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Improving grower-led surveillance: Case-study of the Nursery Production Industry

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29 June 2018

Report prepared for Susie Collins, Angela Spence, Sophie Peterson and Annette Healy
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Commercial-in-confidence

Citation

Loechel, B., Hobman, Elizabeth V., Collins, K., Robinson, C.J., Singh, J., Pavey, C., & Chilcott, C. (2018). Improving grower-led surveillance: Case-study of the Nursery & Garden Industry. CSIRO, Australia.

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Acknowledgments

This report forms Milestone 5 of the project*, National grower-led surveillance system: A method for developing effective grower-led surveillance systems for plant production industries in Australia*, funded by the Department of Agriculture and Water Resources. This project is part of the Australian Government's Agricultural Competitiveness White Paper, the government's plan for stronger farmers and a stronger economy.

We thank our fellow CSIRO research scientists: Aditi Mankad and Ryan McAllister who have reviewed parts of this work.

We thank John McDonald, National Biosecurity Manager, Nursery & Garden Industry Australia (NGIA), for his generous provision of time in assisting the design and implementation of the survey, reviewing the report draft, and answering our many questions about the NGIA's experience developing a biosecurity system for the nursery industry.

Executive summary

The overall aim of this collaborative project between CSIRO, Department of Agriculture and Water Resources (DAWR) and Nursery & Garden Industry Australia (NGIA) is to develop a best practice approach for establishing a grower-led surveillance system for Australia's plant industries.

As outlined in Figure 1, there are three main stages to the project. The project commenced with a review of secondary data on all 39 industry signatories to the Emergency Plant Pest Response Deed (EPPRD) (see Hobman et al. 2017, Milestone 3) to better understand the industries' (and growers') needs, motivations, drivers and barriers regarding plant health surveillance and reporting (Stage 1).

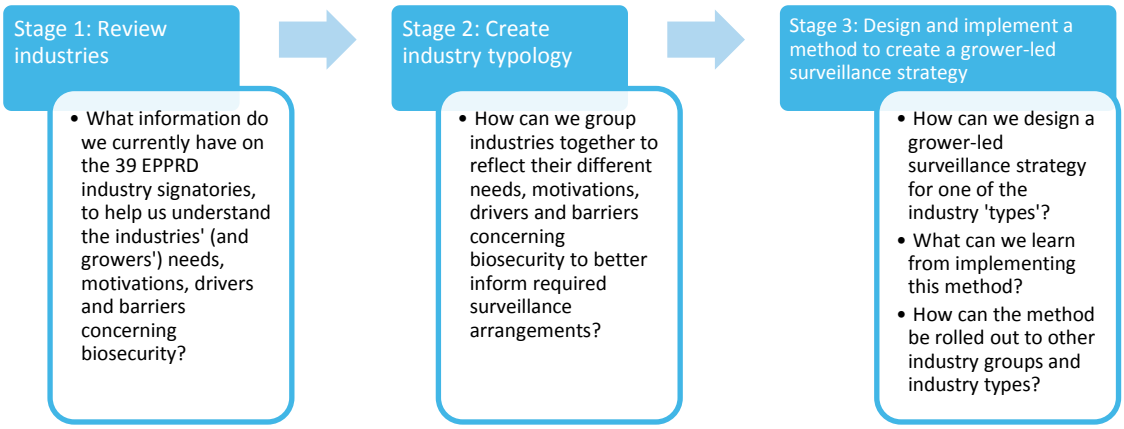


Figure 1. Stages in the project

Following a categorisation of the 39 plant industries according to their risk and capacity profiles (Collins et al., 2017, Milestone 4; Stage 2), the nursery production industry was selected to provide a case-study of the development and implementation of a biosecurity surveillance system for producers. This report presents this case-study and reflects stage 3 of the project.

Research aims

The aim of the case-study was to gain an understanding of biosecurity surveillance arrangements in the nursery and garden industry, the extent of surveillance uptake by growers, and issues that have affected uptake. The study aim was also to provide information on factors that could or have helped or hindered adoption of surveillance practices generally in the industry, and thus inform the development of a best practice approach for designing and implementing a grower-led surveillance system.

Recently, grower-led plant health surveillance has been elevated to the level of a national priority as a consequence of national and jurisdictional capability reviews (Beale et al., 2008; Brooks et al., 2015; Craik et al. 2017; VicDPI, 2008). Grower-led plant health surveillance reflects the shared-responsibility for plant biosecurity between industry, government and the community and is a useful avenue for biosecurity objectives to be integrated with agricultural production systems. The expectation is that lessons from the NGIA experience could inform other plant industries in

Australia, to assist them in developing a system that meets their own particular biosecurity surveillance needs. This "roadmap" for other industries will be detailed in the next and final Milestone 6 report.

Research methods

The case-study involved qualitative and quantitative research methods, and was undertaken in collaboration with the NGIA to ensure the study design and implementation were relevant to the industry context.

First, background information on the nursery industry was collated and combined with the results of the industry categorisation for biosecurity surveillance (showing medium risk and medium capacity) previously conducted in Milestone 4. This provided the information for the Industry Profile.

Second, semi-structured interviews were undertaken with a range of stakeholders across most jurisdictions around Australia (growers, industry representatives, government officials and technical experts; *n*=22). Prospective interviewees were selected based on their involvement in nursery production or their expertise in plant industry biosecurity surveillance more generally. These interviews provided an understanding of many of the major issues (barriers, constraints, facilitators and opportunities) perceived as important in developing and implementing an effective nursery production biosecurity surveillance system.

Third, a quantitative survey of production nursery owners/operators across Australia was undertaken (*n*=213). This survey provided an assessment of plant health surveillance practices, including motivation and barriers/challenges to engage in monitoring, record-keeping and reporting. Most survey participants reported their main plant type produced as ornamental plants (48%) or landscape stock (19%), with fewer participants mainly producing other plant types (e.g. seedling, forestry, fruit and nut tree, plug and tube stock, revegetation stock; see Table 1). Applying a typology framework (similar to that used in the industry typology of Milestone 4), differences in the risk and capacity profile across production nurseries were explored.

Table 1. Main plant type produced by survey respondent nurseries.

Main plant type produced	Number of respondents	Percentage of respondents (%)
Ornamental plants	103	48.36
Landscape stock	40	18.78
Plug and tube stock	14	6.57
Revegetation stock	14	6.57
Seeding stock	13	6.10
Fruit and nut tree stock	13	6.10
Forestry stock	5	2.35
Mine revegetation	1	0.47
Other	10	4.69
Total	213	100.00

Findings

Overall, we found that while the nursery industry has developed an extensive on-farm biosecurity program (Biosecure HACCP) that could be used to assist producers in their plant health management, including surveillance, the uptake of this program among producers is in its infancy (with only 11 BioSecure HACCP-certified production nurseries thus far). Additionally, producer and stakeholder responses suggested a number of areas of concern, as well as opportunities for improvement, as the industry seeks to achieve best practice in plant health management and surveillance. Some of the key findings include:

- Producers appear motivated to monitor their production nurseries for plant pests, although how systematic and comprehensive these efforts are was unclear. Many are experiencing significant constraints in doing so (e.g., financial, skilled labour, time) – resulting in variable crop monitoring and inspection practices. While almost all producers inspected their dispatches (because they have a strong market incentive/imperative to ensure they supply only high quality product to their customers), the inspection of imported materials and surveillance of the broader production nursery site (i.e., beyond the main nursery crops) were identified as areas for improvement.
- Record-keeping does not appear to be common practice, with many producers (especially a sub-group of around 49%) finding it burdensome, unimportant and irrelevant. Producers may record only by exception, when they identify a problem or need to apply a treatment.
- The reporting of suspicious signs of plant pests also appears to not be a first-line response. This is mainly because of the fear of being investigated and potentially quarantined – and the associated losses to one's business and reputation.
- There is a large segment of producers (~43%) who believe they are undertaking adequate plant health monitoring and recording, but who remain disinterested in attaining NIASA accreditation or BioSecure HACCP certification.
- Recent changes in the way nursery industry levies are allocated, which have reduced funding to support producers become accredited under the Nursery Industry Accreditation Scheme, Australia (NIASA), the industry best practice management scheme, have apparently seen a sharp decline in accreditation rates. This is of concern because NIASA not only raises nursery practice standards generally, including those for biosecurity surveillance, but is also a prerequisite for BioSecure HACCP certification.
- Many producers (~45%) knew nothing or very little about BioSecure HACCP, and of those who were not currently certified, 67% reported that they do not ever wish to gain this certification.
- When asked about tools available to assist producers improve their surveillance practices, the vast majority of indicated that they never or rarely use these tools (e.g. biosecurity manuals and websites, pest identification websites and phone apps).
- Across the board, producers perceive the risk of an exotic pest incursion as low (~8% likely) in their nursery, and this contrasts markedly with their perception of pest incursion across the wider industry (~48% likely).

- The perception of 'shared responsibility' is quite negative, with stakeholders perceiving that responsibility has simply been shifted (to industry) rather than shared, and a general lack of knowledge, understanding and interest in the concerns of nursery producers. The reduction in extension officers (who previously supported producers) was seen as a great loss. The partnerships between producers, industry and government were spoken of in negative terms – in particular, government was viewed as assuming a distant, regulatory, punitive role.

Possible actions

On the basis of our interview and survey findings, a number of possible actions are suggested. Responsibility for these actions is not prescribed here however, as some actions may be relevant to industry and others more appropriate for government (jurisdictional or national) to implement or support. At the outset it is also worth noting the value of approaching endemic and High Priority Pest/Emergency Plant Pest (HPP/EPP) surveillance as part of the one system and set of nursery procedures. Strong endemic pest management procedures will not only manage all of the usual (endemic) pest, disease and weed issues in the nursery that producers are most concerned about, but will also provide higher confidence in early HPP/EPP detection. Thus, a focus on plant pest management as one system, rather than separate approaches to endemic and HPP/EPP surveillance, would be expected to provide a stronger overall biosecurity system.

Possible actions are summarised below (see Section 5 for more detail):

- Increase the availability, accessibility and affordability (e.g., subsidy) of on-the-ground personnel, who are resourced to visit production nurseries, skilled in plant health surveillance (including HPP/EPP identification), and who can promote and assist with the adoption of these practices among producers.
- Build the capacity (i.e. knowledge, skills, resources) of producers by embedding plant health surveillance modules (including practical training on HPPs/EPPs, the process of reporting, quarantine procedures and compensation schemes) into existing nursery training programs and practical workshops.
- Consider strategies (e.g., financial and technical support – industry development officers) to promote and increase the uptake of NIASA accreditation and BioSecure HACCP certification.
- Promote:
    - the necessity of implementing a structured crop monitoring procedure (regular, systematic, comprehensive) that informs pest management decision making
    - the importance of inspecting newly-imported plants and plant material as a preventative measure
    - the value of record-keeping in terms of better data for improved business decision-making.
- Consider strategies to improve and utilise records from the earliest stages of production through to and including the point of dispatch.
- Consider strategies to promote and increase the uptake and usage of pest management tools and information resources already available to producers (e.g., Pest ID Tool, www.nurseryproductionfms.com.au). This also may require a systematic evaluation and redesign of the tools and resources with users' needs and abilities in mind.

- More broadly, consider the 'keep it simple', easy and compatible principles when designing tools and resources – the less obstacles and difficulties that a producer encounters, the higher the prospects of uptake and usage.
    - These efforts may go some way to addressing producers' requests for:
        - real-time information/alerts on pests of concern for the industry so that they know what to look out for
        - easier-to-use, flexible and efficient tools for pest identification and recording
        - information presented with visual pictures of pests and diseases so that producers know exactly what they are looking for when scouting for pests
- Better design of communications and engagement with producers around emergency response by the relevant authority(s), including about quarantine procedures, to assist continuous improvement of the system, minimise the fear of the consequences of reporting suspicious signs of a HPP/EPP, and increase awareness of quarantine as a process that is ultimately beneficial for production nursery businesses.
- Consider articulating a value proposition and providing additional and/or outreach assistance to smaller, lower-production value, and remote production nurseries who may be particularly resource-constrained.
- Consider strategies to address the unregulated segments of the market (e.g., formal registration, licensing).
- Consider how best to frame messages when communicating with producers, so that it accords with their personal interests, is relevant to them and gains their attention.
- Consider implementing a communication and engagement plan to develop genuine partnerships among producers, industry and government stakeholders (see Section 6 for further detail).
- Government to consider support for industry biosecurity programs, as well as assistance to enable the national biosecurity system to transition into the new shared responsibility paradigm where industry takes a greater responsibility.

1 Introduction

In order to understand how to develop a grower-led biosecurity surveillance system that is effective for any particular plant industry, it can be valuable to understand the approach and experience of one particular industry that has sought to design and implement such a system. The lessons learned can be helpful to other industries and to government bodies seeking to support their efforts.

The nursery production industry was selected as a case-study for this research partly because it has, over recent years, designed and implemented a best practice biosecurity surveillance system, and partly because the NGIA showed an interest in and willingness to assist the research project.

This report provides an overview of the nursery production industry context (Section 2), including a brief industry profile and outline of the diversity of types of business operations within the industry. This is followed by a description of the biosecurity context of the industry, including a description of the systems that have been developed and promoted to ensure best management practice in the industry. Specific details are provided on the systems and practices used for biosecurity surveillance and a description of points within business operations and associated systems where surveillance is typically conducted. The section concludes with a detailed description of the nursery production industry categorisation within the plant industry biosecurity risk and capacity typology produced in the previous Milestone 4 report.

The next two sections describe the design, conduct and main findings of, first (Section 3), the qualitative research interviews with stakeholders (producers, industry association representatives, government officials and technical experts) and second (Section 4), the quantitative survey of producers. The findings in both sections provide an overview of responses in relation to:

- various aspects and components of the industry biosecurity surveillance system, including critical points for monitoring, recording and reporting
- key challenges and barriers to producers adopting recommended systems and practices
- factors important for improving producer capacity to implement systems and practices, including their motivation to do so

The survey analysis also enabled the development of a quantitative typology of producers, based on risk and capacity profiles, similar to the typology of plant industries provided in the previous Milestone 4 report.

Section 5 provides a series of possible actions for improving industry biosecurity surveillance practices, including addressing system impediments and building producer capacity.

Finally, section 6 provides a plan for communication and engagement with stakeholders (producers, industry and government) to help achieve greater adoption of grower-led biosecurity surveillance strategies and practices.

2 The nursery production industry

2.1 Industry profile

Australia's production nursery industry is one of the largest and most diverse plant industries in Australia. The industry produces in excess of 10,000 different plant species and supplies to a broad array of end users, including the ornamental market, vegetable growers, fruit and nut orchardists, plantation timber, landscapers, re-vegetation and rehabilitation sectors (PHA 2017). Production is diverse, being either intensive or extensive, generating product ranging from plugs and seedlings to advanced tree stock and in-ground plants. The reported size of the industry varies somewhat, ranging from 2,000 nursery production businesses (HIAL 2016) to over 1,000 growers, employing approximately 45,000 people spread over more than 20,000 small to medium sized production and retail businesses (PHA 2013).

The production nursery industry is located in all states and territories of Australia, with the majority of production occurring along the eastern seaboard. Major growing regions include the greater Melbourne region of Victoria, the Northern Rivers and Central Coast regions of New South Wales, and the Border Rivers, Northern and South-East regions of Queensland. Production occurs all year round, with peaks arising during key crop planting periods (e.g. specific vegetable crops) and the spring season for ornamental retail (PHA 2017).

In 2016, the value of production for the production nursery industry was $1.17 billion, with around 83% being attributed to the eastern states (see Figure 2; HIAL 2017). International trade for the year ending in June 2016, saw the industry export roughly $5.7 million worth of fresh nursery products (equivalent to less than 1% of the value of local production), while it imported around $40.4 million worth of fresh product (equivalent to 3.5% of the value of local production) (HIAL 2017). Both fresh exports and imports increased across the five year period of 2011/12 to 2015/16, growing some 54% and 47%, respectively (HIAL 2017). In 2015/16, the industry's largest export market was France, followed by New Zealand, China, Singapore, the Netherlands and others (see Figure 3; HIAL 2017). Exports include fresh nursery product (green stock) of both Australian native plant species and exotics, chiefly as tube stock, plugs, or tissue culture, as well as technology and IP transfer (NGIA 2012, Morris 2000). While the export focus of the industry is currently small, the uniqueness and richness of Australian flora offers ample opportunity for future international export growth (Kachenko and McDonald 2012). The development and growth of this market it is likely to require further research into consumer demand, plant suitability, and economic viability, as well as greater producer support and education to meet all the biosecurity and market access requirements for the various international markets.

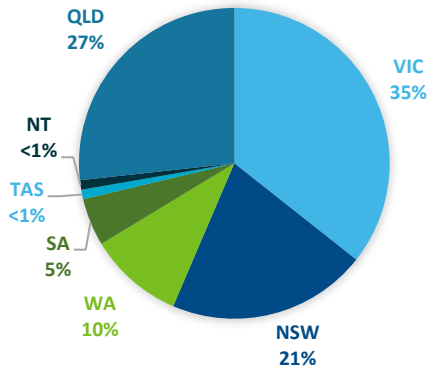


Figure 2. 2015/16 Value of Production by State (HIAL 2017).

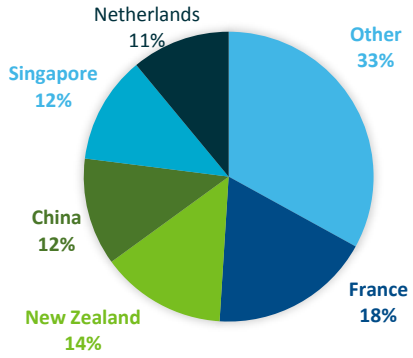


Figure 3. 2015/16 Export value of fresh nursery products by Country (HIAL 2017).

Nursery and Garden Industry Australia Limited (NGIA) is the peak industry body representing commercial growers, retailers and allied traders involved in nursery plant production in Australia. As part of their duties, NGIA represents the biosecurity interests of the industry, and as such they are members of Plant Health Australia and are signatories to the Emergency Plant Pest Response Deed. The industry body has responsibilities towards national and grower level biosecurity planning and implementation, funding and supporting biosecurity initiatives, interacting with federal and state governments on trade issues, and participating in national committees and emergency response efforts.

2.2 Biosecurity in the production nursery industry

Australia averages around 40 emergency plant pest[1] incursions each year, with the nursery industry often affected at some point during the incursion (NGIA 2016). This reflects the broad and diverse base of the production nursery industry, in terms of geography, plant species and end users, making it a key industry when considering plant biosecurity. Significant movement of fresh product occurs both intra- and inter-state, through agricultural and horticultural regions, and cities

[1] The definition of a plant pest used in this document follows that used in the Emergency Plant Pest Response Deed (EPPRD) (PHA 2018): any species, biotype or strain of invertebrate pest or pathogen injurious to Plant Health, Unprocessed Plant Products, Bees or Fungi provided that it is discrete, identifiable and genetically stable, but excludes Genetically Modified Organisms (GMOs).

and towns across Australia. Such movements have the potential to transport pests into areas otherwise free from these threats and may adversely impact not only production nurseries but also other plant industries, agricultural cropping, pastures, and the general environment (NGIA 2016).

The challenge of improving biosecurity standards in the production nursery industry is addressed using three key tools: (i) the Industry Biosecurity Plan for the Nursery Industry Version 3 (2013), (ii) the Biosecurity Manual for the Nursery Production Industry Version 1 (2010) and (iii) the industry developed biosecurity program – BioSecure HACCP. The Industry Biosecurity Plan provides a mechanism for the industry, government and other stakeholders to assess current biosecurity practices and future biosecurity needs, and identifies procedures to minimise the occurrence and/or impact of a pest incursion (PHA 2018). The Biosecurity Manual for the industry is directed towards growers, to help implement on-farm biosecurity, containing information on identifying High Priority Pests (HPPs), crop management, the management of people, vehicles and equipment, and recording methods for pest surveillance and visitors movements (PHA 2018). BioSecure HACCP is a biosecurity program developed by the NGIA to integrate with its best practice management program, the Nursery Production Farm Management System (NGIA 2018).

