reduce tree vigour and nut size, yield, and quality. Aphids excrete honeydew. Occasional pest overseas.
[634] Widespread in Europe, northern Africa, western Asia and North America. Transport of *E. leperii* between countries will be by human transport of infested plant material, usually for planting/propagation.
[635] Wide host range of pome, stone and nut trees.
[636] Crawlers will disperse on wind. They may also be carried between orchards on agricultural machinery, workers' clothes, and pruning material being carried away for disposal.
[637] In California, USA, it is not particularly injurious except on walnut trees with heavy lichen growth, where large populations weaken trees and reduce nut size and yield.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Halyomorpha halys	Brown marmorated stink bug	Wide host range with over 100 species reported as hosts including: hazelnut, pecan, walnut, cotton, sweetcorn, soybeans, maple, oak, fig, cotton, grapes, cherry, peach, and vegetable crops	Nuts	HIGH[638]	HIGH[639]	HIGH[640]	UNKNOWN[641]	HIGH-NEGLIGIBLE
Homalodisca vitripennis (Syn. *Homalodisca coagulata*)	Glassy winged sharpshooter	Feeds on >100 plants including: almond, macadamia, pistachio, walnut, avocado, citrus, Eucalypts, grapes, ash, oleander, blackberry, bottlebrush, bougainvillea, camellia, acacia, chrysanthemum and other ornamentals	Leaves Vector of the bacterium *Xylella fastidiosa*	MEDIUM[642]	HIGH[643]	HIGH[644]	UNKNOWN[645]	HIGH-NEGLIGIBLE
Panaphis juglandis	Dusky-veined walnut aphid	Walnut	Leaves	LOW[646]	MEDIUM[647]	HIGH	MEDIUM[648]	LOW
Quadraspidiotus juglansregiae	Walnut scale	Wide host range including walnut, *Carya* spp., maple and other deciduous trees and shrubs. Conifers such as *Pinus* spp. can also be affected	Twigs, branches	UNKNOWN[649]	UNKNOWN	UNKNOWN	LOW[650]	UNKNOWN

[638] Was recently (late 1990s) introduced from China into North America, where it is spreading rapidly (Kamminga et al., 2014).
[639] High Given the rapid establishment of this species in the United States.
[640] High Given the rapid spread of this species in the United States.
[641] Walnuts are reported as hosts of this pest. No data found describing economic impact (USDA APIS 2010).
[642] Native to south-eastern USA and northern Mexico has spread to other parts of the USA, French Polynesia and Hawaii (Mizell et al., 2008). Could spread on nursery stock from overseas.
[643] Numerous alternative hosts; recent history of spread in USA, especially on nursery stock.
[644] Strong fliers, egg masses could be spread with nursery stock over large areas.
[645] Vector of *Xylella fastidiosa* diseases. Feeding doesn't cause physical signs of damage but the insects secrete a white liquid while feeding that covers the leaves and ground below the infected plant
[646] Occurs in Turkey, parts of Europe (e.g. Poland) and Asia (e.g. India).
[647] Walnut is the only recorded host.
[648] Feeding reduces tree vigour, nut size and yield. Also associated with honeydew and sooty mould (Wani and Ahmad 2014).
[649] Only occurs in North America (Canada, USA, Mexico) (Miller and Davidson 2005).
[650] Not usually not a significant problem. Can cause death of twigs and branches (Miller and Davidson 2005).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
LEPIDOPTERA (Butterflies and moths)								
Acrobasis nuxvorella	Pecan nut casebearer	Pecan, Walnut	Nuts	LOW	MEDIUM	MEDIUM	UNKNOWN	MEDIUM-NEGLIGIBLE
Amyelois transitella	Navel orange worm	*Citrus* spp., walnut, pistachio, almond, grapevine	Leaves, nuts	MEDIUM[651]	HIGH	HIGH[652]	HIGH[653]	HIGH
Archips argyrospila	Fruit tree leafroller	Walnut, oak, apples, apricot, lucerne, common (navy) bean, Bald cypress (*Taxodium distichum*), sassafras (*Sassafras* spp.), Hickory (no recent record of it on pecan)	Leaves	LOW[654]	UNKNOWN	MEDIUM	UNKNOWN	UNKNOWN
Cydia caryana	Hickory shuckworm	Pecan, walnut	Nuts (From early development to maturity)	LOW[655]	HIGH[656]	MEDIUM[657]	UNKNOWN[658]	MEDIUM-NEGLIGIBLE
Cydia latiferreana	Filbertworm	Chestnuts, hazelnut (*Corylus* spp.), beeches, almond, pomegranate, *Quercus* spp.	Nuts	LOW[659]	MEDIUM[660]	MEDIUM[661]	HIGH[662]	MEDIUM
Cydia splendana	Chestnut tortrix moth; Chestnut codling moth	Walnut, chestnut, beech, oak	Nuts	UNKNOWN[663]	UNKNOWN	UNKNOWN	UNKNOWN[664]	UNKNOWN

[651] Has been intercepted on citrus imports from California.
[652] Strong dispersal capability; small insects with high reproductive output.
[653] Affects walnuts in the United States (Burks et al., 2008; Johnson et al., 2009). The larvae feed on kernels, so there would be extra costs associated with management and downgraded crop.
[654] Only occurs in the United States and Canada (Gilligan and Epstein 2014).
[655] North American species.
[656] Expanded range during 1990's in North America.
[657] The number of generations per year will vary from two to five depending on location.
[658] Prior to shell hardening, larval feeding within the nut causes premature nut drop.
[659] North American species, which occurs from Canada to Mexico. Fruit, nuts and plant material can carry pest.
[660] Widespread in USA.
[661] Moths are weak fliers and will be limited in Australia by available hosts (no endemic *Corylus* spp. as in North America).
[662] According to AliNiazee (1998), this is the key pest in almost all filbert orchards in Willamette Valley, Oregon, USA. In unsprayed orchards, Filbertworm damage ranged from 12% to 37%; typically around 20% over 10 years. There are also increased production costs in sorting out affected nuts.
[663] Native to much of Europe, also occurs in Japan, Algeria.
[664] Doesn't cause economic damage (CABI 2015 B).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Erschoviella musculana (Syn. *Nycteola musculana, Sarrothripus musculana*)	Asian walnut moth	Walnut	Nuts, shoots	LOW[665]	LOW[666]	LOW[667]	HIGH[668]	LOW
Euzophera semifuneralis	American plum borer	Wide host range including: walnut, almonds, plum, cherry, olive, oak, pomegranate	Trunk, branches	LOW[669]	MEDIUM	MEDIUM-LOW	LOW[670]	VERY LOW-NEGLIGIBLE
Hyphantria cunea	American white moth, Fall web worm; mulberry moth	Wide host range including: maple, alder, ash, pecan, walnut and hazelnut, Rosaceae species (including apple, plum, pear and cherry), persimmon, poplar, willow, sycamore and mulberry	Leaves	LOW[671]	MEDIUM[672]	MEDIUM	UNKNOWN[673]	MEDIUM-NEGLIGIBLE
Lymantria dispar	Gypsy moth (Asian and European strains)	Extremely polyphagous including chestnut, hazelnut, pecan, pistachio, walnut, *Prunus* spp. (not almonds), *Pinus* spp., maples, oaks, elms, box elder, birches, red gum, corn, apple, *Rubus* spp., blueberry, spruce and pear	Leaves	HIGH-MEDIUM[674]	MEDIUM[675]	HIGH[676]	HIGH[677]	HIGH-MEDIUM