The NGIA has developed the Nursery Production Farm Management System, an on-farm system for growers that encompasses best management practice, environmental and natural resource management, and biosecurity (NGIA 2018). The system consists of three key programs (i) Nursery Industry Accreditation Scheme, Australia (NIASA), (ii) EcoHort, and (iii) BioSecure HACCP. NIASA is the national nursery industry best management practice program covering areas of crop hygiene, crop management, water management and general site management. The second program, EcoHort, is the industry's environmental management system (EMS) designed to assist growers to address and demonstrate sound environmental stewardship and natural resource management. While the third, BioSecure HACCP, is the national on-farm biosecurity program (NGIA 2018).

2.2.1 BioSecure HACCP

BioSecure HACCP is the industry specific biosecurity program designed to assist production nursery businesses with current and future pest, disease and weed management. It is a set of protocols and procedures that enable a business to manage biosecurity risks by establishing an effective internal quarantine and surveillance system for both imported and exported plant material (NGIA 2016).

BioSecure HACCP was developed by the NGIA in partnership with Hort Innovation (formerly Horticulture Australia Limited). The system underwent a pilot trial during 2013–2014 (SDQMA 2014a), after which it was approved for a national three year trial beginning in 2015 (SDQMA 2014b). It is based on the Hazard Analysis Critical Control Point (HACCP) risk management tool designed to identify and control/manage, prevent and/or reduce hazards within a production system (NGIA 2016). BioSecure HACCP provides growers with the decision making tools for supporting on-farm biosecurity, guiding them in identifying the relevant risks and the implementation of controls at critical points within the production system to control those risks. While any production nursery business can adopt the system, to operate as a certified BioSecure HACCP business, NIASA accreditation must also be achieved.

BioSecure HACCP certification has also been designed to gain improved market access. A certified business that complies with specific market access conditions outlined by the receiving jurisdictions (via Entry Condition Compliance Procedures (ECCPs)) has the ability of self-certification for intra- and inter-state movement of nursery stock (NGIA 2016). BioSecure HACCP is at the time of writing (June 2018) a legal market access instrument for all Australian states (QLD, NSW, VIC, TAS, SA and WA – but not yet in the territories), allowing BioSecure HACCP-certified growers to validate meeting their market access obligations through self-certification.

Finally, BioSecure HACCP contains an integrated reporting and auditing (Audit Management System (AMS)) system that ensures compliance to the system. The BioSecure HACCP guidelines lists identified hazards, control points and the procedures to follow to mitigate these risks, as well as the records that are required at the farm level. It also provides templates for recording actions and strategies applied for biosecurity risk management, all of which is required to be uploaded to the electronic data storage audit management system.

It is important to note that BioSecure HACCP is a relatively new program in the production nursery industry, having recently completed a three year national trial, and as such its current level of use across the grower base is limited.

2.2.2 Production nursery operations and biosecurity surveillance and reporting

Biosecurity surveillance and reporting by growers is crucial to the industry. Especially if the industry wishes to achieve optimal pest management decisions, to provide assurance that biosecurity obligations have be addressed, to facilitate market access, and to detect high risk exotic pests before they cause widespread impacts on the nursery industry and others (Telford and Potts 2014). While the production nursery industry is diverse, generally the point of import, the early stages of plant growth, and at dispatch (or export) are the critical stages for effective biosecurity surveillance.

Visual observation is the most important inspection, monitoring and surveillance method that should be used as a minimum and, ideally, in combination with other detection methods, such as trapping or testing (Telford and Potts 2014). Visual observations include an initial whole crop scanning, narrowing down to an appropriate rate of random sampling of individual plants, then further selection to parts of individual plants such as flowers, leaves, stems and roots. Visual observations, testing and sub-sampling also occurs for other products imported or used on site, such as growing media, containers, water, fertiliser. The entire production site and its close surroundings are also an important area that requires surveillance. Monitoring frequency is generally governed by the life cycle of the target pest and practicality. Too frequent (daily) is too costly while at a rate that doesn't match the pest cycle can mean a long lag time before discovery, resulting in significant crop damage. All inspection, monitoring and surveillance methods should be approached in a structured and planned way to increase the effectiveness of the system.

The diversity of the production nursery industry means that surveillance and reporting requirements can vary widely. Table 2 provides some examples of some generic nursery operations and the associated surveillance and data recording that may occur (sourced from the BioSecure HACCP Guidelines, NGIA 2016).

Table 2. Examples of nursery operations and their associated biosecurity surveillance and recording (Source: NGIA 2016).

Operation	Hazard	Control measure	Monitor	Record
Sourcing growing media	Contaminations such as pathogens and known quarantine pests	• Source from approved suppliers • Sample and test media	At receival or before use of any growing media • Check approved supplier status • Sample, inspect, test each batch	• Suppliers name • Materials imports inspection record • Growing media specification records • Corrective action (if required)
Source / store propagation / planting containers	Contaminations such as pathogens and known quarantine pests	• Source from approved suppliers • Clean and treat containers • Store disinfected containers above ground level	At receival or before use of any container • Check approved supplier status • Check treatment of containers	• Suppliers name • Materials imports inspection record • Sterilisation / Pasteurisation procedure • Weed monitoring record • Pesticide application record • Corrective action (if required)
Source / store propagation stock	Plant and propagules contaminated with pathogens and known quarantine pests	• Source from approved suppliers • Source from motherstock free from plant pathogens and other pests • Hold and monitor in a designated quarantine area • Treat with registered pesticides if required	At receival or before use of any stock • Check approved supplier status • Sample, inspect, test each batch • Monitor stock while in designated quarantine area	• Suppliers name • Materials imports inspection record • Imported plant pesticide treatment record • Inspection record • Quarantine record • Pesticide application record • Corrective action (if required)
Planting – seeds, plugs, tube stock etc.	Plant stock and propagules contaminated with pathogens, and known quarantine pests	• Regularly clean and disinfest potting facilities and equipment • Staff to maintain good hygiene practices	Daily when potting • Conduct inspection of plant stock and planting facilities	• Suppliers name • Cleaning and Sanitation procedure and record of activity • Corrective action (if required)
Source / store growing additives	Additives contaminated with pathogens and known quarantine pests	• Source from approved suppliers • Regularly clean and disinfest storage facilities and equipment • Exclude runoff water, soil and	At receival or before use of any stock • Check approved supplier status Daily when potting • Sample, inspect, test each batch	• Suppliers name • Materials imports inspection record • Corrective action (if required)

Operation	Hazard	Control measure	Monitor	Record
		other materials or items that may cause contamination		
Irrigation	Stock contaminated with pathogens	• Check and, if required, treat, water sourced and stored from areas that could cause contamination by plant pathogens	Monthly • Conduct inspection or test of water source	• Water disinfestation record (weekly) • Corrective action (if required)
Pest, disease and weed management	Stock destroyed or damaged by pests (disease, insects or animals and weeds)	• Implement a pest management program • Select and maintain appropriate pesticide application equipment • Train staff responsible for implementation of the pest management plan	Weekly or more often as required • Check stock for signs of insects pests and beneficials, disease and weeds Annually or as required • Check and calibrate pesticide application equipment	• Crop monitoring record • Weed monitoring record • Trap monitoring record • Site inspection record • Biological organism release record • Pesticide application record • Calibration schedule • Visitor record • Vehicle inspection record • Pest monitoring procedure and equipment in place • Staff training record • Corrective action (if required)
Transport to dispatch area	Plant stock contaminated with pathogens and/or other pests	• Regularly clean and disinfest transport equipment and staff • Cover pathways and roads adjacent to beds and benches with materials to reduce contamination with soil (dust) and water	Ongoing • Inspect transport, equipment and pathways	• Cleaning and Sanitation procedure and record of activity • Corrective action (if required)
Detailing and labelling	Stock contaminated with pathogens and/or other pests	• Regularly clean and disinfest equipment and staff	Before use • Inspect equipment used in detailing and labelling	• Cleaning and Sanitation procedure and record of activity • Approved supplier • Materials imports inspection record

Operation	Hazard	Control measure	Monitor	Record
				• Corrective action (if required)
Packaging	Stock contaminated with pathogens and/or other pests	• Regularly clean and disinfest storage areas and packaging	Before use • Inspect packaging and packaging equipment	• Cleaning and Sanitation procedure and record of activity • Approved supplier • Materials imports inspection record • Corrective action (if required)
Dispatch	Quarantine requirements of importing authority not met (e.g. contamination or infestation with quarantine pest or disease) Incorrect or incomplete documentation (phytosanitary or plant health certificate)	• Determine importing authorities quarantine requirements for product(s) to be dispatched • Inspect plants before dispatch for signs of quarantine pests and diseases • Treat product for quarantinable pests and diseases as required • Prepare required documentation • If required, hold plants in quarantine area and monitor for signs of pests and disease before dispatch	Before dispatch • Sample, inspect and/or test all out going product in accordance with the quarantine requirements of the importing authority • Check all documentation is correct and complete	• Materials dispatch inspection record • Plant inspection procedures and facilities • Copies of relevant quarantine or Interstate Certification Assurance documents as required • Crop monitoring record (per consignment at dispatch) • Authorised inspector record • Weed monitoring record (per consignment at dispatch) • Pesticide application record (complete per treatment) • Corrective action (if required)

2.3 Industry typology

The desktop review and subsequent industry categorisation (Hobman et al. 2017, Deliverable 3; Collins et al. 2017, Deliverable 4), created a 'typology' that categorised the 39 reviewed plant industries based on a qualitative assessment of two key dimensions that affect the drivers underpinning grower-led biosecurity surveillance – (i) industry capacity to engage in biosecurity surveillance and (ii) the level of exposure to biosecurity risk.

The first dimension used by the 'typology' represents the industry's capacity to carry out plant health surveillance and reporting, and was measured by a desktop analysis of activity in regard to industry biosecurity plans, programs and personnel. A summary of the results for the production nursery industry are presented in Table 3. The production nursery industry currently has an

Industry Biosecurity Plan (IBP) published in 2013 — *Industry Biosecurity Plan for the Nursery Industry Version 3*. An Industry Biosecurity Plan provides a means for industry, government and other relevant stakeholders to assess current biosecurity practices and future biosecurity needs of an industry (PHA, 2017), and as such was used as an indicator of the biosecurity preparedness of the industry. Industry Biosecurity Plans are intended to be reviewed every 3–4 years, thus it was considered that Industry Biosecurity Plans published in or before 2013, like that of the production nursery industry, were older than the recommended review period, and thus reflected a reduced level of capacity. The second indicator considered was the presence and publication age of a biosecurity manual. These documents are more specifically aimed at producers/growers (PHA, 2017), and contain information to help implement on-farm biosecurity. The manual for the production nursery industry was published in 2010, and again as it was published in or before 2013, was considered to reflect a lower level of potential grower capacity as it may need updating. The final two capacity indicators were the existence of an industry biosecurity program and the presence of some form of industry biosecurity extension personnel. The presence of either was considered to demonstrate an increased level of capacity of both the industry and its growers to undertake surveillance activities, and the production nursery industry had both of these. The combined result for the capacity indicators gave the production nursery industry a medium capacity score.

Table 3. Capacity variable - data indicators with their values and scores, and the total score for the production nursery industry (Sources: PHA 2013, PHA 2010, NGIA 2018).

Industry	Type	Industry Bios. Plan		Bios. Manual		Nat. Bios. Program		Bios. Extension		Total Capacity Score
		Year	Score	Year	Score	Yes/No	Score	Yes/No	Score	
Nursery & Garden	Nursery	2013	2	2010	1	Yes	1	Yes	1	5

The second dimension used by the 'typology' represents the potential risk of a pest incursion and associated economic (and other) loss that potentially faces the industry, and again was measured by a desktop analysis. The indicators used to assess potential risk included (i) the value of production, to provide a reference of the size of the industry and potential economic loss if an incursion occurred; (ii) the value of exports, (iii) imports of fresh produce (expressed as a percentage of fresh local production) (iv) the export growth potential; and (v) the number of High Priority Pests (HPPs), as identified by the Industry Biosecurity Plan. A summary of the results for the production nursery industry are presented in Table 4. In the year ending June 2016, the production nursery industry reported a value of production of $1.17 billion, making it one of the six highest industry earners of the 39 plant industries reviewed, and as such was considered to have a high associated risk of economic losses if an incursion occurred. However, exports by the industry made up less than 1% of its fresh production, indicating a low risk to export trade. Imports of fresh produce, while growing over the five year period from 2011/12 to 2015/16, were still less than 25% of fresh local production, and as such was categorised as a low risk. The export growth potential of the industry was assessed based on the number of countries that there are current exports to and where a tariff reduction is assigned to occur within the next five years (the greater the number of countries where market access will change, the greater the potential economic loss to industry if a biosecurity incursion occurs). The nursery industry was found to have no export growth through future tariff reductions, resulting in a low risk score. The final

indicator was the number of HPPs identified in the Industry Biosecurity Plan, with a greater number of HPPs resulting in a higher level of risk that the industry may experience a biosecurity incursion. Eighteen HPPs were identified, resulting in a mid-range score. The combined result for the risk indicators gave the production nursery industry a medium risk score.

Table 4. Risk variable - data indicators with their values and scores, and the total score for the production nursery industry (Sources: HAIL 2017, PHA 2010).

Industry	Type	Value of Production		Exports		Imports		Export Growth		HPPs		Total Risk Score
		$M	Score	%	Score	%	Score	#	Score	#	Score	
Nursery & Garden	Nursery	$1,171	5	0.90%	1	3%	1	0	0	17	3	10

The collective results of the capacity and risk dimensions placed the production nursery industry within a “medium risk and medium capacity” type (Figure 4). This type can be considered to have an average capability and motivation to develop grower-led surveillance and reporting, which could be further leveraged with some additional outside support.

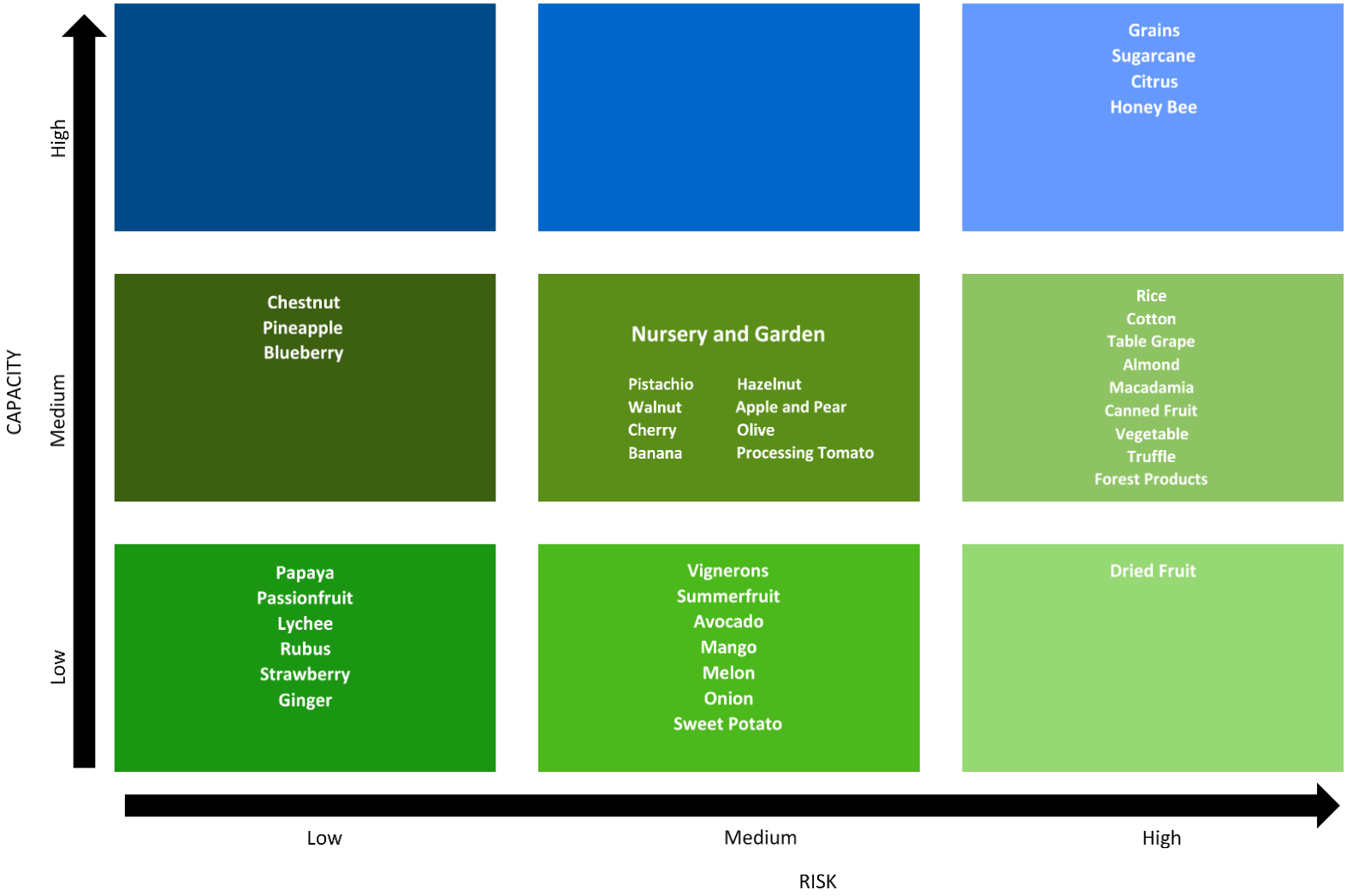


Figure 4. A typology that categorised the Production Nursery Industry (and 38 other plant industries) based on the biosecurity surveillance capacity and exposure to risk (Collins et al 2018).

3 Interviews with industry stakeholders

3.1 Introduction

Interviews were conducted with a range of nursery production industry stakeholders to gain a deeper understanding of the industry's particular characteristics and situation with regards to developing a biosecurity surveillance system. A range of views on the industry's approach to developing a surveillance system for growers was sought to better understand how it applied across various production systems and jurisdictions. Interviews were conducted with not just growers, but office holders within the grower representative bodies (Nursery and Garden Industry) in all jurisdictions where they were active, and with government representatives in most jurisdictions. The aim of the interviews was to understand more fully:

1. Perspectives on the approach the NGIA is taking to improve grower biosecurity management and surveillance (including monitoring, record-keeping and reporting), together with the various opportunities and constraints associated with this approach.
2. Key *challenges and barriers* growers face in applying the system and in undertaking surveillance of plant pests in general and identification of HPPs/EPPs in particular.
3. Identification of *high risk segments* of the nursery production industry and *critical points* within nursery production systems for the introduction, control and surveillance of HPPs/EPPs.
4. Factors that impact on and could potentially improve *grower capacity* to engage in surveillance, including those related to grower *motivation*, and to different segments of the industry.
5. Factors that could *facilitate better partnerships* between the various players important to ensuring a robust surveillance system in the industry.
6. Strategies and initiatives by which producers, industry and government agencies could act to improve surveillance in the industry.

While each of the first five aspects listed above will be addressed in separate sections below, the sixth aspect, suggestions for improvement, will be provided for each aspect as a concluding summary within each of the five sections.

3.2 Method

A total of 21 interviews were conducted (involving 22 individual interviewees), including a range of nursery production growers, Nursery and Garden Industry representatives, and government biosecurity related officers, covering most jurisdictions (refer to Table 5 for a detailed breakdown).

Table 5. Interview participants by stakeholder type and jurisdiction

STAKEHOLDER TYPE	NATIONAL	QLD	NSW/ACT	VIC	TAS	SA	WA	NT	TOTAL
Industry (NGI association)	1	3	1	1	1	1	2	0	10
Government	0	2	1	2	0	1	0	3	9
Grower	N/A	2	1	1	1	1	2	0	8
Total	1	6	3	4	2	3	4	3	22

Note: Totals may not tally exactly with row or column figures due to some NGI representatives also being growers

3.2.1 Participant recruitment

A list of potential interviewees was initially developed from suggested contacts provided by DAWR and the NGIA in initial briefings on the project, as well as from a desktop search of potentially relevant individuals by scanning the NGIA and jurisdictional websites. Follow-up contact with some of resulting individuals yielded suggestions for further contacts (i.e. a process of 'snowball sampling'). Potential interviewees were contacted by email and invited to participate in an interview and were provided with a Project Information Sheet and Consent Form (Appendix A).

3.2.2 Interview structure and conduct

Interviews were conducted over the period December 2017 to March 2018. Interviews were semi-structured in that a list of questions was used to guide the interviews (Appendix B). Further questions were asked and/or the order of questions was changed where appropriate to exploit opportunities to better understand an issue or for efficiency purposes. Interviews took 55 minutes on average, with 17 conducted over the telephone and 4 face-to-face (Brisbane-based interviews). All but one interview was audio-recorded and later transcribed, with one interviewee preferring that audio-recording not occur, so only written notes were made.

3.2.3 Data analysis

The transcriptions and written notes (in the case of the non-audio-recorded interview) were entered into Nvivo qualitative analysis software. Interview transcripts were coded for main themes for each of the interview questions, with the main theme points then summarised and organized accordingly as they related to the six categories of research questions listed above.

3.3 Main findings

3.3.1 Perspectives on the current approach to a biosecurity surveillance system

Responses in this section encapsulate two main themes or response sets, one relating specifically to the NGIA approach to improving on-farm biosecurity, and the second referring more to the plant biosecurity system in general, as it related to either national or jurisdictional (state and territory) aspects.

The current approach to developing a nursery production industry biosecurity system

General satisfaction was expressed with the industry's overall approach to improving nursery practices, including biosecurity management, namely adoption of the Nursery Production Farm Management System (FMS). The FMS includes the Nursery Industry Accreditation Scheme of Australia (NIASA), EcoHort and BioSecure HACCP certification, with EcoHort of lesser importance to biosecurity surveillance.

NIASA was viewed favourably in terms of lifting the general standard of nursery practice in the industry, including of biosecurity management. While it entails only a fairly basic level of requirement for biosecurity surveillance, it was credited with improving standards across the industry.

> *…the NIASA Program across Australia, which is Nursery Industry Accreditation Scheme, has been very successful I believe in raising the standard and levels of nurseries certainly in SA, WA and Tasmania where I've seen it directly. (NGI representative)*

NIASA was viewed as not overly onerous and having reasonable adoption rates by producers, noting that of the reported 600 registered NGI members nationally, around 230 were currently NIASA-accredited (NGIA, pers. comm.).

BioSecure HACCP was seen as providing a much higher standard of biosecurity management. As noted earlier, NIASA accreditation is required as a prerequisite for BioSecure HACCP certification.

BioSecure HACCP was developed as a response to the gaps in biosecurity management (pest, disease and weed management) identified in the other parts of the FMS (namely NIASA). The few respondents demonstrating some knowledge of the process of developing the BioSecure HACCP standards, reported satisfaction with the process.

A concern expressed with respect to BioSecure HACCP by nursery industry representatives was insufficient uptake, noting that, of the 230 NIASA-accredited members, only around 11 reportedly had BioSecure HACCP certification (NGIA, pers. comm.). The low level of uptake was mainly attributed by interviewees to:

- Rigorous monitoring and recording requirements for BioSecure HACCP, with strict audit standards; the recording requirements in particular were perceived as onerous,
- The perception that BioSecure HACCP certification was mainly relevant or of value to businesses that seek to export their product interstate (as it reduces the cost of meeting plant health charges and Interstate Certification Assurance (ICA) requirements), and

- Insufficient uptake of NIASA, the nursery best management practice accreditation scheme, which is a prerequisite for BioSecure HACCP certification.

Of great concern to industry respondents was the recent sharp decline in NIASA-accredited members continuing their accreditation (around 50% decline in the past year reported in some jurisdictions). This decline was attributed to recent changes to the administration and application of the industry 'pot levy' funding pool (a statutory RD&E levy managed by Hort Innovation Pty Ltd), notably the defunding of Industry Development Officer positions, who provided:

- producer engagement and knowledge support required for educating and assisting growers to become and remain NIASA-accredited, and
- auditing of NIASA accredited businesses, the costs of which were covered by the levy. Loss of Industry Development Officers means that to maintain their NIASA accreditation, producers have to pay separately for NIASA auditing, imposing an additional cost.

A limitation to the value of these accreditation schemes to growers was seen in reported indifference shown by some major customers, even large companies and government bodies, to whether the nursery businesses they were supplied by were accredited or not. The lack of a requirement for accreditation in the supply chains reduced the incentive for growers.

> *The problem is most of our customers, whether it's [major retail nursery chain] or commercial landscaping or Government, have a very low recognition of just NIASA which is the basic accreditation that has been around 20 years, so some landscapers or local Governments will request that all businesses are NIASA, but certainly not all of them… (Grower, WA)*

A strong concern of industry participants, particularly representatives of state-based NGI bodies, is the large number of producers who are not members of an NGI body. These producers were seen as at higher risk of poor surveillance practices because they were less likely to receive communications about best practice and related capacity building initiatives from the NGIA or their state NGI body or from government agencies. There was also perceived to be limited capacity for authorities to access data to enable, for example, traceability of plant product, or even knowledge of these operations, for relevant authorities to have some degree of oversight in the case of an outbreak.

Of even greater concern was an 'unregulated' subset of this group, plant producers who were not even registered businesses, commonly referred to as 'backyarders', but who may produce large (commercial) quantities of plants for sale at local markets. Related concerns were expressed about illegal importation of plant products from overseas or interstate to be sold in Australia via online platforms or again, at local markets.

A broader issue of concern mentioned by industry participants was declining membership of State-based NGI bodies, attributed partly to concentration in the industry, with larger nurseries supplanting smaller ones, resulting in fewer independent nursery businesses in existence. This was reported to be reducing revenues for these industry bodies, limiting their ability to provide biosecurity-related and other technical support to growers.

Suggestions for improvement

Interviewees provided some suggestions for how these various issues could be addressed. At a broader level, in the context of low and declining membership of state-based NGI bodies, reference was made to the current Industry Structure Review in process. It was hoped that this review process would strengthen the associations, so that greater support could be provided to producers to improve their surveillance practices.

Relatedly, many industry respondents saw the need for some form of registration scheme for all nursery producers. Such a scheme, it was thought, would enable visibility of the entire industry, for engagement by authorities to assist surveillance capacity building, data collection, auditability, traceability of plant material, and other forms of oversight. In addition, it was hoped that it could provide an additional revenue stream to support industry initiatives to improve grower practices.

With respect to declining NIASA accreditation rates, interviewees mentioned the need to restore funding that subsidised the cost to growers, as the recent increase in this cost was seen as the main cause for the decline in growers maintaining their accreditation. Relatedly, resuming funding for Industry Development Officers, who provide the technical support to assist growers in gaining NIASA accreditation, was also seen as crucial.

With respect to the low uptake of BioSecure HACCP, the main issues related to perceptions of the rigorous requirements for monitoring and record-keeping. A number of interviewees suggested the need for a degree of flexibility for producers to negotiate or tailor the requirements to ensure relevance and feasibility of the practices for the business:

> *The clever thing is to actually do that [adapt the program to the business] – it's very easy to just follow some guidelines and do the doings, to tick the boxes – and so it's been a conscious effort on our part and it's needed a little bit of careful analysis…it's been good for us in that it's forced us to actually go back and say, well, this is what we were doing; this is what the BioSecure requires, now, OK, let's go back and look and see what we were doing was sensible or not and in some cases we modified what we've been doing, having challenged ourselves. In other instances, we've gone back to BioSecurity [HACCP] and said, hey, guys, look this isn't really making sense, how can we make sense of it. So, it's a negotiation process. They say "we require", we say "we need" and you meet in the middle with a sensible outcome. (Grower, VIC)*

It was thought better to have a more user-friendly version of BioSecure HACCP that is widely adopted than an absolutely correct version that very few are prepared to adopt.

Further, some interviewees suggested that BioSecure HACCP could be promoted on the basis of the broad range of benefits it was seen as providing to nursery businesses. The purported benefits included:

- improved surveillance, which enables potentially earlier detection and control of pest problems and hence:
    - improved production characteristics (yield, quality)
    - avoided costs that would have otherwise occurred from the impact of pests on the business (yield/quality loss, chemical and labour costs, reputational loss)
- improved reputation as a 'clean', well managed, reputable business and therefore a higher likelihood of gaining premium markets/ customers

- better records for data analysis and hence, capacity to gain greater knowledge about the business to achieve efficiencies

Finally, with regards to the effect that major customers' requirements for accreditation can have on producer incentive to gain this accreditation, it was suggested that some initiative or scheme be put in place to ensure all major customers require at least NIASA accreditation from their suppliers.

Concerns with the broader plant biosecurity system that affects surveillance

At the national level

A couple of national level issues were reported as having a bearing on nursery business decision-making about biosecurity surveillance. Both related to the consequences of quarantine and were therefore seen as affecting the willingness of growers to report an unusual sign or suspected HPP/EPP. However, it was also evident from interviews that there was a wide variability of knowledge, which was typically quite limited, on the terminology, structures and processes involved with emergency plant pest response decision-making.

Response decision-making process

The amount of time taken for a decision for a response under the Emergency Plant Pest Response Deed can reportedly run into months. This decision-making process can involve numerous industry and government representatives and pest experts to determine whether the pest meets the EPP definition and the technical feasibility and/or benefit/cost of eradication. The process was considered by many interviewees as highly complex and opaque with a high degree of uncertainty as to the eventual outcome. Further, it was reported that even after a determination is made on meeting the EPP definition or the technical feasibility and/or benefit/cost – to eradicate, contain or manage the pest – the production nursery may have to remain under quarantine for an indeterminate amount of time until the pest situation is resolved to the satisfaction of authorities. These factors were reported to increase the level of impact of quarantine on businesses and thereby influence grower willingness to report.

Some respondents argued for better contingency planning for the most well-known or likely EPPs, prior to an outbreak, so that the time taken to reach decisions on the pest at the time of a suspect EPP detection is reduced. This, they claimed, would lessen the impact on growers and hence the disincentive to report.

Inadequacies of the Owner Reimbursement Cost criteria

It was reported that the Owner Reimbursement Costs (ORC) criteria under the EPPRD, which provides reimbursement of direct costs to eligible businesses in the event of implementing a Eradication Response Plan, generally does not include losses incurred in the period of time from initial quarantine to the lifting of quarantine notices/orders if the decision is not to eradicate (no Response Plan). Further, if the pest is determined infeasible to eradicate (based on technical feasibility and/or benefit/cost), a Response Plan may not be developed or approved and so no Owner Reimbursement Costs apply. Additionally, the scheme was viewed as providing limited levels of financial assistance in many cases where a decision is made to contain or manage the pest.

Several interviewees suggested the recompense arrangements to producers could be made more generous or extensive in terms of the types of situations they covered, to again alleviate financial impacts and thereby minimise disincentives to reporting.

At the jurisdictional level

Restrictions on trade during quarantine were reported to severely impact businesses. Development of flexible and/or tailored approaches that allow trade to continue where feasible (i.e. where it does not reduce the ability to manage an EPP event) was seen as helping reduce the burden of quarantine. Interviewees noted that there has been some moves towards achieving greater provisions for trade in recent years, although they were unclear on progress, so any achievements in this area may need to be more widely communicated.

Interviewees noted that some recompense arrangements in the case of a HPP/EPP detection or quarantine event are covered by jurisdictions rather than by the national level Owner Reimbursement Costs under the EPPRD. These too may need to be reviewed to cover a greater extent of circumstances where businesses suffer financially during a HPP/EPP event, to reduce the financial impact on businesses and thereby remove disincentives to report.

3.3.2 Key challenges and barriers to monitoring, recording and reporting plant pests in the nursery production industry

Overall, the most highly cited challenges and barriers by interviewees related to:

- Costs (18 interviews made reference to this factor)
- Lack of knowledge-awareness-skill (15)
- Lack of support/extension (12)
- Time consuming tasks or time constraints (12)
- Lack of trust in the biosecurity system or government (11)
- Lack of benefits (10)
- Paperwork, red tape, bureaucracy, administration (10)
- Staffing issues (labour shortages/turnover) (10)

The summary that follows is organized according to the three main aspects of surveillance – monitoring, recording and reporting. Each section describes the key challenges and barriers reported for that aspect of surveillance

Monitoring

There was a general perception that monitoring being undertaken by many production nurseries was insufficient to enable confidence in biosecurity surveillance (particularly in mid-size to smaller operations). Inadequacies that were mentioned related to monitoring not being undertaken frequently, consistently, systematically or comprehensively enough (i.e. across all relevant or critical aspects of the nursery and all components of the plant/growing media and their environment).

Some respondents indicated that nursery managers and staff may lack the knowledge of how to monitor effectively and efficiently. Larger nurseries were seen as having greater capacity to employ specialist staff or use external pest management consultants for monitoring.

While NIASA provides guidance on procedures and standards for monitoring, these are more rigorous and prescribed in the BioSecure HACCP program. However, the more rigorous (frequent, systematic and comprehensive) approach to monitoring required by BioSecure HACCP was seen as significantly increasing costs, mainly in terms of extra staff hours required.

A crucial part of monitoring as part of surveillance is the ability to identify a HPP/EPP as distinct from an endemic pest, which was seen as typically lacking in nursery staff. Even the ability to identify signs or symptoms that could be considered unusual or suspicious was viewed as likely to be poor, particularly for staff that were employed part-time or casually. Exacerbating this situation, exotic pests can take a number of years to build a population and/or level of impact sufficient to be noticed, and in particular, to be identified as different from endemic pests.

Some respondents expressed an expectation or preference for specialists to do the monitoring as they held the expertise whereas growers may not, as noted by the following grower:

> *We used to have inspectors come out here looking for ants and they'd go away saying, oh, you've got ten different ants on site, whereas I thought we had two, but it's what they're trained to look at. (Grower, WA)*

Suspected identification of a HPP/EPP requires reporting to the authorities, which was seen as posing significant risks to individual production nurseries in terms of the impacts of potential quarantine. Further, it was reported that producers may consider it best not to know if a HPP/EPP was present, which in turn discourages rigorous monitoring and identification procedures by nurseries.

Monitoring may not be considered a priority in production nurseries that produce a large variety of plants – some reportedly up to 400 different species – because any particular plant species represents only a small fraction of the overall plant life on the nursery. Hence, the impact of any one pest (particularly those that are host specific) in these types of production nurseries was seen as small in relation to overall production, making them willing to tolerate a 'background level' of pest presence, as the following grower indicated:

> *Our problem is, we grow about 800 different varieties of plants, so if one plant gets attacked by a bug and gets knocked off it's annoying but it doesn't break our whole business, so we tolerate a certain background level of pests and diseases. (Grower, WA)*

Monitoring of critical points in the nursery production system

Respondents noted the key importance of monitoring as early as possible in the nursery production process. Examples included:

- at point of receival/importation of plant material into the nursery
- the production of germplasm
- import and germination of seeds
- propagation of plants
- growth of seedlings

Interestingly, some growers suggested stock imported from interstate could be viewed as 'low risk' because it had already been inspected a number of times prior to arrival at the nursery.

The point of dispatch, before plants left the nursery, was also seen as an important site of monitoring, because it was commercially important for the nursery to only supply healthy stock to customers. Failure to do so, it was reported, would bring penalties in the form of refusal of payment and/or potential loss of customers, markets or reputation. However, it was noted that dispatch should not be the only point for monitoring, as by this stage in the production process it was generally too late to enable control to prevent the pest population reaching high levels.

The ideal frequency of monitoring between receival and dispatch of product was seen as depending on the period of time a plant is kept in the nursery before being moved on (e.g. 7 days, weeks, months) and type of production process. The traceability of plants as they are moved *within* a nursery – knowing where a batch has come from and where it is physically at all points in time – was also seen as important. Site surveillance, the monitoring of pests across the entire nursery site, not just within production structures or areas, was another aspect of monitoring that was viewed as crucial, particularly for identification of weeds.

Suggestions for ways to improve monitoring by production nurseries

Some respondents expressed a preference for pest specialists to do the monitoring as they hold vastly more expertise than do growers. However, as specialist expertise can be expensive, either government provision of nursery inspectors or a subsidy to assist with employment of pest specialists was seen as required.

A number of respondents highlighted the potential for monitoring of HPPs/EPPs to be undertaken as part of endemic pest monitoring, rather than as an additional, specialised exercise. The success of this approach however, was seen as being dependent upon the capacity of staff/inspectors to identify a HPP/EPP, as noted above, as well as upon the rigour of the endemic monitoring regime.

Relatedly the suggestion was made that combining regular training programs for improving endemic pest monitoring practices, with annual campaigns to educate nursery staff on particular HPPs/EPPs, could over time build grower capacity to monitor for a range of exotic pests.

Clearly, it would also appear that increasing NIASA accreditation and BioSecure HACCP certification rates, due to their progressively higher standards and monitoring requirements, would be beneficial in improving monitoring for surveillance.

Recording

Even when plants are monitored well, recording of the results of this monitoring was generally viewed as inadequate, with producers expressing great resistance to what is viewed as an onerous task. Record-keeping was generally viewed as tedious, time-consuming 'paperwork' (also referred to as 'bookkeeping', 'bureaucracy' or 'administration') that required additional staff resources and was therefore costly. As noted above, the main objection to BioSecure HACCP appeared to be its requirements for record-keeping.

Record-keeping was generally viewed by growers as providing little material benefit, and therefore as a poor use of their time. Interviewees indicated that producers are much more concerned with identifying the cause of a particular plant health problem, ways to fix it, and then applying the solution, rather than keeping records. The most frequent and systematic records with regards to

pest occurrence that were reported as kept were the spray/chemical usage records, that in many jurisdictions are compulsory.

Larger producers were seen as having greater capacity to analyse records for pest, production and chemical usage trends. While definitely in the minority, one (large) producer noted the value of good record-keeping to provide the historical data for analysis of trends and relationships that inform good business decision-making:

> *There are lots of values [of historical data]. You can actually start by understanding what happens when in your nursery you can start to anticipate problems and that's very good. You can also understand what the problems are or where you're spending your money and your time and you can then go back and address it either with some more R&D or whatever it is, but once you understand over time what's happening, it gives quite a different perspective to what you can look at, at the moment. You start looking at trend figures; you say, well alright, this pest is costing us X thousand dollars a year it's worth doing something, or we're always seeing this pest, we've seen the damage as well, maybe we're using the wrong chemical. But you can't do that without the records. You need data to actually make decisions and make sensible decisions and make strategic decisions. (Grower, VIC)*

Similar to the case for monitoring, recording the presence of a suspect HPP/EPP, for the purposes of reporting it to the authorities, was seen as posing significant risks to a production nursery in terms of potential quarantine, thus providing a disincentive to record.

Suggested solutions to improve record-keeping

Suggestions provided by respondents to improve record-keeping included:

- promoting the value of record-keeping in terms of better data for improved business decision-making, as noted above
- development of more efficient technological approaches and techniques to alleviate the time-consuming nature of record-keeping
- provision of technical support officers to promote and assist adoption of record-keeping techniques and technologies
- providing some form of subsidy to cover the extra staffing costs required to improve record-keeping

In addition, similar to monitoring, it would appear that increasing NIASA accreditation and BioSecure HACCP certification rates, due to their progressively higher recording standards, would be beneficial in improving recording for surveillance.