[665] Spread with planting material.
[666] Hosts limited to walnuts.
[667] Can spread by flight. Hosts limited to walnuts so dispersal between regions is likely to be by movement of plant material.
[668] Most important pest of walnuts in Central Asia (Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, Turkmenistan). Occurs from 1100-2100m. Enters nuts through shoot and destroys nut (EPPO date of publication unknown C
[669] Native and widespread in North America. This species has also been reported in Turkey (Atay and Ozturk 2010).
[670] Larvae burrow under the bark.
[671] Widespread in Europe, Asia and North America.
[672] Entered Europe from North America after World War 2.
[673] Larvae defoliate trees (typically at the end of branches) and build silk "tents" (Sourakov and Paris 2010).
[674] Range expansion of invading populations is primarily facilitated by long-range movement by humans. Egg masses are often laid on cars, trucks, trains or boats, on logs, or containers that are inadvertently moved by humans.
[675] Australian climatic conditions along the east coast, Victoria, Tasmania and regions of South Australia.
[676] Spread by natural and human assisted means.
[677] Has caused serious defoliation in wild walnut forests in Kyrgyzstan (Orozumbekov et al., 2003).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Lymantria mathura	Rosy gypsy moth; Pink gypsy moth	Chestnut, walnut, beech, apple, oak, willow, elm, lime trees (*Tilia* spp.)	Leaves	HIGH-MEDIUM[678]	MEDIUM	MEDIUM	UNKNOWN[679]	MEDIUM-NEGLIGIBLE
Saturnia pyri (Syn. *Bombyx pyri*)	Great peacock moth	Hazelnut, walnut, Prunus (including almond), willow, maple, beech, Rubus, poplar, apple	Leaves	MEDIUM-LOW[680]	MEDIUM-LOW	MEDIUM	UNKNOWN[681]	MEDIUM - NEGLIGIBLE
Schizura concinna	Redhumped caterpillar	Wide host range including: walnut, almond, liquidambar, plum, apple, apricot, birch, cottonwood, cherry, pear, prune)	Leaves	LOW[682]	MEDIUM-LOW	MEDIUM	LOW[683]	VERY LOW-NEGLIGIBLE
Thaumatotibia leucotreta	False codling moth	Wide host range including: walnut, macadamia, citrus, grains, cotton, pineapple, oak	Nuts	LOW[684]	MEDIUM[685]	MEDIUM	UNKNOWN	MEDIUM-NEGLIGIBLE

[678] Occurs in China, Korea, Russia (Far East), Can spread with trade like Gypsy moth (*L. dispar*) (OPPO/EPPO 2005).
[679] In Asia outbreaks occur every 4 years and cause significant defoliation of host plants (OPPO/EPPO 2005).
[680] This species occurs in Europe, northern Africa and the Middle East.
[681] Larvae feed on the leaves of a range of trees. Generally, only a minor pest overseas.
[682] North American species.
[683] Occasional pest. Can sometimes cause total defoliation of young plants.
[684] Spread on fruit and nuts (has been detected in California on South African Citrus imports).
[685] Wide host range but is a warm-climate species so is more likely to do well in Qld and NSW.

Pathogens and nematodes

Table 30. *Walnut pathogen and nematode threat summary table*

'Unknown' indicates insufficient information available to make an assessment of risk

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
BACTERIA (including mycoplasma-like organisms and phytoplasmas)								
Brenneria nigrifluens (Syn. *Erwinia nigrifluens*)	Shallow bark canker	Walnut (has also been isolated from sunflower)[686]	Trunk, branches	MEDIUM-LOW[687]	MEDIUM-LOW	MEDIUM-LOW	LOW[688]	VERY LOW - NEGLIGIBLE
Brenneria rubrifaciens (Syn. *Erwinia rubrifaciens*)	Deep bark canker	Walnut	Trunk, Branches, bark	HIGH-MEDIUM[689]	MEDIUM	MEDIUM	LOW[690]	VERY LOW
FUNGI								
Armillaria mellea	Armillaria root rot	Very broad host range including: *Acacia* spp., Acer spp., kiwifruit, European alder, birches, cedar, cypress, citrus, fig, ash, olive, fir, pecan, chestnut, hazel, walnut, almond, Prunus spp., ornamental apple, privet, Eucalyptus spp., pine, oak, blackcurrant, mulberry, rose, grapevine and blueberry	Roots and collar region	LOW[691]	LOW	MEDIUM	MEDIUM[692]	VERY LOW

[686] See: Jamalzade et al., (2012).
[687] Occurs in Iran, France, Spain, Serbia and the United States.
[688] Causes cankers on trunk and branches. Reported to cause symptoms in Spain, Italy and California (Teviotdale et al., 2002), France (Menard et al., 2004) and Serbia (Popovic et al., 2013). However this disease doesn't affect production (Teviotdale et al., 2002).
[689] California and France (Teviotdale et al., 2002).
[690] Emerging issue in California, where many of the varieties appear susceptible (McClean and Kluepfel 2009). Mostly affects mature (8+ year old) trees, causes longitudinal splits/cracks in the bark and necrotic tissue. Symptoms have not been seen in wood that is less than 4 years old. Infected branches weaken and die but trees survive but are less productive (Teviotdale et al., 2002).
[691] The old records of this fungus in Australia are now all assumed to be the native *Armillaria, A. luteobubalina*.
[692] Causes tree death on other hosts.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Geosmithia morbida	Thousand cankers disease	Black walnut and other *Juglans* spp.	Trunk and branches	LOW[693]	LOW[694]	LOW[694]	HIGH[695]	LOW
Grovesinia moricola (Syn. *G. pyramidalis*)	Zonate leaf spot	Wide host range including: pecan, walnut, soursop, avocado, maple, grapes	Leaves	LOW[696]	MEDIUM-LOW	MEDIUM	UNKNOWN[697]	MEDIUM-NEGLIGIBLE
Melanconis carthusiana	Melanconium Dieback	Walnut	Branches	UNKNOWN[698]	UNKNOWN	UNKNOWN	UNKNOWN[699]	UNKNOWN
Neonectria ditissima (Syn. *Nectria ditissima, Neonectria galligena*)	European canker	Apple, European pear, Asian pear, poplar, oak, willow, birch, elm, maple, beach, ash, *Sorbus* spp., walnut	Stems and branches	HIGH	HIGH	HIGH	LOW[700]	LOW
Ophiognomonia clavigignenti-juglandacearum (*Syn. Sirococcus clavigignenti-juglandacearum)*	Butternut canker	Walnuts (including *Juglans cinerea, J. nigra* and *J. regina*) and *Carya* spp. (including pecan)[701]	Stems and branches	LOW[702]	MEDIUM	MEDIUM[703]	UNKNOWN[704]	MEDIUM-NEGLIGIBLE
Ophiognomonia leptostyla (Syn. *Gnomonia leptostyla*)	Walnut anthracnose; walnut leaf blotch; walnut leaf spot	Walnut	Leaves and exocarp	MEDIUM-LOW[705]	MEDIUM	HIGH-MEDIUM	HIGH[706]	MEDIUM

[693] Disease occurs in North America and has been recently reported in Italy (Montecchio and Faccoli 2014).
[694] The fungus is vectored by the exotic Walnut twig beetle (*Pityophthorus juglandis*) (Montecchio and Faccoli 2014). Risk would increase if vector was present in Australia.
[695] Causes a large number of small cankers to develop at beetle entry points. These lead to branch die back and can cause tree mortality. English walnut is susceptible but not as severely affected as Black walnut (USDA APHIS 2009).
[696] Pathogen occurs in North America (USA) and South America (Brazil - recent detection Bezerra et al., 2008).
[697] Causes leaf spots and defoliation.
[698] Occurs in Europe (Teviotdale et al., 2002).
[699] Causes death of twigs, branches and leads to die back and can eventually kill the tree (Teviotdale et al., 2002).
[700] Cankers develop at the infection site, girdles the stem. Pruning can control it on walnut.
[701] See: Broders and Bolland (2011); Broders et al., (2015)
[702] North American species.
[703] Spread rapidly in the USA, birds and insects may assist in vectoring the pathogen (Ostry and Moore 2007).
[704] Caused the death of significant amount of Butternut in the USA but not reported to kill other walnut species. Persian walnut has been shown to be susceptible to the disease (Ostry and Moore 2007).
[705] Widespread in Europe, western Asia, North America (not found in California but found in the Pacific North West), South America and South Africa. It has been established to be not present in Australia – the two old specimens were checked and cleared
[706] Causes lesions on leaves and exocarp. Severe infections can cause leaf drop and tree mortality (Teviotdale et al., 2002). Can also cause black spots on the husk (Belisario et al., 2009).

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
Phymatotrichopsis omnivora	Texas root rot	Broad range of plants including over 2000 hosts. These include cotton, pecan, walnut, pistachio, almond, macadamia, hazelnut, okra, peanut, sugar beet, legumes, fig, apple, Prunus spp., poplars, elms, willows and grapevine	Whole plant as a result or root damage	LOW[707]	MEDIUM	MEDIUM	UNKNOWN[708]	MEDIUM-NEGLIGIBLE
Verticillium dahliae (exotic defoliating strains)[709]	Verticillium wilt	Various including: cotton, olive, pistachio, chestnut, almond, pecan, walnut	Whole plant	MEDIUM	HIGH[710]	HIGH[711]	UNKNOWN[712]	HIGH-NEGLIGIBLE
NEMATODES								
Criconemoides curvatum	Ring Nematodes	Walnuts, almond, peach, carnation	Roots	LOW[713]	MEDIUM	LOW	LOW[714]	NEGLIGIBLE
Criconemoides xenoplax	Ring Nematodes	Walnuts, almond, peach	Roots	LOW[713]	MEDIUM	LOW	LOW[714]	NEGLIGIBLE
Meliodogyne partityla	Pecan root nematode	Pecan, walnut, hickory	Roots	LOW[715]	MEDIUM	LOW[716]	LOW	NEGLIGIBLE

[707] Present in North America. Soil-born.
[708] Kills infected plants.
[709] Non-defoliating strains of *Verticillium dahliae* occur in Australia. The defoliating strain VCG 1A is known to occur in Australia and is currently under review.
[710] Defoliating strain has a higher temperature requirement than non-defoliating strains.
[711] Soil, plant debris, etc. can spread the pathogen.
[712] Limited information on impact other than being listed as a host (Hadizadeh and Banihashemi 2007).
[713] Found in South America, North America, Asia, Africa and Europe (Bridge and Starr 2007).
[714] Reported to be damaging to walnut (Bridge and Starr 2007). Reduced tree vigour.
[715] Reported from South Africa and the USA (Brito et al., 2006).
[716] Spread with infected soil.

Scientific name	Common name	Host(s)	Affected plant part	Entry potential	Establishment potential	Spread potential	Economic impact	Overall risk
VIRUSES AND VIROIDS								
***Cherry leaf roll virus* (*Nepovirus*)**(walnut strains)	Blackline	Wide host range including raspberry, blackberry, Himalaya berry(*Rubus procerus*), cherry and walnut	Whole plant (stunting), leaves, die back	MEDIUM	MEDIUM	MEDIUM[717]	MEDIUM[718]	LOW

[717] Spread by grafting. Vector unknown.
[718] Virus causes leaf pattern and black line, terminal shoot dieback (SPHDS 2011).

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Australia's Tree Nut Industry

2016 Growing For Success

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Disclaimer

Information and statistics provided in this publication are collated and cross checked from a number of sources, including the Australian Bureau of Statistics and directly from industry. These statistics can be reported across varying time periods, and care should be taken before making comparisons.

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Contents

Industry Snapshots

Australian Nuts... Naturally

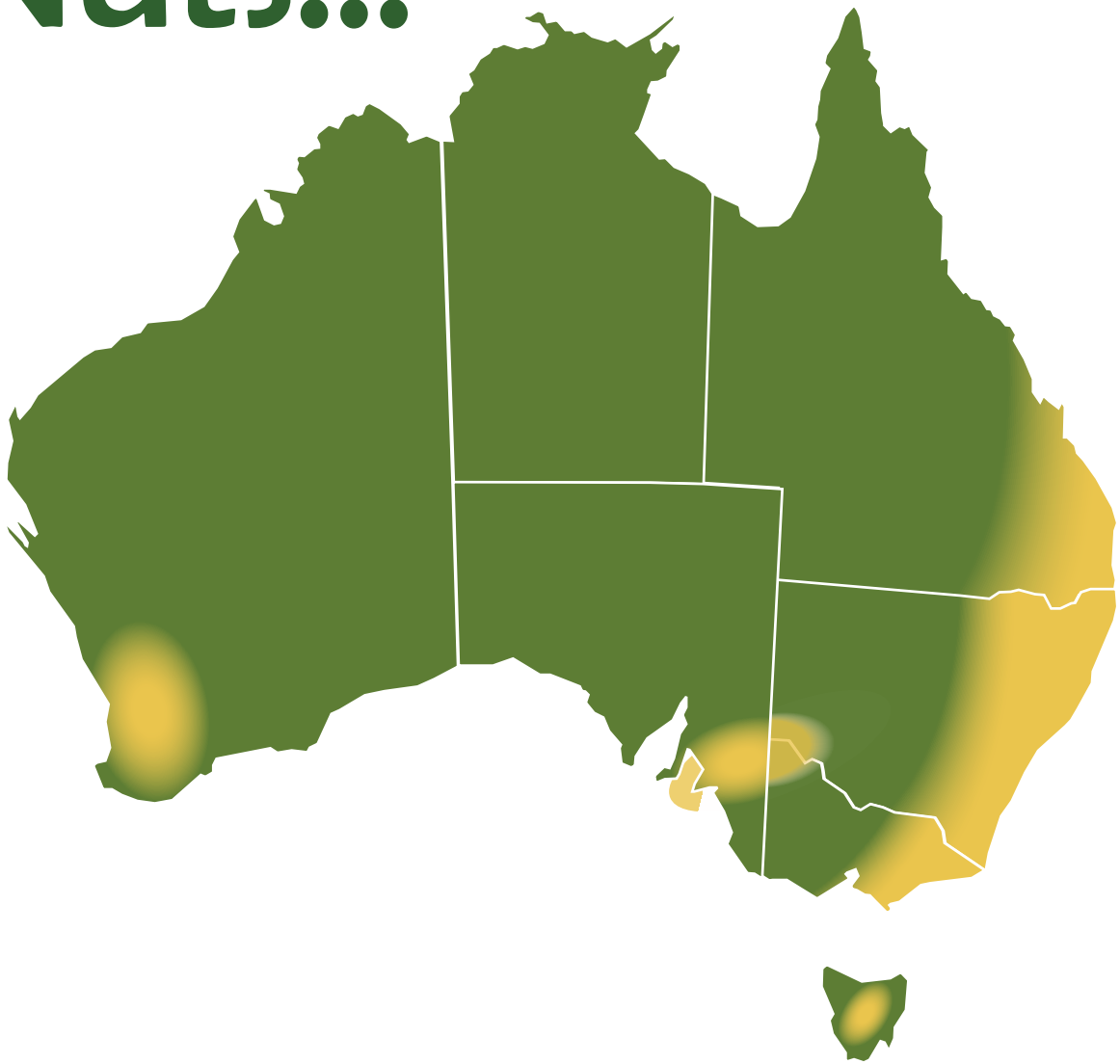
The Australian tree nut industry continues to go from strength to strength. Despite its relative youth compared to other agricultural sectors, the nut industries have relentlessly pursued world's best practices and technologies in developing growing practices specifically for Australian conditions. Today, Australia is home to an enviable pool of knowledge as well as a culture of innovation upon which has developed a future-facing industry whose exceptional product is in demand around the globe.

With a farm gate value nudging $1 billion (2015/16), buoyant markets and sound business models, the industry is enjoying continued investment, which is driving a new wave of significant new plantings across the industry. On the back of these plantings, the Australian crop, in both production and farm gate value, is forecast to increase by over 50% by 2025 as new trees come into bearing.

The Australian nut industry is Australian horticulture's single largest export industry. Australian nuts attract a premium in markets that appreciate food safety, product quality and reliability of supply chains. Buyers from Asia, Europe, the USA and elsewhere recognise Australia as the source of premium quality nuts, especially prized in the northern hemisphere off-season.

The value of nut exports exceeded AU$900 million in 2015-16 and is projected to exceed AU$1 billion within the next few years. Export industries include almonds, macadamias, walnuts, chestnuts, pecans and pistachios, whilst the hazelnut crop is principally consumed domestically. With the level of production now globally significant and expanding strongly, we must ensure that market opportunities are maximised both domestically and internationally.

This expansion in production has important policy implications. Nuts must continue to figure in policy directions and government decisions, particularly in trade negotiations, given the industry's substantial export capacity both now and in the future.



Nuts return a gross revenue of $20,000-$30,000/hectare; compared to a $500 - $700/ha return from grains. Nuts return $2,000 to $3,000 per megalitre of water applied; in contrast, rice returns several hundred dollars per megalitre

Growing Tree Nuts in Australia

Capital and expertise have combined to rapidly expand the area under nut cultivation in Australia. The industry is a mixture of large 'corporate' farms and medium- and small-sized family farms.

Nut growing converts land from broadacre crops with relatively low financial returns per hectare to intensive crops with a high return per hectare of land and per megalitre of water applied.