Reporting

Deficiencies in monitoring, identification and recording of pests can clearly lead to reduced reporting rates. Overwhelmingly, however, the main reason provided by respondents for apparent low reporting levels was the fear of consequences of quarantine. Potential impacts were noted as likely across a range of domains: financially, socially and personally. While financial impacts were considered as likely devastating or even terminal for a business, consequences such as social stigma and ostracism, being shunned in a community or by your industry, and the personal and emotional impacts that flow from these, were noted as equally devastating:

… the grower reported that so straightaway that farm was quarantined, he was closed down and then until they got onto future testing. This testing went on for (and I may be wrong) 30 days and this poor farmer was closed down for 30 days and it virtually broke him not only financially but emotionally. (Grower, QLD)

The impacts of quarantine were reportedly exacerbated by a number of factors (as noted above; reiterated here for completeness):

- the length of time of quarantine prior to a decision being made about a response under the Emergency Plant Pest Response Deed – whether to eradicate, contain or manage the pest
    - it was noted that it can be a difficult and protracted process to
        i. definitively identify a pest or pathogen meeting the definition of an EPP, with laboratory misdiagnosis not uncommon, and
        ii. for the various parties to the process to agree on the response category (based on technical feasibility and cost/benefit of eradication)
- there was reportedly great uncertainty associated with both the length of time and the outcome of this decision; the complexity of the Deed's rules and opacity of some decision-making processes were viewed as adding to this uncertainty
- a decision for eradication or containment could reportedly still result in quarantine restrictions continuing on for an (indeterminate) period following the response decision
- the limited extent of financial support provisions reported in some cases, such as failure to cover financial losses (Owner Reimbursement Costs) in the period of time from initial quarantine to the lifting of quarantine notices/orders where the decision is not to eradicate, and limited levels of financial assistance in cases where a decision is made to contain or manage the pest
- total or high levels of restriction on trade reported during quarantine (although it was noted that partial and/or flexible conditions for trading during quarantine can potentially occur depending on the specific business and pest response contexts)

Relatedly, growers and industry association participants emphasised the extremely low levels of trust in government bodies (state and federal) held by many growers, which also contribute to a reluctance to report. Government agents were seen as having limited engagement with and understanding of nursery business operations and industry context, and little regard for the livelihood or wellbeing of growers:

… but I can tell you now it's growing and growing, there's a groundswell across all of…particularly horticulture….they don't trust Government, they don't believe they're being looked after, they don't believe they're the priority, which is true. Government has lost its whole focus of what Biosecurity is all about, which is the grower. (NGI rep)

Cynicism or distrust of government was also associated with the mantra of "shared responsibility" which was widely seen as a term for disinvestment in biosecurity and *shifting* responsibility onto industry. A decline in state government technical or 'extension' support officers over recent decades in most jurisdictions, was exacerbated by a perceived move to biosecurity officers who had a focus on, and professional backgrounds in, compliance and policing. These shifts were seen

as detrimental to relations between growers and government officers, and hence of the capacity of both to effect change:

> *The Government completely gutted all its development officer services. It has no contact with the industry so I really think that if Government wants to play in this area, then they've got to be in the field. It's not going to come to them no matter what they do and I think they kind of want it both ways at the moment. If Departments want to be involved with industry, then, hey, there's a bit of an obligation there for them to get out and about too. (Grower, VIC)*

> *The agencies themselves have evolved into a more policing type agency, they love it, the people that they've got there are more focused on process; they're more focused on policing, as opposed to focusing on the grower. (NGI rep)*

A number of other reasons for low reporting rates were also identified by interviewees:

- Producers reported they already apply a range of control methods (e.g. chemical sprays) for expected endemic pests, which can also kill many exotics, hence reducing potential identifications.
- Even upon identification of something suspicious or unusual, producers reportedly first are likely to apply controls and hope they eradicate it, rather than report and suffer consequences of a HPP/EPP quarantine.
- Interviewees noted the likelihood of reporting was probably reduced by a lack of awareness/knowledge across a range of areas related to biosecurity surveillance:
    - biosecurity procedures and responsibilities generally
    - surveillance procedures and systems
    - producers' obligation to report
    - how and who they should report to
    - subsequent quarantine procedures
    - related compensation schemes
    - ability/flexibility to continue trade during quarantine
- A lack of expertise or confidence in identification of HPPs/EPPs was also seen as reducing likelihood of reporting.
- Likewise, a lack of technical support such as extension/pest specialists and Industry Development Officers meaning less support, and in particular, *trusted* support, for growers.
- Contracted pest consultants and pest specialists working for chemical supply firms, who, while they were seen as likely to possess the technical expertise to identify suspected HPPs/EPPs, reportedly faced a conflict in relation to reporting. Namely, it was said that their obligation to report HPPs/EPPs, which could lead to devastating consequences for their clients, ran counter to their commercial imperative to 'look after' and thereby retain clients.
- Low membership of state NGI bodies and accreditation with NIASA was seen as leading to lower levels of communication, support, and knowledge about HPPs/EPPs, surveillance

procedures, reporting obligations, etc. (as described above) and hence reduced ability or willingness to report.

- Higher risk segments of the industry, viewed by many interviewees as those who were not members of the state NGI bodies, and/or were backyarders, those believed to be illegally importing plant material from overseas (e.g. through online means) and/or selling online at markets, were seen as also the least likely to report.

Where reporting of unusual or suspicious signs does occur, interviewees suggested it was most likely through a trusted source of expertise, such as a NGI state association officer, pest consultant or technical expert within a supplier firm, or a trusted government pest specialist. However, a declining number of nursery industry technical support officers (Industry Development Officers) and government extension officers, together with the cost of pest consultants, can be expected to reduce exposure to potential trusted sources.

> *For that system to work there's got to be a high level of trust and communication and then you get it working, but without that it won't work… [Feeling] their interests are going to be taken into account and that requires a high level of trust and perhaps some structures that ensure that happens but the first thing is you've got to have trust… You're certainly not going to report it to a database. (Grower, VIC)*

Most jurisdictions and some national programs seek to minimise the cost barrier to reporting by subsidising the investigation process including identification of suspect or unknown pests at diagnostic laboratories. For example, NIASA-accredited members can provide a certain number of samples for free each year for diagnosis of unknown pests at the Grow Help Australia plant health diagnostics facility at the Queensland Department of Agriculture and Fisheries.

Nevertheless, overall, with regard to reporting HPPs/EPPs, there appeared to be many significant disincentives and very few direct incentives to report.

Suggestions to improve reporting

The main reason interviewees cited for dissuading producers from reporting was the fear of the consequences of doing so, and a number of suggestions were made for how these impacts could be reduced. Most of these have been described above in detail so a summary only is provided here:

- improvements to the response decision-making process to reduce the time taken and reduce uncertainty as to the likely result
    - this could involve greater contingency planning for well-known and/or high probability HPPs/EPPs
- expansion of financial assistance mechanisms to cover a greater range of time periods, stages or types of emergency plant pest detection situations that currently do not fit Owner Reimbursement Cost criteria or other (jurisdiction level) criteria for recompense
    - an alternative or complementary suggestion was for an insurance scheme to be established and linked to evidence of high biosecurity standards such as BioSecure HACCP certification
- improve capacity to trade during quarantine, where feasible

Interviewees suggested that declining levels of trust in government, which exacerbate the reluctance to report, needed to be reversed by clear demonstration of support for producers. A range of respondents (growers, industry representatives and government officers) noted the need for return of funding for technical support/extension roles, which both build grower capacity and improve dialogue with government agencies, in turn building the government's capacity to effect change. Industry representatives also mentioned the need to reverse the growing compliance and policing focus of some State government biosecurity agencies and their officers, and to return to earlier extension and technical support models.

Interviewees noted that because skills in monitoring and identifying HPPs/EPPs facilitates reporting, building grower technical capacity is crucial. Thus, programs that provide education and training on pest surveillance and mechanisms that increase nursery industry association membership (and subsequent NIASA accreditation and BioSecure HACCP certification) were both seen as important. Relatedly, a return to funding of *industry* technical support officers ('Industry Development Officers') by nursery industry associations was called for.

3.3.3 High risk segments and critical points within the industry for the introduction and spread of pests

Interviewees were asked a specific question on where they perceived the high risk segments of the nursery industry as well as the critical points in the nursery production system, for the introduction and spread of pests. These segments and points suggest areas for particular attention with regards to surveillance.

Segments of the industry: sub-industry types

The nursery production industry is quite diverse. There are a broad range of what could be called '(sub-)industries' within the industry, although these generally relate to the industry type that the nursery business sells into, e.g. ornamentals and vegetable for retail ('greenlife'), vegetable producers, fruit orchards, forestry, landscape, revegetation/conservation, etc. Generally higher risks did not appear to be associated with different (sub-) industries by interviewees (except where these 'industries' coincided with an industry 'segment' e.g. vegetable *seedling* producers).

Segments of the supply chain

Of greater relevance to interviewees for surveillance purposes were the many segments or components of the supply chain within any particular (sub-) industry. Notably, the beginning and early stages of the plant's life and/or of the production and supply chain system, including importation of plant material (from overseas or interstate), were generally considered the most important segments with regards to biosecurity surveillance, as any infected/infested product could flow through to later stages/segments.

Examples of early stages include:

- seed production and imports
- germplasm/tissue culture production/imports
- other 'starter' material: cuttings, bulbs, rootstock
- imports of cut flowers, whole plants, etc.

- propagation from seeds/tissue culture/cuttings, etc.
- various stages of seedling/cutting propagation and production
- different aged plants (week to months)

Supply-chain effects

A number of interviewees noted that the greatest incentive for a producer to monitor and maintain healthy pest free stock (and to demonstrate best practices e.g. through accreditation) tends to be market and supply chain related. That is, the fear of losing customers or a premium market if their stock is deficient/infested or they can't demonstrate best practice, or conversely, the potential to gain a customer/market share due to having a good reputation or best practice accreditation. Unfortunately, as noted above, some respondents indicated that even large corporations and government bodies may not require suppliers to hold NIASA accreditation.

Transport

Transport was identified as another critical part of the industry with regards to biosecurity, as it was crucial to the movement of product between the different components of the supply chain. Transport for the nursery industry appears to rely principally on trucking, although postal and courier services, air transport, shipping, rail and private/personal cars (e.g. people travelling interstate to live/work/holiday) could also be important transporters of plant material.

Interstate movement control as a critical point

The strength and robustness of interstate plant movement control arrangements, including quarantine upon arrival/receival were seen as essential to biosecurity and surveillance for interstate trade. However, a number of respondents noted the importance of time- and cost-savings, efficiencies and flexibility to the economic viability of producers, and therefore the need for greater harmonisation of interstate plant movement controls across jurisdictions, as well as industry self-regulation/certification with respect to movement control compliance.

Some interviewees claimed there was limited awareness among growers that Biosecure HACCP certification already provides for self-certification of interstate movement control compliance in most jurisdictions (as noted above, BioSecure HACCP certification is a legally recognised instrument in all Australian states). State and territory governments can enable certification of plant consignments for interstate movements, either using government inspectors on a case-by-case basis for each consignment or through accreditation of a business to self-certify under the Interstate Certification Assurance (ICA) Scheme. While using state government inspectors for each consignment can come to represent a significant cost where consignments are frequent, the government auditing process to enable producers to maintain their ICA accreditation for self-certification was still viewed as representing a significant cost by some industry representatives and growers. Thus, due to industry arrangements for auditing of self-certification through BioSecure HACCP, the program was viewed by some industry representatives and growers as having the potential to provide significant cost savings. However, the extent of knowledge among growers of this benefit of BioSecure HACCP certification may be limited.

The nursery industry as a critical segment in its own right

At a broader level it was noted that, due to its role at the early stages of all plant-based commodities, the nursery production industry *as a whole* comprises a critical segment of plant-based industry in Australia. However, it was claimed that despite this, government and industry biosecurity and surveillance efforts (projects, programs, subsidies/incentives) tended to focus on 'end commodity' products e.g. the apple & pear, or cherry, or citrus industries – rather than on the nursery production industry that forms the critical entry point/segment in the supply chain to these end commodities. Relatedly, it was noted that the nursery industry, in covering all plant types, requires a level of knowledge of pests way beyond any particular plant commodity, suggesting greater support for biosecurity surveillance is required than for commodity industries.

Critical points within a nursery production system

The most critical points within a particular nursery nominated for surveillance were:

- at point of import or receival
- early stages of plant growth
- dispatch

Import/receivals and dispatch were the two most commonly nominated points for surveillance, with receivals often going into quarantine for a period of time for monitoring. Surveillance of plants before entry into the main nursery was seen as important to prevent pests entering the production system. Dispatch surveillance was seen as critical because supplying unhealthy or pest infested plants to customers could lead to non-payment, loss of reputation or even loss of the customer/market.

Early stages of growth where many plants are crowded together in a relatively small space were also considered important. Keeping track of the movement of plants (batches) to different locations within the nursery as they progressed through different stages of growth was also mentioned.

The entire nursery site itself (and immediate surrounds) were also seen as important to undertake surveillance, especially for weeds.

Transportation between different sites of a nursery business – usually reflecting movement of stock to different locations within a nursery system at different stages of growth.

Membership segmentation

Interviewees also viewed the biosecurity surveillance risk of industry segments in terms of what could be seen as the 'level of regulation' to which nursery businesses voluntarily subscribed. Membership of a NGI association and any subsequent decision to become accredited/certified with a component the Farm Management System (NIASA, EcoHort and BioSecure HACCP), are voluntary decisions. As noted above, producers who were members of an NGI association, and especially those who held some level of accreditation/certification, were viewed as a lower risk for biosecurity, due to likely higher surveillance standards. It was noted however that many non-members were commercial producers who were known to NGI associations and even government agencies and thus did receive some communication products and engagement activities from them regarding biosecurity and other matters. Considered of highest risk were other producers

(and the numbers appear not well known) who are not connected at all to industry or government bodies and may not even be registered as a business. Some of these were said to produce commercial quantities of plants, while others were non-commercial producers (hobbyists, backyarders, collectors) some of whom were suspected of importing plant material illegally from overseas and selling at local/ 'farmer' markets.

Size

Production nurseries can also be segmented by size with larger nurseries generally viewed as having greater capacity (financial, labour availability, expertise) for surveillance. The small- to mid-size nurseries were therefore seen as most in need of government or industry support systems.

Geography

Some geographic areas and jurisdictions had higher levels of risks attributed to them:

- Northern Australia with proximity to and pathways from Asia, Melanesia, Pacific Islands, etc.
- capital city surrounds/ peri-urban areas with many backyard/hobby/non-commercial producers and/or Non-English Speaking Background producers who are less connected to information sources and support networks
- jurisdictions and regions that lack area freedom of a pest.

Suggestions for improved surveillance for industry segments and critical points

The beginning and early stages of the plant's life and/or of the production and supply chain system were seen as requiring the main focus of surveillance, due to the potential for infected/infested product flowing on to later stages/segments.

Within a nursery, the critical points for surveillance were considered to be at importation/receival of plant material, in the early stages of plant growth, and just prior to dispatch. This did not preclude the need for systematic surveillance of other stages and sites within the nursery.

Systems to track where plants are moved to and from within the nursery were viewed as important. Within a large nursery or a nursery system located across multiple sites, surveillance procedures to prevent infestation from one part of the nursery system to another may be required.

Overall, the nursery production industry as a whole, given that it represents an early stage for many other plant industries, particularly horticulture, was viewed as requiring higher priority for supportive measures to improve surveillance.

Smaller to mid-size nurseries were viewed as requiring greater support to improve surveillance practices because they tended to lack a range of capacities (financial, labour availability, expertise) that assist surveillance.

Those segments of the nursery industry less connected with an industry association and government agencies, particularly 'backyard' operations who nevertheless could be producing commercial quantities of plants, were viewed as at highest risk for poor surveillance and biosecurity generally. For this reason, a nursery production registration scheme was advocated to enable greater communication with, and oversight of, these 'unregulated' segments.

Some interviewees suggested that large customers in the supply chain, such as major retail chains and government bodies who purchase significant quantities of plants from nurseries, need to be encouraged to require their suppliers to become accredited, in order to provide a market incentive for nurseries to gain NIASA accreditation and BioSecure HACCP certification.

3.3.4 Grower capacity

Interviewees were asked about the capacity of growers to undertake surveillance activities in terms of their levels of knowledge, skill and motivation.

The knowledge and skill of growers to identify a HPP/EPP was seen as understandably low, as it generally requires specialist expertise to distinguish between endemic and exotic pests, and it was reportedly not uncommon for even specialists and diagnostic laboratories to misdiagnose.

Capacity of different industry segments

Larger nursery production operations were seen as more likely to have the capacity to employ specialist staff who focussed on pest control and also to possess greater resources (e.g. specialised equipment) giving them greater ability to identify endemic, if not exotic, pests. Non-specialist staff working in these nurseries were therefore able to report what they saw as unusual signs or symptoms to the specialist staff, who had more skill in determining pest status (or at least whether the symptom should be considered unusual or suspicious). Smaller nurseries were considered to generally lack this capacity, reducing their likelihood of reporting unusual or suspicious signs.

As noted above, production nurseries that are members of their state nursery industry association were viewed as higher in capacity (knowledge and motivation) to undertake surveillance, as compared to the non-member/'unregulated' sector.

Support for grower capacity building

The necessity for awareness raising, education and training of nursery staff in pest identification and control, including surveillance, was seen as very important. Many interviewees noted the valuable contribution of a current project in this regard: "Building the resilience and on-farm biosecurity capacity of the Australian production nursery industry", supported by Hort Innovation and delivered by the Queensland Department of Agriculture and Fisheries. The various resources provided by this project were highly valued, particularly workshops in each State and Territory, with some interviewees calling for more workshops each year. The workshops were valued particularly because growers could undertake practical pest identification activities within a working nursery, gain training on best practice and procedures for surveillance, and have access to pest experts to discuss issues.

Capacity issues of concern

Loss of government extension officers and Industry Development Officers

Of great concern to many interviewees was the progressive loss of ongoing specialist support to growers from, first, retraction of State government extension officers over recent decades, and second, the more recent loss of Industry Development Officers (IDOs) supplied by the state-based Nursery & Garden Industry associations. A shift in roles for government personnel from technical

support and extension to biosecurity compliance and policing was seen as exacerbating the decline. Changes in funding arrangements at the national level were cited as the reason for the defunding of the Industry Development Officers.

> *HIA used to fund, bring funds into each State; we used to get funding to deliver an IDO and that's gone now and that's a disaster. (NGI rep)*

Reduced NIASA funding and accreditation rates

Related funding changes reducing financial support for NIASA accreditation, which was seen as leading to an immediate large drop in growers gaining and maintaining accreditation, was also viewed as a great concern for ongoing biosecurity surveillance capacity. The NIASA program is a best practice guide across a range of nursery management aspects. While the biosecurity surveillance components of NIASA were generally considered only moderate in extent and depth, they were seen as at least providing a degree of guidance, so assisting in improving practices compared to non-accredited producers. Importantly, however, NIASA accreditation being a prerequisite for BioSecure HACCP certification, a drop in the former was expected to ultimately lead to a reduction in the potential for BioSecure HACCP adoption.

Grower motivation

Interviewees were asked what they thought would affect, or could improve, grower motivation to undertake surveillance activities. The most highly cited influences on motivation related to:

1. Economic costs and benefits (mentioned by 12 interviewees) – these may include, for example:
    a. gaining or maintaining premium markets due to accreditation/certification
    b. improved yield and/or quality due to improved pest management – enabled, for example, by analysis of good pest management records
    c. avoided costs of a large pest infestation – improved surveillance that catches an (endemic) pest early avoids costs that would otherwise have occurred
    d. savings on chemical bills due to more efficient pest control
    e. savings on market access costs by moving from government managed plant health inspections programs (ICAs) to self-certification under BioSecure HACCP
2. The desire for professionalism – seeing oneself as being a 'good'/'reputable'/ 'professional' nursery manager (9)
3. That surveillance was easy to do – and therefore was achievable (7)
4. Threat perception – growers would be more motivated where the risk (likelihood and/or consequence) of a pest outbreak was higher (6)
5. Responsibility to comply with laws and regulation (5)

Other influences on motivation that were mentioned included:

- reputational benefits – being seen by other businesses as a good/ reputable/ professional nursery manager (4)

- compatibility of recommended surveillance practices with current nursery practices and systems (4)
- time-saving efficiencies – e.g. through new or improved technologies or systems that reduce paperwork (3)
- simple, clear steps and pathways – to implementing improved surveillance systems and practices (3)

Suggestions for building grower capacity

Smaller to mid-size nurseries were viewed as requiring greater support to improve surveillance practices particularly because they tend to lack the financial capacity to either employ pest specialists on site or contract external pest consultants.

Some form of regulation on non-members of NGI associations, such as a registration scheme, was viewed as required, partly so that industry and government bodies could identify all nursery production facilities, which would enable communication with them to at least begin a process of raising awareness and capacity.

Continuation and expansion of initiatives to improve producers' capacity for surveillance. In particular, interviewees indicated that industry and government should continue to support and expand initiatives such as the project "Building the resilience and on-farm biosecurity capacity of the Australian production nursery industry". This project conducts workshops in working nurseries to provide practical surveillance training for growers.

Provision of technical support people on-the-ground, able to visit growers in their nurseries, and preferably with specialist expertise on pest identification and control, was seen by many interviewees as crucial for building grower capacity. Both government and industry technical support personnel were called for as both had declined. The value of government extension was seen not only in their technical capacity but their ability to feedback information into government decision-making processes, to help ensure better policy.

Return of prior Nursery and Garden Industry support for NIASA accreditation, in the forms of subsidies and Industry Development Officers, was seen as crucial to build grower capacity for biosecurity surveillance.

Suggestions for increasing grower motivation to undertake surveillance

Measures that improve financial benefits or reduce costs to growers of improving surveillance were viewed as strong motivators. This may require simply promoting the financial benefits that flow from improved surveillance (as listed in points 1.a-e above) or it may require putting in measures or modifying systems to provide greater financial returns and/or savings.

Utilising the desire of producers to be seen as professional and reputable nursery managers, and highlighting the benefits that flow from good business reputation, were suggested as potential strategies to encourage adoption of best practice in biosecurity surveillance.

Interviewees suggested motivation could be improved by ensuring surveillance systems and practices are: simple and easy to understand and implement; achievable and feasible for the nursery; compatible with current nursery practices, such as endemic pest surveillance, either

complementing or extending them; not overly onerous in terms of labour/time-taken to undertake them.

Raising awareness of HPP/EPP threats and also of compliance responsibilities were also viewed as useful in motivating producer action.

3.3.5 Facilitating better partnerships

The overwhelming theme of comments in response to the question on how partnerships could be improved between producers and other actors such as industry bodies and government, related to the concept of "shared responsibility" (mentioned by 12 interviewees).

Of these, 11 interviewees mentioned government, typically referring to declining or inadequate government support for plant biosecurity and/or grower technical/extension support (including mentions by State government officers). While most of this concern appeared to be related to State government, many interviewees, particularly growers, did not make this distinction.

While industry was understandably also often mentioned (10) in relation to facilitating better relationships, the main theme here tended to be of how much growers and the nursery production industry was affected by declining government support (8).

Other common themes were the need for better communication (6), improved relationships (5), greater consultation and responsiveness by government (4) and improved flexibility/compromise/ and reciprocity in negotiations with government (3). In addition, reducing the fear associated with reporting and the consequences thereof, was seen as helpful in improving grower engagement with government.

Shared responsibility

Government was a focus of negative comments, particularly in terms of the recent shift of an increasing portion of responsibility for biosecurity support from government onto industry, which was generally viewed as disinvestment by government in plant biosecurity and overwhelmingly as detrimental (even by some government interviewees):

> *… sometimes there's a lot more support in other countries for the provision of that material through government in terms of providing assistance in maintaining a system for the industry, rather than the industry funding it themselves. So, Australia walked away from that….it all went back to industry, if you really want this you should fund it, so we provide capacity if people pay for it, but if people aren't prepared to pay for it, then it might go by the wayside. (State/Territory Government Officer)*

> *If you don't fix the domestic scene where you've got industries (this is particularly horticulture) they're already doing stuff and they were already suspicious of Government in this whole space; Government has done very little to actually demonstrate true partnership, true shared responsibility. What Government has clearly demonstrated is that they've offloaded things they didn't want. So, the cynicism, we as a sector at the moment I can say and probably others in horticulture, would actively push back against Government... (NGI rep)*

Some industry participants however acknowledged the failure of industry/growers to give biosecurity the priority it required:

I've been involved with relationships with the State Ag Department and National Nursery Industry Association for a long time and I see a large push from Government of pushing responsibilities onto industry but industry not really caring, or having the financial motivation or drive to do it. So, our problems get out of hand and are not picked up because industry isn't really looking for it. (Grower, WA)

This inertia was seen as arising partly from a lack of producer capacity to identify HPPs/EPPs:

When I have a pest or disease issue on a plant I'm more likely to take a reasonable stab in the dark as to what it is and spray it with a chemical, rather than getting out the microscope and definitely identifying it specifically, and so that leads to a sort of bit of a hit 'n' miss application and not really identifying that there is a bug here that no one has seen before. Whereas if you get the Ag Departments involved, and if they had the time, if they were involved, then you've got entomologists that are bit keener about discovering things and actually look to check it is what we thought it was or, no, it's something new. (Grower, WA)

Both producers and government interviewees viewed the reduction of on-ground State government pest experts and extension support to growers as a great loss. This was due not only to the loss of expertise in identification of pests in nurseries, but also because of the decline in related engagement and dialogue between officers and growers. These interactions at the nursery level were seen as improving both the grower and the extension officer's capacity. However, just as important, a range of respondents (growers, industry representatives and some government officers) felt they enabled a feedback mechanism to government decision-makers higher up the chain on industry/grower needs and constraints, and therefore facilitated strategies more likely to be successful in effecting change.

While in-house pest specialists and/or commercial pest consultants were seen as alternative options, both were viewed as involving financial costs that growers would prefer to avoid.

Exacerbating the loss of government technical support and agencies becoming increasingly out-of-touch, was the industry perspective that they were seen as moving to more of a regulatory and punitive role rather than supportive and facilitatory, as noted earlier. The shift was blamed for fuelling growing cynicism and distrust, and hence lack of cooperation with government aims.

Given the absence of government extension officers, some level of government funding for industry provided support personnel was seen as crucial:

The main frustration which I mentioned earlier, was the Ag Department not doing adequate surveillance themselves and I think they try to shelve or palm off responsibility and not have the budgets they used to for active management or monitoring of pests and diseases, even though they well and truly know that if they catch a new pest and disease to the State or country it's a lot cheaper controlled earlier than later. I would like to see them contributing financially towards some sort of industry pest monitoring service or whatever that was able to try and pick up some of that stuff. If they don't want to do it 100%, then they need to put in money to fund a portion, that's better than nothing. (Grower, WA)

Relatedly, government decision-/policy-makers were viewed as increasingly lacking the requisite levels of knowledge to assist growers. Seen as underlying this was a lack of engagement with, and even concern for, growers:

You've got middle to low-level bureaucrats causing industries millions of dollars-worth of heartache because of who they are and nobody holds them to account …they don't even understand the industry, yet they can't get off their bum to actually engage industry. (NGI rep)

Interviews with State and Territory government officials revealed a variety of roles providing support to growers and/or industry, however they tended to be:

- acting at a broader level across multiple plant industries rather than specifically focussed on the nursery production industry
- primarily in a centralised and desk-based role, rather than decentralised and on-ground (visiting businesses), although this did still take place in some jurisdictions
- employing multiple avenues to engage with growers (telecommunications and media technologies such as email, websites, video clips, social media platforms; attendance at industry conferences and field days)
- typically under-resourced relative to the need

Government interviewees generally conceded they were under-resourced, as expressed by the following respondent:

I should say that at a State level we are really under-resourced when it comes to surveillance. We've got the national plant health surveillance program (as I was saying) which forms the bulk of our surveillance efforts, apart from fruit fly, so we do need to look at partnerships or some way of improving our surveillance effort because I think we're not doing enough at the moment. (State/Territory Gov officer)

However, where jurisdictions still provided extension personnel, they were highly valued by the government agency:

I guess the ongoing presence – our guys are there quite regularly and that's always a good thing. Once you're out of sight you're out of mind but with our surveillance regime here just having that continual presence and that rapport with the guys, that's got to be a benefit, our relationship with the industry… those positions that were about engaging and providing extension to growers have dwindled over the years but I think they're on the up again, as in the Department has realised that they're a worthwhile investment and a valuable way to keep in touch with industry. I think because we're a small jurisdiction we have those good one-on-one relationships and we've had continuity of staffing positions for a while that has built that trust. (State/Territory Gov officer)

An additional perspective on shared responsibility saw that is was important for other powerful players in the supply chain, notably large customers of nursery production businesses such as retail chains and government bodies, to share the responsibility for improving industry biosecurity surveillance capacity. As mentioned above, this perspective saw the need for these organisations to require accreditation/certification of their suppliers in schemes such as NIASA and BioSecure HACCP:

The problem is most of our customers, whether it's [large retail nursery chain] or commercial landscaping or Government, have a very low recognition of just NIASA which is the basic accreditation that has been around 20 years, so some landscapers or local Governments will request that all businesses are NIASA, but certainly not all of them,

and large commercial plantings in WA going into re-vegetation sites have gone in from businesses not NIASA accredited. (NGI rep)

Suggestions to achieve better partnerships

Overall, interviewee responses suggested that the mantra of "shared responsibility" was viewed poorly by industry, due to their assessment that governments were disinvesting in plant biosecurity (and other) support for growers and *shifting* responsibilities to industry. To improve the relationship of government with growers, most interviewees saw the need for more substantive engagement with growers and a demonstrated commitment to material support for grower biosecurity efforts.

Relatedly, interviewees overwhelmingly pointed to the need for a return to greater government support for grower technical support /extension officers. Field staff able to visit growers in their nurseries, and preferably with specialist expertise on pest identification and control, were seen as crucial for effective communication and relationship building. The value of government extension officers was seen not only in their role in improving grower technical capacity but their perceived role as a conduit of information on grower needs and constraints into government decision-making processes.

Some industry representatives also suggested the government-grower relationship could be improved by returning the focus of plant biosecurity personnel from that of compliance and policing back to the prior approach of technical support and relationship building. This was also seen as benefitting the industry knowledge level of government personnel who were seen as becoming increasingly de-skilled in their understanding of industry context and nursery systems and practices.

3.4 Conclusion

This section provided an overview of factors considered important for improving biosecurity surveillance in the nursery production industry by a range of producer, industry and government personnel. An understanding of these perspectives provides a broader context for insight into the nursery production industry's approach to improving grower biosecurity surveillance capacity than accessing producer input alone. In combination with the findings of the producer survey, this will assist the aim of this component of the research (Milestone 5) in providing suggestions for how the industry's approach could be strengthened.

4 Survey of Production Nurseries

4.1 Introduction

A survey of a sample of production nurseries in Australia was undertaken to further explore plant health surveillance in the industry. Our previous review of 39 plant production industries in Australia (Hobman et al., 2017 Deliverable 3) revealed a number of findings about the nursery and garden industry (see Table 6 below for a summary). However, because this prior research had a broader biosecurity focus, there still remained gaps in our understanding of nursery producers' plant health inspection, record-keeping and reporting practices.

For instance, while we know the proportion of production nurseries who monitor their crops, keep records and are willing to report – we know very little about how often inspections are performed (and at what stage in the supply chain); how producers perceive plant health surveillance and reporting practices; and the types of challenges producers perceive when seeking to perform such practices. We also do not know how capable producers may be in implementing a plant health surveillance and reporting system themselves, and the risk profile across producers (in terms of the likelihood of a pest incursion, and potential economic consequences at the producer level). Information on these aspects will provide us with deeper insights into the drivers of, and barriers to taking action, and the degree of heterogeneity across producers – findings that will ultimately help to inform the design and delivery of successful surveillance and reporting initiatives.

Table 6 Prior research findings for the nursery industry

Results from Instinct and Reason (2016; n=62 nursery and garden farmers) and KG2 (2013; n=59 nursery and garden producers)
Approximately 34% believe that a pest or disease outbreak is likely or highly likely in the next 12 months
80% are supportive of biosecurity measures
Approximately 67% agree that they have good knowledge in making decisions about the potential risks of pests and diseases
47% are aware of a biosecurity plan for the nursery industry
31% have a biosecurity plan on-farm
66% monitor their crops/orchards/plantations
Approximately 40% keep a record of monitoring, with 73% of these willing to share this record
The vast majority (~97%) are willing to report a new pest or disease
• 77% would like a no-blame reporting and advisory service • 70% would like an easy reference for identification • 69% would like to know who to report to • 46% would like a reduced risk of quarantine • 29% would like biosecurity warning or alerts • 25% would like to know pest and disease types and symptoms • Approximately 30% would like no information about biosecurity
49% are members of their industry association
The most popular communication channels are DPI or Agriculture, State/territory departments, and industry bodies/groups, or the internet

We therefore conducted a survey to examine plant health inspection, record-keeping and reporting practices in greater depth, among a sample of production nurseries in Australia. It is important to note that the survey did not include a comprehensive assessment of psychological factors (e.g., attitudes/beliefs, perceived costs, self-efficacy, intentions) that have been discussed in the literature as potential predictors of engagement in biosecurity (Mankad, 2016). This is because the survey sought to undertake a focussed assessment of the plant health inspection, record-keeping and reporting practices undertaken by producers (to identify areas of strength and development), and in particular, to explore the challenges currently facing producers. In this regard, the survey had an exploratory focus rather than an empirical, hypothesis-testing focus. We did however measure a few psychological constructs that reflected biosecurity capacity or risk to inform an assessment of grower types (similar to the industry typology as discussed in Section 2.3). These constructs included: relative importance of inspecting and record-keeping (as indicators of capacity in terms of motivation), threat perceptions (as an indicator of risk) and perceived technical skill/expertise in inspecting and detection (as indicators of capacity).

The survey was designed to improve our understanding of the behaviour, motivations, barriers and needs associated with plant health inspection, record-keeping and reporting among production nurseries. Thus, the aim of the survey was to understand more fully:

1. The different types of plant health surveillance (inspections, record-keeping) activities that production nurseries are currently performing
2. The key challenges and barriers producers face when conducting inspections, keeping records and reporting suspicious signs of pests
3. The supports that producers may require when undertaking plant health surveillance
4. How different segments or groups of producers may vary in their capacity and risk to undertake plant health surveillance

4.2 Method

A total of 1,066 identified producers were invited to take part in the survey (between Tuesday 3rd April and Wednesday 18th April 2018), with 213 completing the survey (19.98% response rate). Potential participants were required to be 18 years or over, and from a production nursery. To maximise reach, two modes of survey delivery (telephone and online) were used.

4.2.1 Telephone recruitment

Recruitment to the telephone survey was managed by Q&A Market Research, an independent research company based in Brisbane, Australia. Q&A were provided with a list of production nurseries available on the NGIA website (http://traderegister.ngia.com.au/types/production_nursery). They also sourced potential participants by referring to business listings. A target of 200 respondents in this mode and state quotas were set. Ultimately, 883 production nurseries were called, and for 498 of those, someone was actually spoken to (the remainder were either not answering, disconnected, engaged or else the call went to an answering machine, business number or fax line). Of the 498 contacted:

- 97 did not qualify (due to not being a manager/owner/operator, or where the state quota was already filled)
- 79 refused to participate either before or during the survey
- 120 were yet to be contacted later (callbacks left at completion of the study)
- 2 did not understand and/or speak English well enough
- 200 completed the survey (thus, the response rate for the telephone survey was 40%).

The recruiters introduced themselves to the person who answered the phone, and explained that they were calling to invite them to participate in a survey of production nurseries in Australia. The recruiters explained that the survey was being conducted by CSIRO and funded by the Department of Agriculture and Water Resources as part of the Agricultural Competitiveness White Paper – the government's plan for stronger farmers and a stronger economy.

4.2.2 Online recruitment

Recruitment to the online survey was conducted by NGIA on behalf of CSIRO, using an anonymous link provided by Q&A Market Research. NGIA emailed 568 subscribers inviting them to participate in the survey (see Appendix C for the email). Ultimately, 13 completed it (thus, the response rate for the online survey was 2%). This low response rate may reflect the fact that many production nurseries may have already been contacted via telephone.

The email explained that the survey was being conducted by CSIRO and funded by the Department of Agriculture and Water Resources as part of the Agricultural Competitiveness White Paper – the government's plan for stronger farmers and a stronger economy. This statement was repeated on the first page of the survey.

4.2.3 Survey

The survey questionnaire is included in Appendix D. There were minor differences in language and presentation between the telephone and online versions of the survey, in keeping with the requirements of the different communication modes.

4.2.4 Data preparation

Q&A Market Research delivered two datasets to CSIRO (online and telephone). CSIRO labelled and merged these datasets together, before importing into STATA for subsequent analysis.

4.3 Results

4.3.1 Sample Description

The final sample of 213 participants comprised 166 males and 45 females (1 selected the 'other' category), with the majority being an owner-manager (n=159, 74.65%), and a smaller number of employed managers (n=48, 22.54%) and staff members (n=6, 2.82%). Most participants were aged between 45 and 64 (n=131, 61.50%) (see Appendix E, E.1-E.3). In terms of state distribution, the

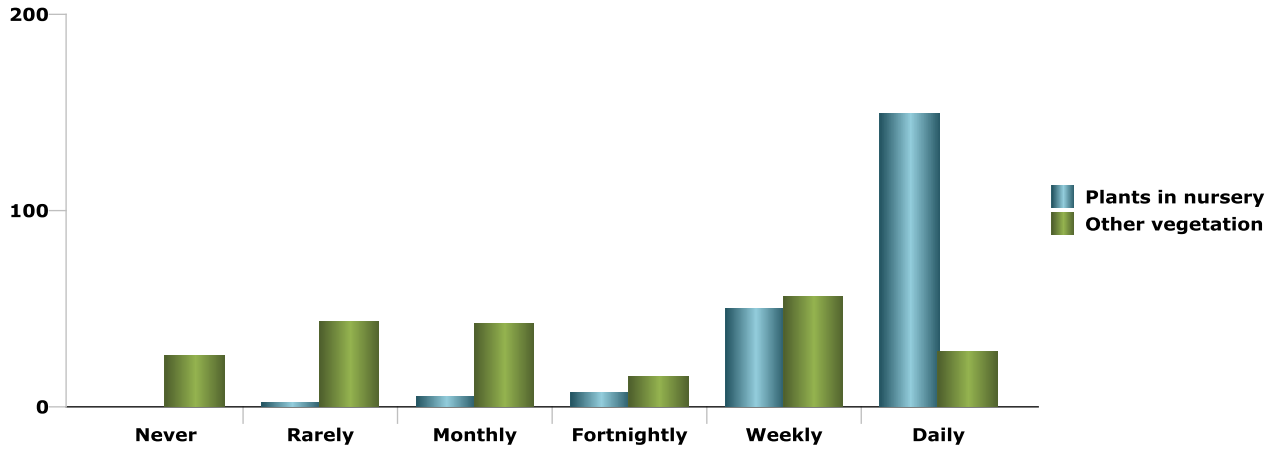
final sample closely represented the population of production nurseries by state (see Appendix E, E.4). Most participants produced either ornamental plants (n=103, 48.36%) or landscape stock (n=40, 18.78%), and sold their produce through retail greenlife (e.g., Bunnings, Aldi, Garden centres) (n=117, 54.93%) (see Appendix E, E.5-E.6). The fact that only two types of plant types were represented well in our sample should be kept in mind when reviewing the results. Ultimately, the given results cannot be said to reflect that of the broader population of production nurseries, which includes seedling, forestry, fruit and nut tree, plug and tube stock, revegetation stock, and mine revegetation.