Tree nut production in Australia is dominated in scale by almonds and macadamias, with the former representing more than 50% of the total area planted and the tonnage produced. The macadamia, Australia's iconic native species, accounts for approximately 30% of area planted and tonnage produced.

Current Australian nut production had a farm gate value of almost $1 billion from the 2015-16 season. This represents a 250% increase over the last five years. Overall, the farm-gate value of Australian tree nuts is forecast to increase by a further 50% by 2025.

Tree nuts provide attractive alternative production options to the more traditional but largely low value Australian agricultural industries which are currently under pressure from the low labour costs, and heavily subsidised production of overseas competitors.

The tyranny of distance generally means that most agricultural commodities carry a high export freight cost to our major markets. By contrast, the high value of nuts compared to most broadacre crops means the freight cost is an insignificant component. For example, a 20 foot container of almonds or macadamias has a market value in excess of $150,000 compared to around $5,000 for a container of wheat. Freight costs per kg are comparable but as a proportion of value there is a stark difference.

Australia enjoys a reputation in consuming countries for unsurpassed food-safety and environmental standards (clean and green). Our relative isolation has generally provided Australian agriculture with a pest- and disease-free environment. The Australian nut industries have a long history of participation in government-sponsored residue testing, with an exemplary track record measured against some of the strictest residue limits in the world, providing global markets with justifiable confidence in the Australian product.

Tree nut industries require long-term development capital, technological skills and research to build on advantages. With the support of research and development funding from the Australian Government, Australia is producing some of the highest nut yields per hectare in the world in particular for almonds, pecans and macadamias. Long-term breeding programs aimed at improved varieties are also in progress.

From orchard to processing, the Australian industry has excelled at producing a wide and growing range of tree nut crops. Underpinning this success are several factors including the variety of climatic and agronomic zones, excellent infrastructure and processing systems, investment in research and development, and skilled growers and advisors.

Australian Tree Nut Area Planted & Production

Area planted, hectares	2011	2016	2021	2025
Almonds	26,944	36,000	44,000	46,000
Macadamias	18,000	19,000	25,000	26,000
Walnuts	2,790	3,590	4,340	4,500
Pecans	1,400	1,800	2,300	2,700
Chestnuts	1,240	1,440	1,640	1,800
Pistachios	900	1,100	1,600	2,000
Hazelnuts	140	1,370	2,220	2,760
Total Area Planted, hectares	**51,414**	**64,300**	**81,100**	**85,760**

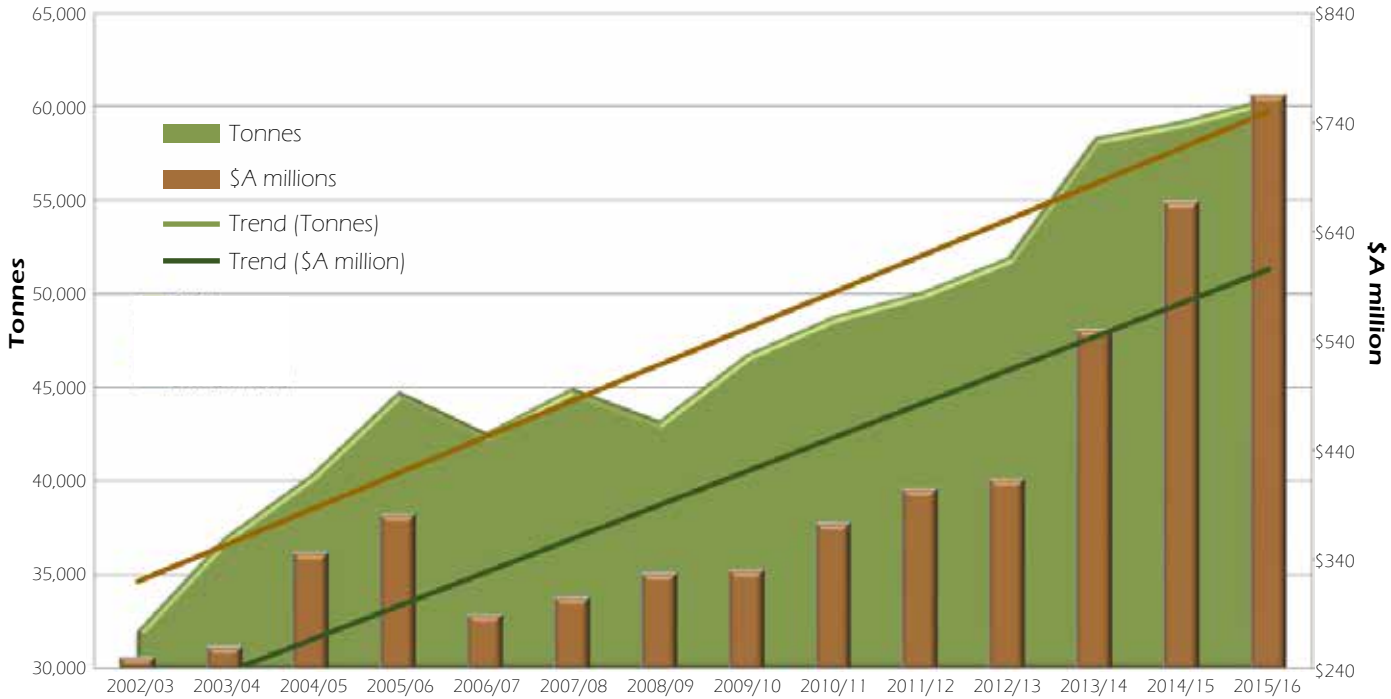
Production, tonnes	2011	2016	2021	2025
Almonds, kernel	37,626	80,140	109,000	130,000
Macadamias, in-shell	28,500	50,000	58,000	65,000
Walnuts, in-shell	3,455	6,000	16,866	17,490
Pecans, in-shell	3,375	4,009	4,193	4,908
Chestnuts, in-shell	2,000	2,500	3,000	3,200
Pistachios, in-shell	1,100	1,950	2,300	3,500
Hazelnuts, kernel	79	170	2,553	3,174
Total Production, tonnes	**76,135**	**144,769**	**195,912**	**227,272**

Value (farm-gate), AU$ million	2011	2016	2021	2025
Almonds	188.0	641.1	872.0	1,040.0
Macadamias	90.0	250.0	300.0	315.0
Walnuts	13.8	30.0	67.4	71.0
Pecans	18.6	22.1	23.1	27.0
Chestnuts	10.0	12.5	15.0	16.0
Pistachios	10.5	23.0	25.0	35.0
Hazelnuts	0.4	1.7	22.5	31.7
Total Value, AU$ million	**$ 331.3**	**$ 980.4**	**$ 1,305.0**	**$ 1,535.7**

Source: Australian Nut Industry Council 2016

Australian Nut Consumption

Australian Nut Consumption at Trade 2003-2016



Source: Nuts for Life 2016

Australian nut consumption is growing at a rate above the world consumption demand, at 5-6% year on year. The Australian nut crop is heavily consumed in local markets and any shortfall between domestic demand and available supply is met by imports. The almond, macadamia, walnut and pecan industries have all been developed with a strong international focus and are increasingly exported as production grows.

In 2015-2016 domestic nut consumption was approximately 60,000 tonnes. This values the industry on current trade prices in excess of $740 million, split almost equally between domestic and imported product. This trade price equates to an estimated retail value of $1.5 billion.

The evidence suggests that as economic growth and incomes increase in developing countries, so will their demand for nuts.

Trade & Export

Tree nuts are Australia's largest horticultural export sector, accounting for approximately 45% of all horticultural exports in 2015-16 and valued at over AU$900 million. Thanks to a powerful and persistent worldwide dietary trend and a strong set of local production values that emphasise food safety and eating quality, as well as excellent social and environmental stewardship credentials, the Australian tree nut industry is likely to surpass AU$1 billion in export sales within the next few years.

Australia currently exports nuts to around 55 countries. The principle barrier to expanding exports is the tariffs that remain in some key existing and some potential new markets. These tariffs restrict nut consumption by increasing the price to the importing market, in some cases prohibitively. The recently negotiated free trade agreements between Australia and the nations of Japan, China and South Korea, whereby most nut tariff lines are now being phased out, have resulted in expanded sales and exports of Australian-grown nuts almost immediately. These countries and others, such as India, are nut importers with significant potential for growth.

With the next phase of expansion already underway, the industry needs to make the most of these export market development opportunities.