Gross value of production provided a gauge of the business's size (see Appendix E, E.7) - here there was a fairly equal representation across categories, up to the $2.5 million mark. Over the entire sample, around 12 full-time equivalent staff on average were employed (SD=18.86; ranging from 1 to 160). Participants indicated that most of the plants they sold were to local (43.06%) or intra-state markets (35.17%). Approximately one-fifth (20.55%) of produce were sold interstate, and very little was exported overseas (1.21%). A similar pattern emerged for the purchase of plants and plant material (see Appendix E, E.8).

4.3.2 Plant health surveillance practices

Inspecting main nursery vs. other vegetation on property

There was a higher frequency of inspections of plants/plant material undertaken in the main nursery compared with other vegetation elsewhere on the property, with the majority reporting daily inspections (Note that 3 participants did not answer the question about inspection of other vegetation).

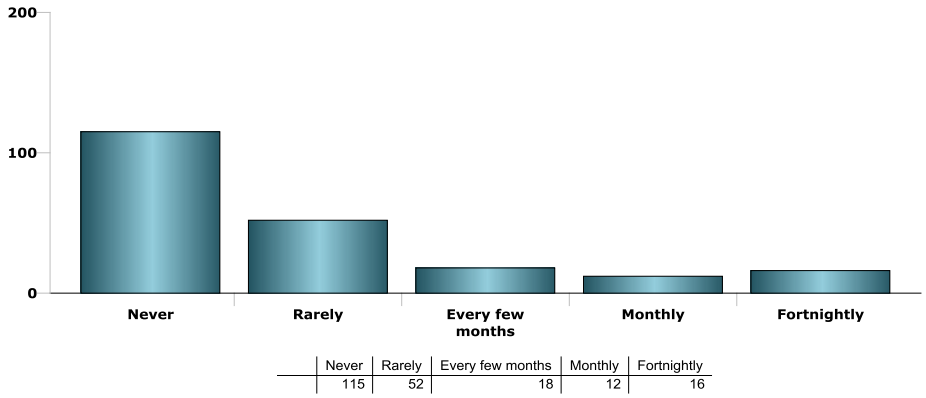


	Never	Rarely	Monthly	Fortnightly	Weekly	Daily
Plants in nursery	0	2	5	7	50	149
Other vegetation	26	43	42	15	56	28

Figure 5 Inspections undertaken on the plants and plant material in the nursery, and of vegetation elsewhere on the property

Professional inspections

The majority of participants did not engage the services of a local pest expert to inspect the nursery for signs of pests (n=115, 53.40%). Those that did, tended to either do so on an infrequent basis (n=52, 24.41%) or at least every few months (n=46, 21.60%).



Never	Rarely	Every few months	Monthly	Fortnightly
115	52	18	12	16

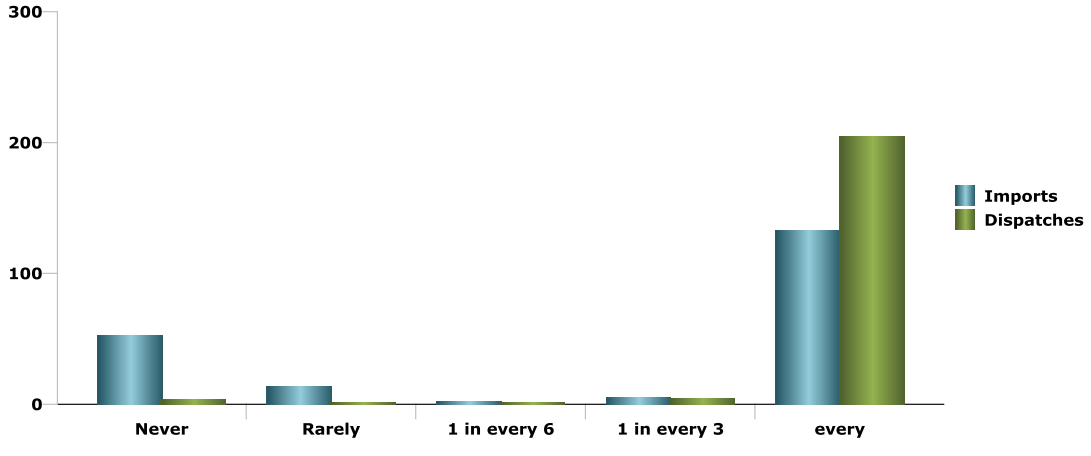
Figure 6 Professional inspections undertaken (by a local pest expert) in the nursery

Purchased plant material

Participants on average stated that they bought around half (47.28%) of their plant material from suppliers with NIASA accreditation or similar accreditation (SD=42.13%, ranging from 0% to 100%) (Note that 35 participants did not answer this question).

Inspecting new imports and dispatches

In terms of inspecting imported and dispatchable plants and plant material, the vast majority of participants indicated that they inspected every import/dispatch. However, there seemed to be a sizeable (24.4%) proportion who never inspected imported stock.



	Never	Rarely	1 in every 6	1 in every 3	every
Imports	52	13	2	5	132
Dispatches	3	1	1	4	204

Figure 7 Inspections of imported and dispatched plants (and plant material)

Relative importance of inspecting

On a scale from 0 (not at all important/not a priority) to 3 (high importance/high priority), the relative importance of inspecting hovered towards the upper-end of the scale (mean=2.79; SD=0.51). As shown in Figure 8, most participants viewed inspecting as a highly important activity.

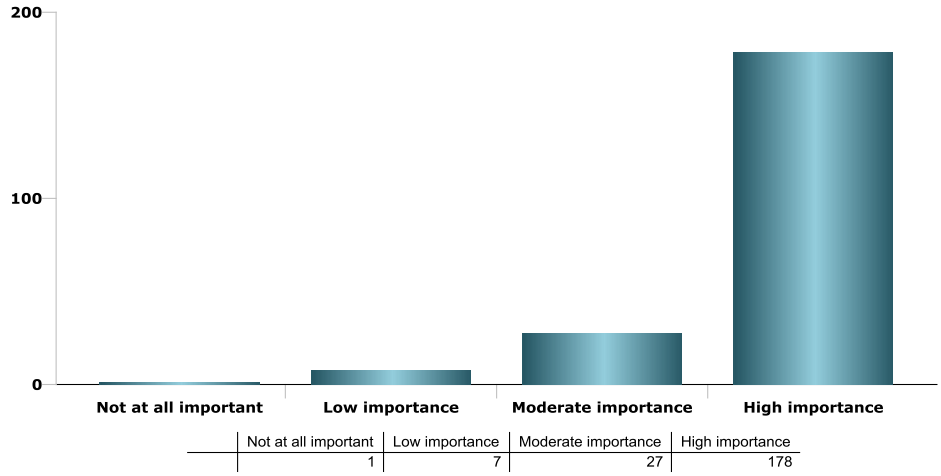


Figure 8 Ratings of importance of inspecting plants and plant material in the nursery

Perceived technical skill in inspecting

On a scale from 0 (below average) to 2 (above average), perceived technical skill in inspecting plants or plant material was 1.59 on average (SD=0.61) indicating a higher level of perceived skill across the board.

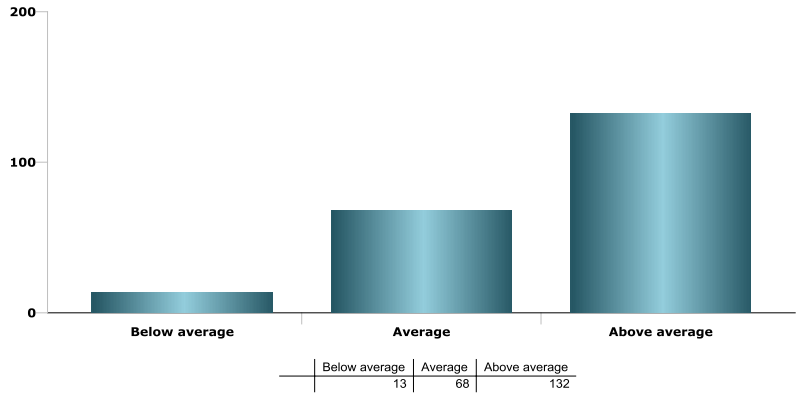


Figure 9 Ratings of technical skill of nursery staff in conducting inspections

Challenges to inspecting

Responses to the open-ended question about the biggest challenge their nursery faces in conducting regular inspections were coded into a number of themes (see Table 7). A good proportion (n=77, 36.15%) stated that they experience no challenges in performing inspections. However, for those who did mention a challenge, it was usually with respect to time or labour constraints.

Table 7 Main challenges in conducting inspections

THEMES	SUB-THEMES	FREQUENCY OF MENTIONS	EXAMPLE QUOTE
Time constraints	Not enough time, general mention of time as a challenge	43	It's time consuming [1] Time constraints [53]
	Managing one's time, establishing a routine	20	Allocating time for people to do it [20] Time management [61]
Labour/skill constraints	Not enough staff, lack of knowledge/expertise, need to train staff	31	Technical expertise [55] Having the experienced staff that can carry out examinations [73]
	Staff motivation (to inspect, report, attend training)	3	Getting staff motivated to do training courses [131] Getting busy staff to keep inspection front of mind [206]
Too costly, no benefit	Takes too much (is a waste of) time, costs outweigh benefits	8	Don't get paid enough for product to spend enough time doing that [11] The cost of having somebody working on that all the time, hard to see the benefit [15]
Competing priorities	Other tasks of higher priority	4	The challenge is time management and it becomes a low priority job despite having a high priority within the business [18] Demand on time for other things [24]
Scale of production	High volume, variety and throughput of plants to inspect	14	Scale of our operation, very large scale [59] Quantity of plants we have at any one point in time [94]
Pest management	Difficult to control pest outbreak, mention of specific pests as a challenge	13	Killing the little buggers. Eradication controls and controlling them [185]
	Identifying pests accurately and early	10	Being able to identify the pest [108]
	Keeping up-to-date with new pests and treatments	12	When something comes up that we have not seen before [98]
Weather constraints	Rain or other events that hinder inspecting	8	Rainfall can be an issue [50]
No challenges	No challenges experienced, inspecting is routine	77	We have no issues at all really. It's pretty much under control [8]

4.3.3 Record-keeping practices

Record-keeping of inspections

On a scale from 0 (never) to 4 (always), the average rating for keeping records of inspections was just below the mid-point (sometimes) of the scale (M=1.89, SD=1.67) (Note that 1 participant did not answer this question). However, looking at the frequency distribution (Figure 10), reveals that there is a large percentage of producers who always take records, and another large percentage of producers who never take records.

Figure 10 Record-keeping of inspection activities

Relative importance of record-keeping

On a scale from 0 (not at all important/not a priority) to 3 (high importance/high priority), the relative importance of record-keeping hovered around the mid-point of the scale (mean=1.64; SD=1.13). As shown in Figure 11, there was considerable variability in responses.

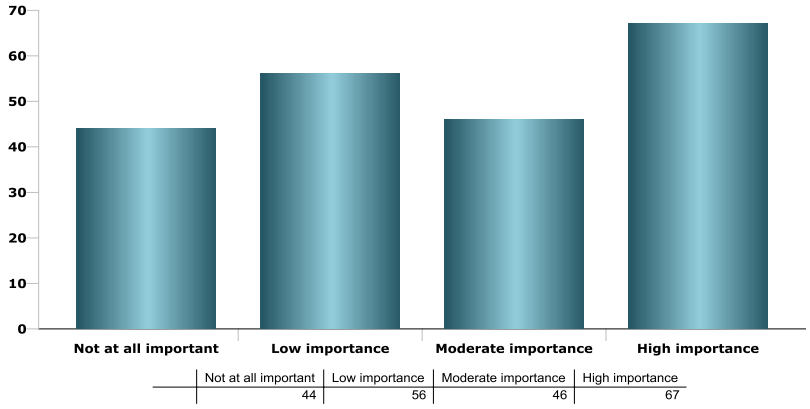


Figure 11 Ratings of importance of record-keeping

Challenges in record-keeping

When asked to report the biggest challenge their nursery faces in formally recording the results of inspections, the following themes emerged (

Table 8).

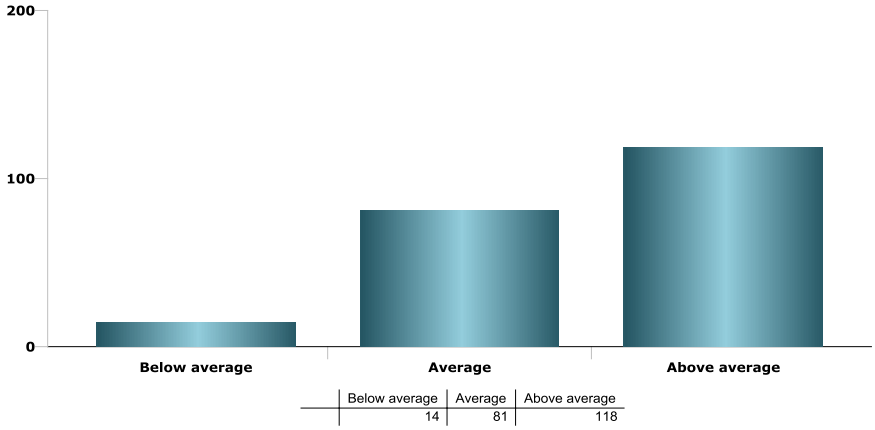
Table 8 Main challenges in record-keeping

THEMES	SUB-THEMES	FREQUENCY OF MENTIONS	EXAMPLE QUOTE
Time constraints	Not enough time, general mention of time as a challenge	63	Time consuming [1]
	Managing one's time, establishing a routine	11	Time management [49]
Perceived no need	Not necessary, no benefit, not important to record, just deal with the problem immediately	25	Keeping it relevant, I don't want to record just to file it [86] We don't record in a written, we act on something when it's seen [128]
	Only record the treatment, and/or if there's a problem	16	We do insecticide spray recordings only [67] It's the treatment that gets recorded [71]
Administration constraints	Difficult and effortful to manually record; need a more efficient and convenient recording system	22	Inconvenience, constantly inspecting [72] Having to do it manually and maintaining it accurately [73] Having a program that assists in recording off site [114]
Labour/skill constraints	Not enough staff, cannot afford more staff, lack of knowledge/expertise/literacy, need to train staff	17	Lack of skilled staff who are available and want to work [11]
	Staff motivation and attention (to remain engaged and record things properly/accurately)	12	Human error, forgetting [3] Getting staff to do it [5]
No challenges	No challenges experienced	51	Not a challenge [120]
	No challenges experienced because do not record at all	10	We don't record it, no challenge [188]

4.3.4 Detection

Perceived technical expertise

On a scale from 0 (below average) to 2 (above average), perceived technical expertise was 1.49 on average (SD=0.62) indicating a higher level of perceived expertise in making decisions about whether something requires further investigation (Figure 12).



Below average	Average	Above average
14	81	118

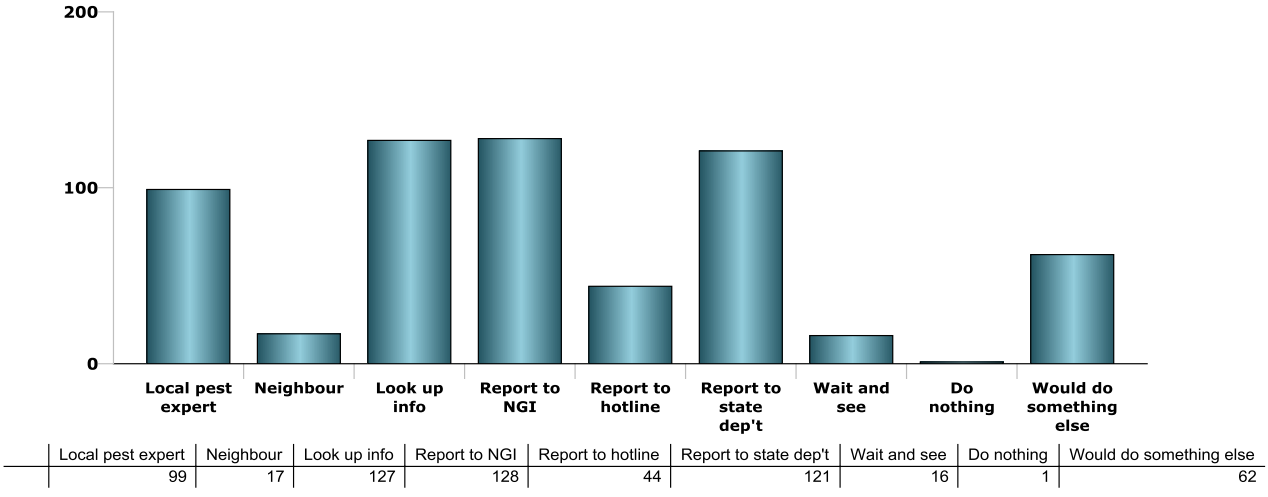
Figure 12 Ratings of technical expertise of nursery staff in detecting signs of pests that may require further testing

4.3.5 Reporting

Likely response to a strange sign

If they noticed something strange, roughly 50% of participants indicated that they would respond by searching for more information on pests, consulting with a local pest expert, or reporting it to either state or national Nursery and Garden Industry or the state Department of Primary Industry or Agriculture. Very few indicated that they would talk to a neighbour for advice, or just wait and see. About 25% indicated that they would report it to the plant pest hotline.

For those who indicated they 'would do something else', quite a few stated they would isolate/quarantine the affected plants (n=15) or try to treat the plant (n=14). Relatedly, a small number suggested that they would take a sample for testing (n=6) and/or endeavour to identify the problem (n=4). Additionally, some stated that they would contact someone with expertise in the industry (e.g., industry development officer, biosecurity contact, CSIRO, another agency, industry association) (n=19) or a government department (e.g., DPI) (n=6).



Local pest expert	Neighbour	Look up info	Report to NGI	Report to hotline	Report to state dep't	Wait and see	Do nothing	Would do something else
99	17	127	128	44	121	16	1	62

Figure 13 Participants who would take certain actions in response to spotting a suspicious sign of a pest

Challenges

When asked about the biggest challenge that may face nurseries in formally reporting suspicious signs of a pest or disease, the following reasons were identified (Table 9).

Table 9 Main challenges in formally reporting signs of a pest or disease

THEMES	SUB-THEMES	FREQUENCY OF MENTIONS	EXAMPLE QUOTE
Business impacts	Fear of quarantine, business shut-down or production interrupted	87	Because it might quarantine them [160] Terrified of being shut down [11]
	Financial loss, loss in sales/business, no income, costs involved in reporting/eradication	66	Because they could be shut down for a time and lose a lot of income [204] Because they will shut your nursery down and not compensate you at all [12]
	Reputation loss	12	Reputation can be called into question [1]
	Plant material loss	5	Fear of having to dispose of stock [164]
Labour/skill constraints	Lack of knowledge/awareness, blasé attitude, unsure of process of reporting	30	The lack of expertise in many areas due to minimal staffing and experience [205] They don't understand it's a serious matter [26] Not being able to identify it as a risk [63]
Biosecurity process	Negative/fearful view of reporting (too slow, unreasonable, heavy-handed, not confidential), being blamed, no help provided, don't want to be investigated	37	Authorities being heavy handed [28] They fear an unreasonable response from the regulator [144] Scared of getting into trouble [43]
	Mistrust government	3	General suspicion of government agencies [161]
Time constraints	Too busy to report	3	Too busy [129] They are time poor [133]
Don't know why they wouldn't report		19	I don't know why they wouldn't do it [138]

4.3.6 Threat perceptions

Own nursery vs. industry

Participants on average reported that the % likelihood (ranging from 0% to 100%) of an exotic pest incursion would be higher for the nursery industry as a whole (mean=48.45%, SD=32.27%) as compared to their own nursery (mean=8.17%, SD=13.81%). Only two participants rated that the likelihood of an exotic pest incursion in their nursery would be higher than 50%, whereas 72 participants rated that the likelihood of an exotic pest incursion in the industry would be higher than 50%.

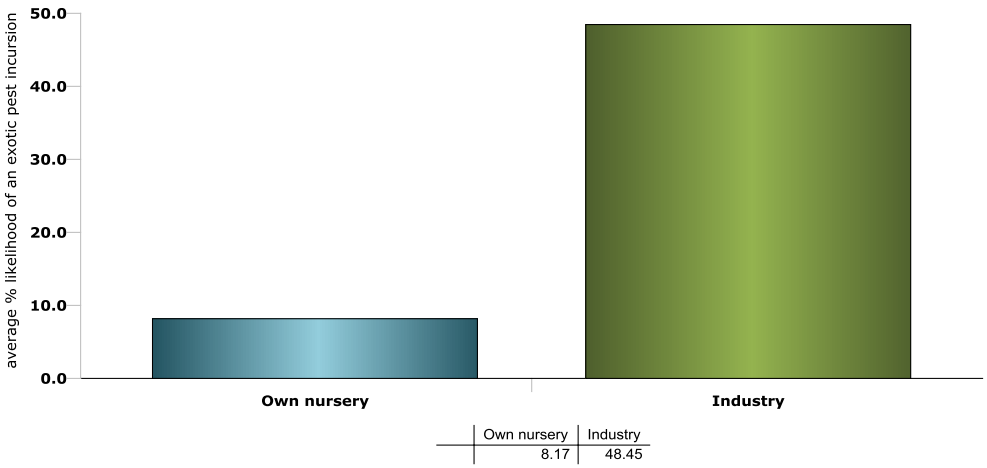


Figure 14 Average perceived likelihood of an exotic pest incursion occurring in the next 12 months

4.3.7 Biosecurity Tools/Supports

Currently used

Participants were asked about the tools that they currently use, being provided with a list including:

- the Industry Biosecurity Plan (IBP) for the Nursery Industry
- the Biosecurity Manual for the Nursery Production Industry
- the BioSecure HACCP Manual
- the Nursery Production Farm Management System website www.nurseryproductionfms.com.au
- the FarmBiosecurity website www.farmbiosecurity.com.au
- Pest ID, the online electronic plant pest identification resource provided by NGIQ
- any mobile apps that help growers identify and report suspicious signs of pests and diseases

The vast majority of participants indicated that they never or rarely use these tools (ranging from 68% for PestID to 89% for mobile phone apps to identify pests). This is reflected in average scores that hover towards the bottom end of the scale from 0 (never) to 3 (often) as shown in Figure 15.

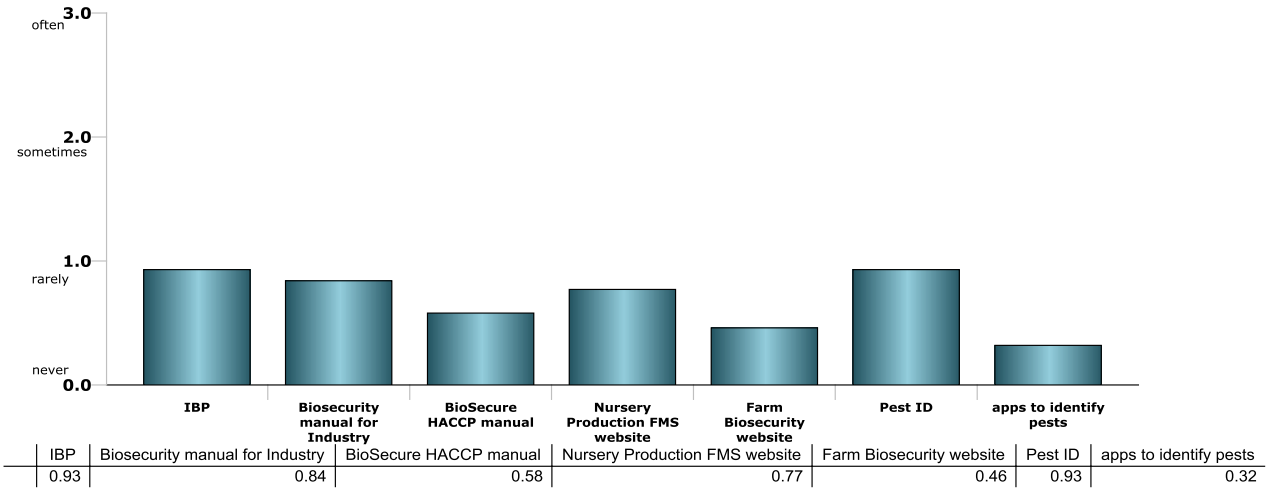


Figure 15 Mean rating of use for different biosecurity tools currently available to production nurseries

Support required

When asked to freely nominate anything else that the industry could provide their nursery to help improve its capacity to engage in plant health surveillance, the following suggestions were offered (Table 10).

Table 10 Supports required

THEMES	SUB-THEMES	FREQUENCY OF MENTIONS	EXAMPLE QUOTE
Labour/skill	Need for staff training, workshops, education, traineeships	24	Probably more education like courses for registered nurseries [172] More pest identification field days [207]
	Accessible local contact person, extension officer, qualified inspectors to help	16	Have more consultants available [54] Have more field officers to respond to enquiries [56] Extension officers who would assist farmers [60]
Financial	Monetary support for labour to perform plant health surveillance, accreditation	8	Some way to deal with labour costs with record-keeping [115] Funding to allow for all inspections we have to have [118] Something to help with the labour requirements of recording and inspecting [119]
	Free or cheap microsopes	2	Provide free or cheap microscopes [183]
Pest information	Real-time information/alerts on pests (local, current, imminent threats, overseas pests of concern)	34	High-risk communication for us to look out for pests onground [78] Regular information on risks [103] More information on worldwide pests and disease that are affecting overseas, proactive information [63] Useful to have a system email alert to keep people current with what happens in the industry. Hard to know what is happening country-wide especially important when new issues are arising [66]
	Visual pictures, printable material on pests	11	Materials to show staff, pictures etc. [127] Physical photo identification card of pests and diseases so that staff know what they are looking out for [146]

			Perhaps a colour wall chart of common insects with 10x magnification of typical hand lens [173] Need appropriate information, especially pictures very early of threats [115]
	Easier-to-use tools for identification and recording	30	Provide a proforma record book [64] A good crop monitoring app would be great [87] More simple app on my phone, I've tried some but couldn't really operate them [108] I know everyone has been going on the phone apps, they are difficult to use [173]
	Information on managing pest outbreak	5	More information on pest incursions to educate people on how to handle them [128] Information on how to deal with an outbreak [73]
	Information on how to inspect, make records &/or report	7	Some sort of guidebook for inspections and record keeping [151] Handbook on procedures about inspections and record keeping [37] More information on how you go about reporting and checking on plants coming in [96]
Biosecurity system	Focus on quarantine – entry into Australia and interstate movements	9	Plants brought into Australia [105] Allowing too much foreign fruits and vege from overseas is a real risk, government should restrict that more [130] It's not us, it's the illegal imports and backyard operators [149]
	Greater regulation of nurseries (mandatory inspections, record-keeping, media accreditation, registration) including promotion of accreditation	13	Nursery registration and accreditation of propagation material [41] A legislated requirement for nurseries to be registered and accredited – the rest follows from there [203]
	Climate of support and help for the business	3	Glad (to) have agriculture department here on site if I was assured that I wouldn't be closed down if an incursion was found. I want them to come prepared and know what it is and what I need to do to stop the incursion – proactive approach not a reactive approach and the shut-down approach [86] The industry needs to rise above bureacracy and be more practical about the issues and problems that occur [161]
No support required	Don't need help	53	Nothing [187]
	Already have enough support and information	17	Not really, we are mostly accredited for stock in Tasmania, the training was very good [180] The industry is already doing a great job with what they are doing now [18]
We're too remote/small to be given support		5	Difficult to say we don't have much contact with them, never had a visit. We're too small for them to bother with [30] Difficult to get anyone to come up to North Queensland when there is a concern. Workshops and things are run by nursery industry who don't come up here [124]

4.3.8 Accreditation/Certification

Accreditation status

More than half (57.75%) of participants did not hold any type of accreditation. Approximately one-third (29.11%) are NIASA-accredited, and very few were BioSecure HACCP-, EcoHort- or QA Program accredited/certified.

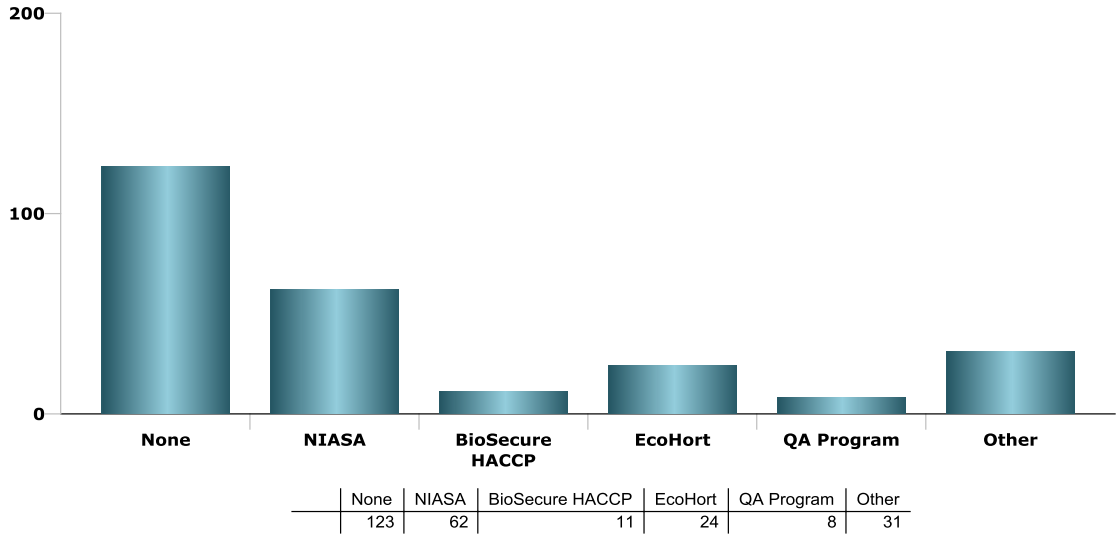


Figure 16 Participants with different accreditations/certifications

Self-rated Knowledge of BioSecure HACCP

Across the sample, there was considerable variation in knowledge of BioSecure HACCP (see Figure 16) (Note that one participant did not answer this question). Around 45% of participants either knew nothing or only a little about BioSecure HACCP.

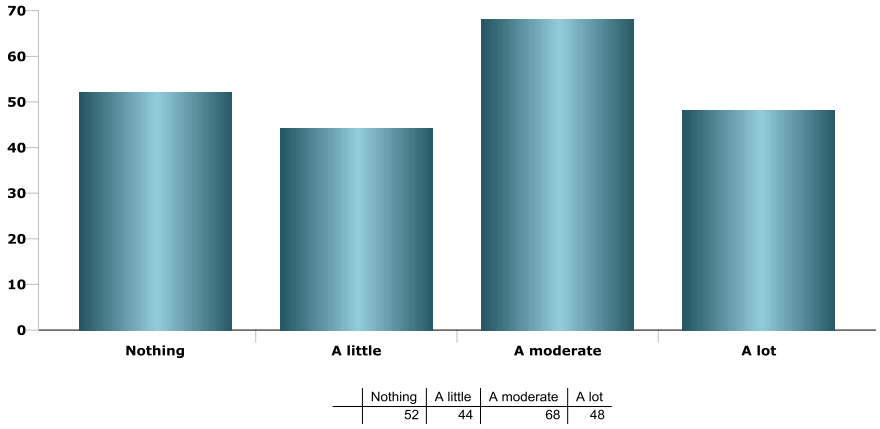


Figure 17 Ratings of knowledge of BioSecure HACCP

Intentions to gain BioSecure HACCP

The majority (67.33%) of participants currently without BioSecure HACCP (n=202) reported that they did not intend to gain BioSecure HACCP certification. Approximately one-fifth (22.27%) stated their intentions to do so in the next few years and the remainder were either about to apply this year (4.46%), or were currently in the process of applying (3.47%) (Note that 5 participants did not

answer this question; and 11 were not presented this question because they already held BioSecure HACCP certification).

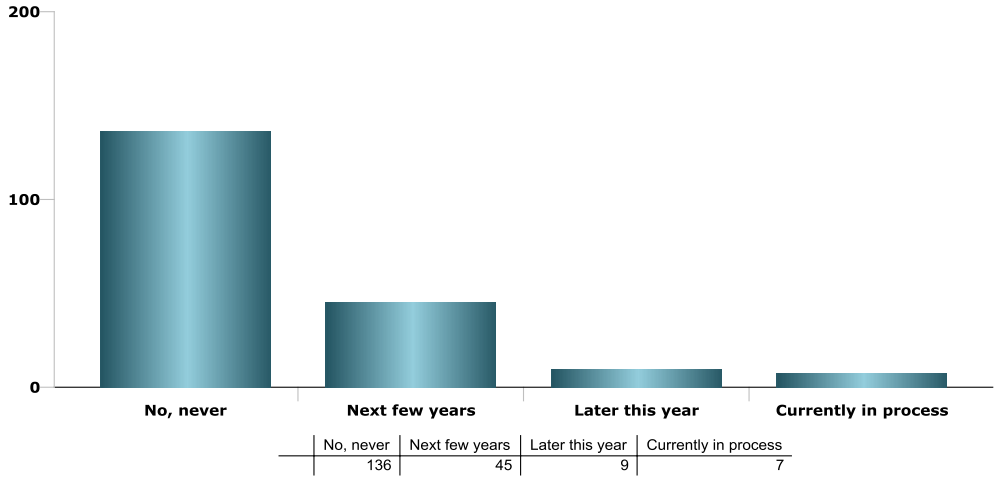


Figure 18 Ratings of intentions to gain BioSecure HACCP certification

4.3.9 Producer Typology

Our earlier review of 39 plant production industries across Australia proposed that production nurseries, in comparison to other industries, may be considered to have medium 'capacity' to develop and implement a plant health surveillance and reporting system, and to be at medium 'risk' in terms of the potential economic loss from an exotic pest incursion (refer to Collins et al., 2018, Deliverable 4 and Section 2.3 of the current report).

A similar risk and capacity typology assessment may be undertaken at the individual producer level – to determine the presence and extent of variation in the biosecurity capacity and risk profiles of production nurseries. The results from such an exercise may inform the tailored design and targeted delivery of grower-led surveillance initiatives, such that production nurseries are receiving the assistance they need.

We therefore followed a similar method to that used in our previous industry typology analysis, by first identifying relevant indicators of biosecurity capacity and risk at the individual production nursery level. However, our method then diverged by retaining all the indicators and subjecting them to a latent profile analysis (described below).

Indicator selection

1. **Biosecurity capacity** was defined as the individual production nursery's capacity, as represented by its human capability and motivation, to develop and implement a plant health surveillance and reporting system. Human capability was reflected by the nursery's current surveillance and record-keeping practices[2], their accreditation/certification status, and perceived skill or expertise in surveillance and detection. Motivation was reflected by

[2] We only included those key plant health surveillance practices that are considered relevant to all production nurseries.

the relative importance the nursery placed on plant health surveillance and record-keeping, and their intentions to gain BioSecure HACCP in the future.

Thus, the indicators for biosecurity capacity included:

- Nursery plant and plant material inspections (crop monitoring)
- Imported plant and plant material inspections
- Dispatched plant and plant material inspections
- Record-keeping
- Accreditation/certification status
- Intentions to gain BioSecure HACCP certification
- Perceived technical skill in inspections
- Perceived technical expertise in detection
- Relative importance placed on inspections
- Relative importance placed on record-keeping

2. **Biosecurity risk** was defined as the risk to the individual production nursery in terms of the potential economic loss and likelihood of an exotic pest incursion. Potential economic loss was reflected by the total value of production for the business in the last year. The likelihood of an exotic pest incursion was assessed by the percentage of its imported (and exported) stock from (to) interstate or overseas markets, and the production nursery's self-reported risk of a pest incursion in the next 12 months.

   Thus, the indicators for biosecurity risk included:

   - Value of production
   - Origin of imports
   - Destination of exports
   - Perceived risk of pest incursion for the nursery, in the next 12 months

Appendix F provides the scoring key for each of the indicators of biosecurity capacity and biosecurity risk. Each production nursery was given a score for each indicator, ranging from low to high values (to reflect low to high capacity or risk).

Identification of producer typology

A series of latent profile analyses were conducted to examine the heterogeneity in biosecurity capacity and risk profiles among producers. This type of analysis categorises people into mutually exclusive and exhaustive sub-groups whose members show similarity in their responses on the observed indicators. Four latent profile analyses were performed using STATA/MP 15.1. The models were compared on the basis of the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), the conceptual interpretability and utility of the class structure, and adequacy of class sizes. Table 11 summarises the fit criteria and expected class sizes of five models.

The fit indices indicated an improvement in model fit as the number of classes increased, however the 5-profile model contained one profile with only 5 participants. The 2-profile model contained more commonly-acceptable, adequately-sized classes (at around the n=100 mark), it did not seem to distinguish the small sub-group of known producers in the population who are accredited and engaged in best practice plant health surveillance. This small group was however revealed in the 3-

profile model. Ultimately, the 3-profile model was selected given its statistical and parsimonious fit to the data, and the conceptual interpretability of the three profiles.

Table 11 Latent profile fit statistics and expected proportion in the population and expected sample number (based on posterior probability)

NO. OF PROFILES	NO. OF FREE PARAMETERS	LOG-LIKELIHOOD	AIC	BIC	EXPECTED POPULATION PROPORTION (EXPECTED SAMPLE N)				
					Profile 1	Profile 2	Profile 3	Profile 4	Profile 5
1	28	-4340.47	8736.930	8831.046	100.00% (n=213)				
2	43	-4198.51	8483.014	8627.549	50.42% (n=106)	49.58% (n=107)			
3	**58**	**-4157.29**	**8430.573**	**8625.528**	**49.55% (n=105)**	**42.95% (n=92)**	**7.50% (n=16)**		
4	73	-4048.63	8243.269	8488.643	6.83% (n=14)	44.61% (n=94)	7.47% (n=16)	41.09% (n=89)	
5	88	-3850.35	7876.697	8172.490	9.01% (n=19)	41.78% (n=87)	39.43% (n=85)	7.44% (n=16)	2.35% (n=5)

Note. Bold font indicates selected model. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

Table 12 summarises the overall sample item means, the within-profile item means (and associated standard errors). For ease of reference, we have applied colour codes to reflect low (red), medium (orange) or high (green) capacity as per the response scale for each of the biosecurity capacity indicators. Similarly, we have applied colour codes to reflect low (green), medium (orange) or high (red) risk for each of the biosecurity risk indicators.