Current and Forecast Value (AU$ million) & Exports

Exports, tonnes	2011	2016	2021	2025
Almonds, kernel	20,805	54,858	79,846	94,562
Macadamias, in-shell equivalent	18,700	39,200	46,000	52,000
Walnuts, in-shell	2,623	3,222	17,031	19,164
Pecans, in-shell	2,046	958	2,226	2,607
Chestnuts, in-shell	671	18	1,033	899
Pistachios, in-shell	300	655	650	650
Hazelnuts	-	-	-	-
Total Exports, tonnes	**45,145**	**98,911**	**146,785**	**169,881**

Total Export Value (FOB), AU$ million	2011	2016	2021	2025
Almonds	135.2	617.5	720.0	850.0
Macadamias	82.0	256.0	300.0	350.0
Walnuts	10.5	15.4	76.1	80.0
Pecans	11.3	10.6	12.2	14.3
Chestnuts	3.4	0.5	5.2	4.5
Pistachios	1.0	6.5	6.5	6.5
Hazelnuts	-	-	-	-
Total Export Value AU$ million	**$ 243.3**	**$ 906.4**	**$ 1,120.0**	**$ 1,305.3**

Source: Australian Nut Industry Council 2016

Comparative Advantage

The Australian tree nut industries show a comparative advantage over competitors in a number of areas. Depending on the nut industry, advantages may take the form of lower per unit production costs, higher yields and a 'country of origin' gene pool. This allows Australia to compete (in both production and processing) with countries that have lower labour costs. In addition, Australian tree nut production generally reflects a high level of supply complementarity into key importing markets, thanks to advantageous supply windows and enhanced quality.

The major producers against whom Australia must compete are:

- Almonds: USA and Spain
- Pecans: USA, Mexico and South Africa
- Macadamias: USA (Hawaii), South Africa, Kenya, Guatemala
- Pistachios: USA, Iran, Turkey
- Walnuts: USA, China, Chile, Eastern Europe

In all cases, Australia is a powerful competitor based on cost or quality, or both.

Underlying World Demand

World demand for nuts is growing at about 4% a year, well above natural population growth. This expansion is coming from an increasing awareness of the health benefits of nuts and an increasing prosperity in developing economies.

Developing economies, such as India, China, Eastern Europe and the Middle East, are all showing strong, growing demand for tree nuts. As disposable incomes rise, consumption of traditionally expensive foods increases. Nuts are not luxury foods (they are priced at similar levels to medium cuts of beef), but they traditionally have been beyond the pockets of the poor.

The evidence suggests that as economic growth and incomes increase in developing countries, so will their demand for nuts.

Why Australian Nuts?

Australia's agricultural industries are among the most sophisticated, highly mechanised and environmentally aware in the world. If there is one thing its farmers know how to do it is to grow high quality produce. The Australian nut industry has developed in this competitive, globally-focussed environment. Key features of the industry include:

In-season nuts – all year round

A key driver in Australia's export success is the ability to provide reliable and premium quality supply in the northern hemisphere off-season. The Australian crop is timed perfectly to supply northern hemisphere markets for the critical Christmas trade, a shipping schedule that challenges northern hemisphere competitors. The benefit for the international nut trade and consumers is that they now have access to a ready supply of the freshest nuts all year round.

Export focussed

Australian farmers have a reputation for being among the most efficient and advanced in the world. Due to our relatively small population, Australian farmers are acutely aware of the need for and needs of export markets, and the importance of supplying reliable lines of high quality product. Our highly skilled growers have concentrated on refining their ability to supply premium product to buyers around the world.

World class horticultural skills

Our growers have developed horticultural skills that have put them at the forefront of the world for nut yields per hectare and quality, something that is recognised by growers around the world. The Australian nut industry is quick to adopt the very latest innovations and practices in production. Pecan and almond growers from traditional growing countries such as the USA regularly visit Australia to learn Australian techniques. The Australian macadamia industry provides research and development information to the rest of the world.

Investment in research and development

Investment in research and development across the sector is significant, and our industry is a world leader in nutrition, biological controls, harvesting and post-harvest handling. We are constantly improving the understanding and practice of growing high quality nuts in Australian conditions.

The nut industries were one of the first sectors of horticulture to take advantage of the Australian Government R&D and marketing levy models and has been an active partner with the various horticulture RDCs such as HRDC, AHC, HAL and now HIAL. This partnership has assisted the rapid growth in productivity and export earnings that has characterised the nut industry over the last decade.

Clean and green

Consumers today are much more demanding than in the past when it comes to the environmental credentials of the food they eat.

Australia is an island nation surrounded by oceans that act as natural barriers to some of the most troublesome and costly pests and diseases that affect nut crops in other countries. This is a powerful marketing point of difference.

Many growers apply integrated pesticide management techniques in their orchards as a way of maximising the use of natural controls such as beneficial insects, thus limiting pest and disease damage and minimising pesticide use. Some orchards are even certified organic.

Top quality from top growers and processors

Australian walnut growers are producing some the best quality walnuts in the world from relatively cool growing areas. Australian chestnuts are highly regarded for their flavour and quality appeal; Australian macadamias have developed a reputation in Asia for premium taste and quality, and demand from buyers for Australian almonds, walnuts and pecans is high because of their reputation for excellent taste and quality.

Australian processors too have developed using the highest standards and investing the latest in technology and infrastructure, such as fully automated cracking and shelling machines, electronic and near-infra-red sorting and grading, x-ray scanning, robotic packing, automated and climate-controlled warehousing with lot-tracking, and an increasing adoption of state-of-the-art treatment systems for micro-bacteriological control.

Industry cohesion

Each of Australia's tree nut industries has a strong, well-organised industry association which supports its growers in providing technical advice and funding research and marketing. All have a focus on ensuring customer satisfaction and delivering exceptional value for money by expanding horticultural skills and the market both domestically and overseas.

The seven local tree nut industries come together under the Australian Nut Industry Council (ANIC). Through ANIC the nut industries work together, sharing resources, experience and ideas to promote the benefits of Australian-grown nuts.

Nuts and Health

Research spanning the past 30 years has conclusively shown that regular nut consumption can significantly reduce the risk of heart disease. There is also research supporting the role nuts can play in diabetes and weight management.

There are now in excess of 500 scientific research studies and publications to substantiate the positive effect that regular nut consumption has on health. Some of these benefits include:

A handful of nuts (30g) at least five times a week may reduce the risk of developing heart disease by 30-50%.[1-5] This is due to the wide range of heart healthy nutrients that nuts contain - healthy fats, fibre, antioxidants, vitamins such as vitamin E and folate, minerals such as magnesium, selenium and zinc, plant sterols and arginine.

Two handfuls a day (60g on average) significantly lower blood cholesterol and particularly LDL (bad) cholesterol – risk factors for heart disease.[6,7] Again, the healthy fats, fibre and plant sterols that nuts contain help regulate cholesterol production.

Nuts help prevent weight-gain, promote weight management and reduce the risk of developing obesity.[8,9] The fats, fibre, protein and low GI effect increases satiety helping to control appetite.

A regular handful of nuts (30g) may reduce the risk of developing type-2 diabetes.[10] Nuts have a low Glycemic Index (GI) effect and they play a role in improving insulin sensitivity and managing blood glucose control.[11,12]

Preliminary research is suggestive of a positive function for nuts on brain function, cognition and memory.[13,14]

As a result of all these health effects nut consumption reduces overall mortality.[15]

Adding nuts to the diet improves the quality of the diet and helps to reach recommended nutrient intakes because nuts are nutrient dense.[16,17] Nuts can be thought of as "nature's own vitamin pills" - small packages that contains more than 28 different nutrients. Each nut variety has a unique combination of nutrients.[18]

The nut health message is surely getting through to consumers, who are responding by increasing consumption. Over the past five years, Australian tree nut consumption has increased 70% in dollar terms and 20% by weight.[19] The higher consumption trend reflects an increase in family budget spending on nuts, which is helping to support underlying demand. Having said that, according to the Australian Health Survey 2011-13, Australians are eating just 6 grams of nuts on average a day[20], well short of the Australian Dietary Guidelines' recommended 30 gram per day serve[21]. In 2016 the Australian Institute of Health and Welfare (AIHW)[22] found that 1.4% of the cost of burden of disease in Australia is due to a "diet low in nuts and seeds" (similar to a diet "low in vegetables"). The AIHW also found around 16% of the costs of heart disease and 7% of the costs for type 2 diabetes can be attributed to a "diet low in nuts and seeds".

The Australian tree nut industry across the supply chain voluntarily invests, along with the Australian Government through Horticulture Innovation Australia, in a health education program, *Nuts for Life*, to raise awareness and promote the health benefits of nuts to Australians. On the back of the extensive research outlined above, Nuts for Life and the broader industry have a crucial role to play in raising consumption of nuts to a level closer to the recommended daily serve guidelines.

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Industry Snapshots

Almonds

Australia is the second largest producer of almonds in the world. In 2015, the area under production was 31,115 ha producing a record crop of 82,509 tonnes.

Production areas

- Almonds are grown along the Murray Valley in South Australia, Victoria and New South Wales, with plantings also located in Western Australia.
- There are five major growing regions in Australia encompassing:
  - Adelaide and the Riverland (South Australia)
  - Sunraysia (Victoria)
  - Riverina (New South Wales)
  - Swan Valley (Western Australia)
- Ownership structures are diverse with orchards owned by sole producers, family enterprises, both private and public companies, and investment funds.

Current production

- Since 2001 the total area planted to almonds has increased from 5,232 hectares to 31,115 ha in 2015.
- Production in 2015 was 82,500 t of kernel.
- The three major varieties grown in Australia include; Nonpariel (50.1%), Carmel (31.4%) and Price (11.3%), with other varieties making up approximately 7.3% of plantings.
- Approximately 64% of almond production (kernel) comes from Victoria's growing regions, followed by 22% in South Australia and 12% in New South Wales.

Industry potential

- The almond industry is currently in a period of significant expansion estimated to increase orchard area to 45,000 hectares by 2018 with production increasing to 130,000 tonnes by 2025.
- Almonds have become an attractive crop for investors because the industry is highly mechanised, suited to large-scale orchards and has proven to be profitable and stable.
- Trees begin producing almonds after three years and reach full cropping after seven to eight years. Presently 7.9% of almond plantings are not yet bearing a crop and 8.2% of bearing trees are not yet fully mature.
- Consumer demand for almonds continues to increase strongly, both domestically and globally. In the past five years Australian consumption has risen by more than 40% while global demand has been limited by supply. Demand is being driven by improving living standards in developing countries rise, the range of new products using almonds expands rapidly and consumers turn to healthy snacks.
- Almonds were Australia's most valuable horticultural export product in 2015 with sales of $745 million. This represents 36% of Australia's total value of horticulture exports.

Markets: present and future

- Australian almonds supply nearly all domestic consumption, and most of the growth in production is being directed to overseas markets.
- Some almonds are imported into Australia but this is mainly for use in baking and confectionery, where small kernel size is preferred.
- Current domestic consumption of almond kernel is 22,000 tonnes a year.
- In the past five years Australian consumption has risen by more than 40%, whilst global demand has doubled in the last decade.
- Fifty countries now buy Australian almonds, with India being Australia's largest overseas market. With their dynamic economies and large populations of increasingly prosperous and health conscious consumers, Indian and Asian markets will continue to import more almonds well into the future.
- While markets in India and Europe are growing strongly, strong growth has been in the recent Free Trade Agreement countries in Asia, Japan, Korea and China.
- Marketing and promotion programs funded by industry support increasing domestic per capita consumption and targeted overseas market development.

Competitive advantages

- Australian almonds are harvested counter seasonally to the US and Spain and Australia's new season product is available in time for many Asian religious festivals that celebrate with nuts.
- Australian orchards are comparatively high yielding and have a good mix of varieties.
- Australian product is highly regarded in terms of quality and crackout rates (in-shell to kernel ratio).
- Export demand for quality Australian almonds is matching the growth in supply.
- Australia is close to the expanding Asian market and marketers are willing to address niche market requirements.

Chestnuts

The Australian Chestnut industry is developing new processing techniques for frozen peeled chestnuts, chestnut meal, flour and puree products, all of which have the potential to expand the market in Australia and internationally.

Production areas

- The Australian chestnut industry operates principally in the southern states of Australia, including
  - NSW: Around Orange, Southern Tablelands, Blue Mountains and Batlow
  - Tasmania: Northern and Central
  - Victoria: North-east and Central; East of Melbourne
  - South Australia: Adelaide Hills
  - Western Australia: South-west
- Approximately 70 per cent of the national crop is grown in north east Victoria.
- The main varieties grown are Red Spanish, Purtons Pride and De CoppiMarone. Chestnuts flower during November and December and are harvested from March through to May.
- Many chestnut orchards are small family-owned orchards, but there are several large-scale commercial plantings, and the average size of new orchards is increasing.

Current production

- In 2016, chestnut production was valued at $8.5 million (LVP). In 2016 there were around 1,300 hectares containing approximately 200,000 chestnut trees. The industry estimates that with more trees planted, production will rise to approximately $9.8 million by 2020.
- The industry is primarily focused on the domestic market with approximately 2 per cent exported mainly to Asian markets.
- Area under production is about 1,300 ha.
- Production is normally about 1,200 t a year of fresh chestnuts (dependent on seasonal conditions)

Industry potential

- Chestnut production is expected to increase to 2,000 t by 2020 as young orchards come into production.
- New varieties and improved orchard management techniques have reduced time to bearing and resulted in increased nut yield, nut size and ease of peeling.
- Some chestnuts are handpicked but more growers have moved to being fully mechanised as a result of new harvesting machinery being developed.
- Growers are planting and re-working older trees to newer and more consumer-friendly varieties.

Markets: present and future

- Chestnuts are highly valued in Europe, the USA, Japan, China and Korea.
- Most growers sell their crop through the fresh wholesale markets.
- Current chestnut consumption in Australia is estimated at 1,200 t, which is satisfied by domestic production.
- Small quantities of fresh and frozen peeled chestnuts are exported to Japan and Singapore.
- The Australian industry is developing new processing techniques for frozen peeled chestnuts, chestnut meal, flour and puree products. These value-added products are now being successfully marketed locally and overseas and have the potential to expand the overall market for chestnuts.
- The chestnut industry is seeking new export markets for fresh and frozen peeled chestnuts to sustain increased production.
- Nut size is important in the fresh chestnut market and new pruning techniques have enhanced this quality.

Competitive advantages

- Australian chestnuts are fresh in the northern hemisphere off-season.
- The Eradication Program for Chestnut Blight undertaken by the Victorian Department remains ongoing. The fungal disease has devastated orchards and native forests overseas. Regular surveys will continue with the aim of eradicating the disease.
- With the exception of New Zealand, importing fresh chestnuts into Australia is prohibited.
- Australia is free from insect pests such as the chestnut gall wasp and chestnut weevil.
- Australia's pest-free status means chestnuts are produced without insecticides.
- Australian chestnuts are highly regarded in Japan for good flavour and quality appeal.
- The Australian chestnut industry is consumer focused and the latest tree varieties being selected are based on ease of peeling and superior flavour. Overseas, yield is generally given a higher priority than eating quality in varietal selection.

Hazelnuts

Locally grown nuts receive a price premium and are sought after by restaurant chefs, patisseries and confectioners because of the fresh taste of the local product compared to imported kernel.

Production areas

- Hazelnuts are grown in the temperate areas of south-eastern Australia. The main production regions are the Central Tablelands of New South Wales around Orange, and north-east Victoria around Myrtleford. They are also grown in central and eastern Victoria and increasingly in northern Tasmania. There are small levels of production in South Australia and Western Australia.
- Until recently, it was thought that hazelnuts would only thrive in Tasmania and the cooler, higher altitude regions of Victoria and New South Wales. Plantings in warmer regions such as Mudgee and Narrandera, in the Riverina region of southern NSW, are doing well which suggests that other areas may be suitable for production.
- Many hazelnut operations are small orchards of up to 6,000 trees although this is slowly changing with the average size of new hazelnut orchards increasing and more productive varieties being planted. Most orchards are family operated enterprises. Hazelnuts generally take seven to 10 years to come into commercial production

Current production

- In 2016, hazelnut production was valued at $1.7 million (LVP). The industry is set for rapid expansion—there are approximately 200 hectares planted, consisting of around 100,000 trees. The industry estimates hazelnut production in 2020 will be 300 tonnes with a value of $2.1 million.
- Area under production is about 200 ha, including young orchards yet to come into commercial bearing.
- Production is about 130 tonne in-shell, which is expected to increase as new orchards begin producing commercial quantities.
- New areas of Hazelnut plantings have extended into southern NSW, eastern Victoria and throughout wider regions of Tasmania.

Industry potential

- By 2020 the area under hazelnut production is expected to be about 250 ha producing approx. 300 tonne in-shell. This is because of an expansion in plantings and a number of young hazelnut orchards reaching commercial production. We also expect there will be an increase in hectares under production as farmers look towards increased crop diversity.
- Interest in growing hazelnuts in Australia is increasing with a key driver being the opportunity to offer fresh Australian hazelnuts to the domestic consumer, and as more production comes on-stream, as an import replacement crop for restaurants and premium quality confectioners and patisseries.

Markets: present and future

- Current domestic consumption of in-shell hazelnuts is relatively small at about 130 tonnes a year. Domestic consumption of hazelnut kernel is currently around 2,000 tonnes, equivalent to 4,500 T in-shell.
- Australia imports approximately 2,500 t of hazelnut product annually, mainly as kernel, primarily from Turkey which are generally used by mass market confectioners.
- Australian hazelnuts in-shell are sold at farmers' markets and fruit shops. There are several boutique cracking facilities producing kernel which is sold through the internet, farmers' markets, specialist health food shops, confectioners and patisseries. Some producers value-add to their kernels by making confectionery and health food products, hazelnut oil, flour and meal.
- Locally grown kernels receive a price premium and are sought after by restaurants, confectioners and patisseries because of the fresh taste of the local product compared to imported kernels.
- Demand for hazelnuts increasing globally and awareness of the health benefits of including a handful of nuts in the daily diet, consumption continue to increase.
- There is potential for exporting in-shell to Asian markets where foodstuffs produced under high safety standards are preferred.
- Between 1,500 and 2,000 ha of well-managed plantings would meet Australia's current requirements.

Competitive advantages

- Australian hazelnuts offer a fresh supply in the northern hemisphere off season.
- Australia is free from Eastern Filbert Blight, a serious disease affecting the industry in the USA.
- Because of the absence of serious pests and diseases in Australia, hazelnuts are produced here with little use of herbicides and pesticides; indeed, organically grown hazelnuts are now being produced in Australia.
- Australian production is well supported by research, leading to improved, more efficient and sustainable production systems.

Macadamias

Production areas

- Macadamias are grown along the eastern seaboard of New South Wales and Queensland, from Nambucca Heads in the south through to Mackay in the north. About half of the Australian crop is produced in NSW and half in QLD.
- Production is growing fastest in Bundaberg and Emerald in QLD and the Clarence Valley in NSW.
- Ownership structures are diverse and comprise a combination of family-owned orchards, business ventures and investment company projects. Many owners are first time farmers.

Current production

- Area under macadamias is almost 19,000 ha.
- Production for 2016 is forecast at 50,000 tonnes in-shell @ 10% moisture. The kernel equivalent is approximately 16,700 tonnes.

Industry potential

- The industry is still growing, with expansion in most growing regions. Bundaberg is the fastest growing established region with new areas being developed in MacKay and Emerald in Queensland and the Clarence Valley in NSW. Bundaberg became the single largest growing region in 2016.
- There has recently been a resurgence in new plantings with almost 600,000 trees or 2,000 ha established in the last five years. There are currently around 6 million macadamia trees under cultivation; about a third of these are yet to reach full production.
- By 2020 about 24,000 ha will be planted to macadamias with kernel production of around 19,500 tonnes. Export value is expected to exceed $300 million.
- Global demand exceeds supply. Consumption is increasing as a result of increasing interested in healthy foods and an increasing awareness of the versatility of tree nuts. The biggest growth in demand is coming from Asia, where major city consumers in particular are focussed on health, convenience and new products.
- The in-shell market has grown from almost nothing to a third of global consumption in 5 years and the kernel market remains strong globally.
- Macadamias currently represent around 1.5% of the world trade in tree nuts. As awareness and production increase, the Australian Macadamia Society predicts continued growth in the industry.

By 2020 about 24,000 ha will be planted to macadamias, with kernel production greater than 18,500 t. Export value will exceed $300 million.

Markets: present and future

- Around 30% of Australian macadamias are sold in-shell, mainly to China where consumers favour in-shell product. They are flavoured and cut to allow hand cracking with a key.
- Approximately 70% of Australian macadamias are sold as kernel. Kernel is processed for snack food lines and as an ingredient in confectionery, cereals, ice-cream and bakery products. There is also a growing market for food oil and beauty products such as moisturisers and hair care.
- The domestic market consumes about 30% of total production, 95% of which is sold as kernel.
- Consumption of macadamias in shell is increasing in China and this market is expected to grow significantly over the next 5 years,
- 9,300 tonnes of kernel were exported in 2015 and around 11 tonnes in-shell. This represented about 70% of total industry production and had value of $220 million.
- Asian markets are showing the greatest growth driven by increasing trade interest and consumer awareness. In the last few years market development campaigns have supported the product in China, Taiwan and Korea.
- Promotion of health benefits is a support driver of demand and, combined with new market penetration, is expected to underpin further industry growth.

Competitive advantages

- Macadamias are the only Australian native food plant to be widely traded internationally.
- Australian farms and processors have high product standards, with a demonstrated capacity to produce superior kernel.
- Through the Australian Government's National Residue Survey the Australian macadamia industry can demonstrate 16 years of 100% compliance with all relevant standards.
- There is a strong financial commitment to domestic and export market development and on-farm research funded by a compulsory grower levy on production. The industry spends about $2.2 million annually each on research and development and marketing.
- Australia holds the only natural germplasm resources for macadamias, and has spent over $4 million over the last ten years on a comprehensive breeding program. Early indications are that yield increases of 30% are possible from new varieties.
- The industry has a strong representative body, the Australian Macadamia Society, which is driving further industry and export development.

Pecans

Australian pecans are harvested in the northern hemisphere off-season meaning that fresh Australian product can be shipped into major markets in the pre-Christmas season and, importantly, in good time for Chinese New Year.

Production areas

- The majority of the Australian pecan crop is produced under irrigation in the Gwydir Valley, east of Moree in northern inland New South Wales.
- Smaller scale production extends from the Hunter Valley and Nelson Bay on the NSW Central Coast to the Mid North Coast near Kempsey and the North Coast around Lismore.
- Pecans are also grown in Central Queensland around Mundubbera and Eidsvold and in the South East in the Lockyer Valley and south to the NSW border.
- Small plantings also exist in South Australia and Western Australia.

Current production

- Area under pecans is 1,350 ha.
- Production is about 3,000 t in-shell (1,650 t kernel).

Industry potential

- Pecans production in Australia in increasing slowly but steadily with about 100-200 new hectares being planted annually. "Trawalla" farm, established on 700 ha by the Stahmann family in the 1970s, remains the only large-scale orchard in Australia but a number of new smaller orchards have been planted in recent years.
- Since pecan trees take 10 years or more to reach full production there is a substantial lag time before new plantings impact crop size but after a long period of stagnation production increases are now being observed.
- Pecans are extremely long-lived and remain highly productive for more than a century, making them a genuinely long-term investment. They are relatively tolerant of a range of growing conditions although productivity is naturally dependent on the right combination of sun, soil and water.
- In the right environment a pecan tree will grow very large and so careful husbanding is required to maintain a commercial orchard.
- Stahmann Farms Enterprises operates Australia's largest pecan processing plant in Toowoomba (QLD) from which it supplies inshell and kernel products to domestic and international markets. Other smaller processors, including Organic Pecan Enterprises, supply mostly local markets.
- Global production remains concentrated in USA and Mexico which together account for 90% or more of the world crop. South Africa continues to expand production with small but significant crops also to be found in Central and South America.

Markets: present and future

- The bulk of Australian pecan product is sold as kernel for domestic consumption with distribution split between retail and manufacturing channels.
- Australian pecan kernel exports find their way to all corners of the globe from North America to Europe, the Middle East and East Asia.
- The pecan market has been strong in recent years, especially since the entry of China to the world market in the early 2000s.
- Pecans constitute less than 5% of world tree nut trade and their consumption is still mainly concentrated in the USA, where they are a native nut. Demand in Asia, Europe and the Middle East is growing although the intense interest from China has severely limited availability in recent years
- Pecan nuts have many marketable health benefits among which their exceptionally high level of antioxidants (one of the highest of all natural food products) is most noteworthy. The Nuts for Life campaign continues to play an important role in bringing such benefits to the attention of Australian consumers, and it has been influential in continuing consumption growth in Australia

Competitive advantages

- Australian pecans are harvested in the northern hemisphere off-season meaning that fresh Australian product can be shipped into major markets in the pre-Christmas season and, importantly, in good time for Chinese New Year.
- The Australian pecan industry has been fortunate to remain free from troublesome scab disease which blights much of the production in the USA, and innovative production techniques mean that the bulk of the Australian crop is grown without the use of chemical pesticides.
- Australia's clean green image and the robust food safety regimes required in Australia and validated by internationally recognised QA systems, support strong interest by a health conscious middle class throughout the world and, increasingly, in our Asian region.

Pistachios

Pistachio production in Australia is fully mechanised, requiring minimal labour and ensuring international competitiveness.

Production areas

- The major production areas are along the Murray River Valley between Swan Hill, Victoria and Waikerie, South Australia. Further plantings are in central west VIC and Pinnaroo, SA.
- There are also a small number of growers in central NSW; southern Victoria and Western Australia but only produce very small yields.
- A central commercial processing facility is at Robinvale in Victoria.
- The pistachio industry includes a mix of medium-sized and smaller operations. The bulk of the crop is produced on medium-sized orchards.

Current production

- Area under production is 950 ha (2015 data).
- Production averages 1,800 t in-shell per year (2 year avg 2015/16).
- The industry has recovered from a fungal epidemic of 2011 and there are now new plantings being developed with plans for further establishment. It is estimated that 30ha was planted in 2015, 100ha planted in 2016 with 50 - 100 ha pa in following years.

Industry potential

- By 2016, the area under pistachio production is expected to increase to 1,100 ha. It is estimated that by 2020 pistachio production could average 3,000 t a year ($25 million).
- Pistachios are an attractive crop because of their hardiness in drought conditions, tolerance of poor soil and water, long tree life and resistance to common orchard pests and diseases.
- Improved orchard management and quality processing techniques have established a profitable and sustainable industry.
- An established commercial processing and marketing facility allows growers to concentrate on pistachio production and provides a mechanism for maintaining product quality.
- Pistachio production is fully mechanised, requiring minimal labour and ensuring international competitiveness.
- Processing facilities have the capacity to efficiently process increased tonnage.

Markets: present and future

- There is significant potential for increasing production in Australia to meet domestic demand. Australian consumption of pistachios is 3,500 t a year and has been increasing at 9% a year, compound, since 2000 (2015 data). About 60% of demand is currently imported.
- The demand for pistachios is increasing globally, and in Australia, because of increased awareness of the health benefits of including 30 to 50 grams of nuts in the daily diet.
- Pistachios are mainly consumed as a snack food, a market sector that is growing in western countries. Consumption of snack foods is also increasing in developing countries as disposable incomes increase. There is also now a rapidly increasing market for kernels in the baking and food services sectors.

Competitive advantages

- The absence of any support work by the Departments of Agriculture, for more than 15 years, left a major gap in the detailed agronomy of pistachio growing under Australian conditions. It has been necessary for PGAI/HAL sponsored and financed projects to fill the gap and to conduct what may be regarded as basic to more established industries.
- The implications for success of these projects are significant for the existing 50 pistachio growers but of greater significance in the development of a new horticulture option for the River Murray Valley. By improving the economic performance of existing pistachio orchards, proof of viability will be shown to other farmers for an expansion of the Australian pistachio industry.
- In 2003 the Australian pistachio industry initiated a position, Research Field Officer, with the financial support of the Australian government through the former Horticulture Australia Ltd. The program has continued through a number of projects culminating with the final project that concluded in May 2016.
- Over that period the pistachio industry has undertaken world quality research particularly related to the Australian bred variety 'Sirora'."
- Australian pistachios are harvested fresh during the northern hemisphere off-season.
- Pistachio crops in Australia are less troubled by pests than they are overseas. Lower chemical use reduces the cost of production and Australia can exploit the clean, green image of its agriculture.
- Pistachio farming is capital intensive, ensuring that Australia can compete with lower wage cost producers such as California and Iran, the two major suppliers of pistachios.

Walnuts

The southern hemisphere produces just 3% of traded walnuts annually and for six months of the year Australia can supply the freshest walnuts in the world.

Production areas

- The Australian walnut industry operates in most states of Australia and has grown significantly in recent years due to growth in the establishment of large scale commercial plantings.
- Major walnut production areas in Australia are on the east coast of Tasmania, the Goulburn Valley near Shepparton and the Murray Irrigation area near Kerang and Swan Hill i n Victoria and in the Riverina near Griffith in New South Wales.
- Small scale orchards are scattered in the Ovens Valley, Gippsland and Central region of Victoria, Southern Highlands and Central Tablelands of New South Wales, the Adelaide Hills and Riverland regions of South Australia, and in south-west Western Australia.
- The Australian industry is a mix of small, older orchards and new, more extensive orchards. Most orchards are family operations but these do not represent the majority of area under cultivation.

Current production

- The production of Australian walnuts in 2016 was in excess of 6,000 tonnes in-shell, with a farm-gate value of $30 million and export value of $15 million.
- A near 3,600 ha of mature and developing trees were under cultivation in 2016. This number is expected to rise to more than 4,300 ha by 2021 as current growers expand their orchards, and as new growers enter the industry in current and new regions.
- Webster Limited is the largest walnut grower, owning and/or managing more than 3,100 ha of orchards. When mature, these orchards are expected to produce over 18,000 tonnes in-shell per annum.

Industry potential

- Investment in new orchard establishment continues through current enterprises and new entrants. Orchards established in the last five years have provided a firm base on which to further build the industry.
- New varieties and improved propagation and orchard management and irrigation techniques have reduced time to bearing and increased nut yield.
- Australia is in a favourable position for walnut production across the southern hemisphere because of the suitability of climatic conditions, water, soil types and topography and capital raising ability.
- Factors that encourage investment in walnuts include; disease free status of most walnut pests and diseases in Australia; walnuts are wind pollinated; continuing strong global demand for walnuts and; increasing awareness of the health benefits of walnut consumption.

Markets: present and future

- Current domestic consumption per annum of walnut is 600-800 tonnes of in-shell and 4,900 tonnes of kernel (circa 9,000 tonnes in-shell equivalent). Walnuts are sold through major retail chains and into the bakery and confectionery industries.
- Australian in-shell walnuts are sought by the local market because of their superior flavor and freshness compared to imported product, and supply the premium quality end of the market at a premium price.
- Several cracking facilities are currently operating, and a state-of-the-art cracking facility commissioned at Leeton in New South Wales in 2014, facilitating the supply of kernel to the Australian market.
- Locally produced walnuts now supply total domestic demand for in-shell walnuts. There is also demand for good quality Australian walnuts in export markets, with about 70 percent of Australia's walnut production currently being exported.
- Global growth in demand for walnuts has been maintained since 2011. World consumption has been increasing at a steady rate of about 4% per year. With the greater awareness of the health benefits of including a few grams of nuts in the daily diet, this rate is expected to be at least maintained.

Competitive advantages

- Australia is a reliable exporter of counter-season walnuts to the northern hemisphere. The southern hemisphere produces just 3% of traded walnuts annually and for six months of the year Australia supplies the freshest walnuts in the world.
- Australia is free from many walnut pests and diseases affecting other countries, so chemical use is low in Australian walnut production.

Who is ANIC?

The Australian Nut Industry Council (ANIC) is a federation of the seven commercial tree nut industries in Australia. ANIC's mandate is to bring efficiencies to the industry in areas of commonality and collective action throughout the supply chain. Through ANIC, the nut industries achieve together what would be difficult or impossible individually.

Australian Pecan Growers Association Inc

www.pecangrowers.org.au

Almond Board of Australia Inc

www.australianalmonds.com.au

Australian Macadamia Society

www.australian-macadamias.org/trade

Australian Walnut Industry Association

www.walnut.net.au

Hazelnut Growers of Australia Inc

www.hazelnuts.org.au

Chestnuts Australia Inc

www.chestnutsaustralia.com.au

Pistachio Growers' Association Inc

www.pgai.com.au

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