Table 12 Estimated means (SE) for the 3-profile model and the overall sample

INDICATOR	RESPONSE SCALE RANGE	OVERALL SAMPLE ITEM MEAN (SE)	PROFILE 1 lower capacity moderate risk	PROFILE 2 higher capacity moderate risk	PROFILE 2 higher capacity higher risk
Biosecurity Capacity		n=213	n=105	n=92	n=16
Inspecting plants	0 (never) – 5 (daily)	4.59 (0.05)	4.59 (0.07)	4.58 (0.08)	4.69 (0.19)
Inspecting imports	0 (never) – 4 (every import)	2.75 (0.12)	2.35 (0.18)	3.07 (0.19)	3.35 (0.45)
Inspecting dispatches	0 (never) – 4 (every dispatch)	3.90 (0.04)	3.89 (0.05)	3.90 (0.06)	4.00 (0.14)
Recording	0 (never) – 4 (always)	1.89 (0.11)	0.35 (0.07)	3.40 (0.08)	3.42 (0.18)
Accreditation	0 (none) – 3 (BioSecure HACCP)	0.78 (0.07)	0.54 (0.09)	0.81 (0.10)	2.30 (0.25)
Intention to gain BioSecure HACCP	0 (no, never) – 4 (already BioSecure HACCP)	0.43 (0.05)	0.20 (0.06)	0.47 (0.06)	2.70 (0.23)
Inspecting skill	0 (below average) – 2 (above average)	1.56 (0.42)	1.44 (0.06)	1.63 (0.06)	1.93 (0.15)
Detection skill	0 (below average) – 2 (above average)	1.49 (0.04)	1.38 (0.06)	1.55 (0.06)	1.81 (0.15)
Inspecting importance	0 (not at all important) – 3 (high importance)	2.79 (0.03)	2.70 (0.05)	2.88 (0.05)	2.93 (0.13)
Recording importance	0 (not at all important) – 3 (high importance)	1.64 (0.08)	0.94 (0.09)	2.24 (0.09)	2.80 (0.22)
Biosecurity Risk					
Production value	1 (up to $200,000) – 7 (above $10,000,000)	3.17 (0.11)	2.91 (0.15)	3.17 (0.16)	4.94 (0.40)
Origin of imports	1 (imports only from local sources) – 4 (imports include overseas)	2.53 (0.05)	2.50 (0.08)	2.49 (0.08)	2.93 (0.19)
Destination of exports	1 (exports only to local sources) – 4 (exports to overseas)	2.47 (0.07)	2.44 (0.10)	2.43 (0.11)	2.82 (0.27)
Perceived risk of exotic pest incursion	0% (not at all likely) – 100% (it's certain)	8.17 (0.95)	7.26 (1.36)	8.81 (1.47)	10.62 (3.53)

Profile 1 comprised a large segment (n=105, 49.3%) of production nurseries that prioritised the inspection of plants in the main nursery as well as dispatches, but paid less attention to the inspection of imports and record-keeping. While their inspecting and detection skills were generally better than average, they were less likely to have some form of nursery accreditation and expressed a low desire to gain BioSecure HACCP certification in the future. These nurseries tended to have a lower production value but some exported (and/or imported) plant material to (and/or from) more than locally or intrastate, mainly into interstate markets.

Further analysis of profile 1 revealed the general location of these nurseries: 57 (54.3%) in major cities, 37 (35.2%) in inner regional areas, and 11 (10.5%) in outer regional areas.

Profile 2 comprised another large segment (n=92, 43.2%) of production nurseries that also prioritised the inspection of plants in the main nursery as well as dispatches, but unlike Profile 1, they still paid some attention to the inspection of imports and record-keeping (and rated these activities as somewhat more important than other business duties). Similar to Profile 1, these nurseries were generally less likely to be NIASA-accredited or BioSecure HACCP-certified and showed low intent to gain this accreditation/certification in the future. Their self-reported skills in inspecting and detection were also generally better than average. These nurseries, on average, had a production value just below the mid-point of the scale and also transacted more broadly than their local and intrastate markets, entering into the interstate markets.

Further analysis of profile 2 revealed the general location of these nurseries: 48 (52.2%) in major cities, 31 (33.7%) in inner regional areas, 11 (12.0%) in outer regional areas and 1 (1.1%) in remote areas (1 nursery provided a postcode that was unknown).

Profile 3 comprised quite a small number (n=16) of production nurseries. This select group is characterised by relatively high scores across all the biosecurity capacity indicators. Of particular note is the fact that these nurseries are more likely to be NIASA-accredited or BioSecure HACCP-certified. In terms of biosecurity risk, this group contained nurseries with a higher production value on average. Most transacted plant and plant material with at least the interstate market, and half (n=8) indicated that they even transacted with overseas markets.

Further analysis of profile 3 revealed that all these nurseries were located in major cities.

4.4 Main Findings

We again highlight the fact that our sample of production nurseries was predominantly made up of nurseries that produced ornamental plants (n=103, 48.4%) or landscape stock (n=40, 18.8%). There remains a large number of other types of nurseries who are not represented well in our survey (i.e., seedling, forestry, fruit and nut tree, plug and tube stock, revegetation stock, and mine revegetation). Ultimately, this means that the following findings should be interpreted as being reflective of a smaller subset of production nurseries that produce ornamental plants or landscape stock.

4.4.1 Inspections

Most producers stated that they conduct daily (if not weekly) inspections of plants and plant material in the main nursery. Producers also appeared to place a high priority on this activity –

that is, the vast majority stated that inspecting plants and plant material was highly important compared to other activities in running their business. Furthermore, most nurseries (93.90%) felt that they have at least an average level of technical skill to conduct inspections – suggesting that skill is not a barrier for the majority. Additionally, we noted that the vast majority of producers (93.4%) felt that they had at least an average level of technical expertise to determine whether a strange sign required further investigation or not. Overall, these results indicate that producers across the board are performing plant inspections to a standard consistent with best practice. When asked for the main challenge encountered in inspecting plants and plant material, many indicated that they experienced no challenges at all. However, those that did raised the following top issues:

- Time constraints, both in terms of simply not having enough time and in the management of time.
- Labour/skill constraints, in terms of not having enough skilled staff
- Pest management, in terms of the difficulties associated in identifying pests accurately and early, keeping up-to-date with new pests and treatments, and in controlling pests.
- Scale of production, in terms of having a high volume, variety and throughput of plants to inspect

Inspection of other vegetation elsewhere on the property is less frequent across the board – this may be partly a reflection of the type of production nursery – that is, some nurseries may not necessarily have other vegetation on site that they need to monitor. Similarly, engaging the services of a local pest expert was not common across the board – the majority (53.40%) had never used this service. Around one quarter did so rarely, and about one in every five nurseries did so at least every few months. Again, it is possible that there is no need for this service to be performed with regularity for some nurseries, and/or cost could be a significant barrier (something which was identified in our stakeholder interviews).

Inspection of imported or dispatched stock revealed that most producers inspected every import/dispatch. However, there was a good proportion (24.4%) who never inspected imported stock. The relatively stronger focus on monitoring dispatched plants and plant material is not surprising as the potential consequences of selling poor quality stock are salient and negative (in terms of reduced return business). This raises the question: What can be done to support producers in conducting appropriate quarantining and checks on imported stock?

Purchasing of NIASA- or similarly-accredited plant material was highly variable (ranging from 0% to 100%, and averaging 47.28% of all purchased material). It is possible that the low number of NIASA-accredited suppliers may put downward pressure on this variable – that is, nurseries may not be able to purchase NIASA-accredited plant material because there simply is an insufficient number of suppliers with this accreditation.

Suggestions for improving inspections

The survey results indicate that there is room for improvement in inspection activity, especially beyond the main nursery and of plant material due to be dispatched. In particular, the inspection of newly-imported plants and plant material was not performed as frequently. Inspections are a time-intensive activity, and given the sheer volume of plants and plant material that many

nurseries need to monitor, it would appear that producers would benefit from support in the form of additional skilled labour (as indicated by many of our survey respondents). To this end, it will be important to consider the availability and supply of trained staff, as well as the presence, accessibility and affordability of training courses to upskill staff in the industry. We also note that the perceived risk of an exotic pest incursion gravitated towards the lower-end of the scale range (~8% likelihood) indicating that producers perceive that it is unlikely they will experience an incursion over the next 12 months. This perception contrasts markedly against their risk ratings for the broader industry (~48% likelihood). In light of this differential, it may be possible to promote imports inspection by highlighting how this particular 'border-control' activity is something that can help protect them from problems that might emerge in the broader industry.

4.4.2 Record-keeping

Record-keeping can be identified as a significant area for improvement. A large proportion (35.21%) do not keep any records. Approximately one-third (27.70%) state that they always keep records, and the rest are in between. A similar pattern of results was observed for the importance placed upon record-keeping: a large percentage of producers stated that it was either 'not at all important' (20.66%) or of 'low importance' (26.29%). Given record-keeping is essential for the attainment of area freedom, it is clear that this is one area that needs attention. Around a quarter stated they did not experience any challenges in record-keeping. However, many challenges were reported by others, including:

- time constraints, with many highlighting that record-keeping is time-consuming
- perceptions that record-keeping is not needed, only when a problem is encountered or treatment applied
- administration constraints, reflecting the difficulties, inconvenience and inefficiencies in having to record
- labour/skill constraints, both in terms of not having enough skilled staff and maintaining staff motivation and attention to record things

Suggestions for improving record-keeping

There is substantial room for improvement in record-keeping among producers – it does not appear to be a commonly-performed activity, except in situations where there is an emergent problem and/or where a treatment has been applied. Similar to that of inspections, producers may benefit from support in the form of skilled labour to keep on top of record-keeping. However, it is even more crucial for record-keeping to be a simple, easy, convenient and effortless activity for producers to do. For example, it may be possible to create a pre-populated automated form indicating 'below threshold' or 'absent' pests – such that producers need only interact with/modify the form (by say, clicking/checking a button) in the instances where they have noticed a problem and/or applied a treatment. This process would therefore be consistent with their current mode of operating where producers only record by exception. Furthermore, given that almost all producers (~96%) indicated that they inspect every dispatched plant and plant material, we can suggest that any efforts to promote record-keeping should focus on recording at the point of dispatch in particular. By focussing support for recording of inspection activity at this

clearly critical/important juncture in the supply chain, producers may be more willing to comply, and it may be possible to derive a comprehensive understanding of plant health across the industry.

4.4.3 Reporting

It would appear that many producers would respond proactively to noticing a strange sign of a pest, either talking to a pest expert/agronomist, searching for more information, taking a sample, or notifying the NGI, state department, or plant pest hotline. Very few stated that they would only 'wait and see', 'do nothing', or talk to their neighbour. Via an open-ended, hypothetical question, we further elucidated some of the most significant challenges to making formal reports as:

- fear of quarantine or business shut-down/interruption
- financial loss or the costs involved in reporting/eradicating
- fear of the response from authorities
- labour/skill constraints in terms of staff lacking knowledge/awareness or assigning importance to the matter
- reputation loss

Suggestions for improving reporting

The present sample of producers indicated that they would be proactive in seeking assistance (including formally reporting) if they were to notice something strange. However, when asked why other producers may not report, the main responses listed above indicate that there exist a number of significant barriers to reporting. Given the purview of this project in identifying ways of supporting producers in reporting suspicious signs of pests, it will be critically important to address these barriers. We note that these efforts may require quite substantial changes to the current reporting and response mechanisms in place, but ultimately should be informed/guided by the need to support the individual producer in maintaining and enhancing their livelihood in the long-term. It is this end goal that appears top of mind for producers, such that where they feel as though they will be actively supported through a pest incursion, they will be more likely to proactively seek assistance.

4.4.4 Producers' suggestions for improvements

It would appear that producers rarely use the biosecurity materials (e.g., industry biosecurity plan, biosecurity manual for the nursery and garden industry, Farm Biosecurity website) that have been specifically developed to support them. This low level of usage might reflect a lack of awareness that the tools exist, but also a fundamental lack of engagement with the tools and resources.

Around one quarter of participants indicated that they did not require any more support to improve pest and disease surveillance capacity in their nursery. However, many other producers mentioned the following possible improvements:

- Real-time information/alerts on pests so that people know what to look for. A few people also indicated that they would like information on how to inspect, keep records, report and manage pest outbreaks.
- Visual information – that is pictures/photos of pests so that producers know what they are looking for.
- Easier-to-use tools for identification and recording. This suggests that current apps may need to be redesigned with producers to ensure they are user-friendly.
- Labour/skill increases via training, workshops, education courses and traineeships, and/or the provision of on-the-ground local contacts to provide support.
- Biosecurity system improvements in terms of increasing regulation of the industry (e.g., legislated requirement for nurseries to be registered, promotion of accreditation) and its systems (e.g., accreditation of propogation material, mandatory inspections); as well as a focus on quarantine at borders (into Australia and interstate).
- Financial support to enable the business to employ staff for plant health surveillance activities, and/or accreditation/certification

Furthermore, only 29.11% of production nurseries were NIASA-accredited and even fewer were BioSecure HACCP-certified (n=11). A vast proportion (39.42%) do not have any accreditation at all. While 55% knew at least a moderate amount about BioSecure HACCP, 67.33% (of those currently without BioSecure HACCP) do not intend to gain certification in the future. Around one in every five nurseries (22.27%) however, said that they would do so in the next few years; and a small number were either in the process of certification or wanted to do it later this year. The fact that 45% know nothing or only a little about BioSecure HACCP suggests that more work needs to be undertaken to support producers in understanding what BioSecure HACCP (and its prerequisite, NIASA) involves, how to apply/participate and the potential benefits to the business. It may also be useful to reduce the barriers to entry and labour-intensiveness of participation (e.g., cost, reading dense information versus participating in practical courses) – so long as biosecurity outcomes are not adversely affected by these changes. To inform these endeavours, further research with producers would be required to understand their self-reported barriers to participation.

4.4.5 Biosecurity capacity and risk profiling

Our earlier industry typology report suggested that the production nursery industry may possess medium biosecurity capacity and biosecurity risk (in comparison to other plant production industries in Australia). Our analysis of the biosecurity capacity and risk profiles at the individual producer level lent support for these results. Here, we found 3 meaningful sub-groups of producers as follows:

- Profile 1: This large group (49.3%) of nurseries is characterised by lower biosecurity capacity and moderate biosecurity risk. These production nurseries tend to prioritise inspection activities in the main nursery and with dispatched materials, but show less regard for the inspection of imported materials and the need to keep records. They also show low motivation to gain accreditation/certification. Their self-reported skills (in

inspecting and detection) appear to be sound, which suggests that this group of nurseries has the capabilities required to perform plant health surveillance adequately. On average, these nurseries have a lower production value (compared to other nurseries), but they do transact more broadly than local markets (which raises their overall biosecurity risk a little).

- Profile 2: This large group (43.2%) of nurseries is characterised by higher biosecurity capacity and moderate biosecurity risk. These nurseries tend to be performing plant health surveillance and record-keeping to an adequate level, however, they do not seem to be inclined to seek formal accreditation/certification. These nurseries have a slightly higher production value than Profile 1, but are similar in terms of their market interactions.
- Profile 3: This small group (7.51%) of nurseries is characterised by higher levels of biosecurity capacity across all dimensions, and higher levels of biosecurity risk. These nurseries either were already accredited/certified (e.g., NIASA- and/or BioSecure HACCP) or expressed an intention to gain accreditation/certification in the future; and they believed their plant health surveillance and record-keeping practices were well aligned with best practice. On average, these nurseries had a higher production value and many either transacted with interstate and/or overseas markets.

Suggestions for tailoring grower-led surveillance and reporting to grower types

Both Profile 1 and 2 do not appear to be interested in gaining BioSecure HACCP certification, and given that these sub-groups comprise the vast majority (92.49%) of production nurseries, it may be important to explore some of the barriers to participation in BioSecure HACCP (this issue was not addressed in the survey), including simply a lack of knowledge/awareness of the scheme, or the costs to entry. Despite the widespread lack of BioSecure HACCP certification, both sub-groups still appeared to undertake plant and plant material inspections in the main nursery and of dispatched material, at a perceived acceptable level. Profile 2 also inspected imported material, and kept records at an adequate level – so the additional benefits of securing BioSecure HACCP may, arguably, not be especially critical for this sub-group (because they already are performing some activities relevant to the program).

This leaves approximately 50% of production nurseries that may require more intensive support to improve their imports inspection, and record-keeping activity – although this effort should be considered in light of their relatively lower biosecurity risk profile. As per our suggestions for improving inspections, this may involve upskilling staff and increasing staff availability and supply to the industry. And as per our suggestions for improving record-keeping, this may involve modifying the current system to make it easier and simpler for producers to do (e.g., prefilled recording sheets, automated uploads, recording-by-exception, only recording inspections undertaken on dispatched material).

5 Possible actions for designing and implementing a grower-led surveillance system

This case-study is based on an industry that is categorised as medium-risk, medium-capacity in the industry topology (see section 2). The case-study analysis showed that risk and capacity variation exists within a given industry. As such a range of possible actions to support a grower-led surveillance system for this industry are proposed based on our research findings. Responsibility for these actions is not prescribed here however, as some actions may be more relevant to industry and others more appropriate for government (jurisdictional or national) to implement or support. At the outset it is also worth noting the value of approaching endemic and HPP/EPP surveillance as part of the one system or set of procedures. Strong endemic pest management procedures will not only manage all of the usual (endemic) pest, disease and weed issues in the nursery that producers are most concerned about, but will also provide higher confidence in early HPP/EPP detection. Thus, a focus on plant pest management as one system, rather than separate approaches to endemic and HPP/EPP surveillance, would be expected to provide stronger overall biosecurity system.

These actions are focussed on building producers' biosecurity capacity (with a particular focus on enhancing producers' motivation to engage in plant health surveillance), and of fostering improved partnerships among industry and government stakeholders. This should contribute to the development of a positive climate that involves, understands and supports producers, and ideally can serve as a best practice model applicable to other plant industries. Some of these actions are developed further in the roadmap prepared for all 39 plant production industries covered by this project (Milestone 6).

5.1 Building producers' capacity

5.1.1 Monitoring

While the vast majority of production nursery personnel who were surveyed (comprising mainly owners and managers) rated plant inspection as a high priority activity for their business, our collective findings revealed that the monitoring of plants and plant material is quite variable, both within and between producers. Producers seem to prioritise the inspection of plants and plant material in the main nursery, and those that are due to be dispatched. However, the inspection of other vegetation on the broader nursery site, and of imported plants and plant material was generally performed less regularly.

This variability may be partly a reflection of the fact that many producers are time-poor, deal with large volumes of stock, and lack staff who are sufficiently skilled to monitor for pests in an efficient way. Most do not engage the services of a local pest expert to inspect their nurseries, with such

services seen as expensive. It is also the case that producers may be reluctant to undertake comprehensive and rigorous monitoring as they fear quarantine should a HPP/EPP be found.

Interestingly, interviewees noted the importance of monitoring plant and plant material as early as possible in the nursery production process – this includes imported stock (including seeds), germplasm production, plant propagation and growth of seedlings. However, there seemed to be a perception among some interviewees that stock imported from other states could be viewed as 'low risk' because it had already passed a number of inspections prior to arrival at the nursery. This perception may also partly explain why a certain group (around 30%) of producers reported that they never or rarely inspect imported stock. Somewhat of a corollary however, is that producers seemed to perceive that the risk of an exotic pest outbreak was far more likely in the broader industry (~48%) than in their own nursery (~8%). We would expect that such a differential would increase their efforts at inspecting imports, but it may well be that producers have confidence in their suppliers and consider a pest outbreak as occurring outside this supply chain.

Possible actions:

- Increase the availability, accessibility and affordability (e.g., subsidy) of on-the-ground personnel who are skilled in monitoring for pests.
- Build the capacity (i.e., knowledge, skills, resources) of producers by embedding pest monitoring and detection modules into existing nursery training programs and practical workshops.
- Consider strategies (e.g., financial and technical support – industry development officers) to promote and increase the uptake of NIASA accreditation and BioSecure HACCP certification.
- Promote the economic benefits of implementing a robust and well-structured crop monitoring, site surveillance and inspection program.
- Promote the importance of inspecting newly-imported plants and plant material as a preventative measure.
- Promote uptake and usage of existing pest management tools and resources (e.g., Pest ID), especially those that provide real-time information/alerts along with pictures or photographs of pests of concern. Review such tools and resources to ensure they meet producers' needs and abilities.

5.1.2 Recording

Both interview and survey data revealed that many producers see record-keeping as onerous, time-consuming and unnecessary. The survey results revealed that record-keeping activity was substantially lower than other types of plant health surveillance practices (especially among around 50% of producers whose recording practices were on average almost non-existent). Producers also tend to have less motivation to keep records because they may be occupied with what they view as more important competing priorities. Many producers keep records by exception – that is, only when they notice a problem that requires some action (e.g., pesticide application). However, even in this case, there may be a disincentive to record the presence of a possible HPP/EPP due to the fear of quarantine.

Possible actions:

- Development of a more efficient, flexible and convenient record-keeping process to make it easier for producers to record (especially while out in the field). Consider technologies that enable automatic pre-filling of records such that producers only need to make recording interventions on the infrequent occasions where there is a deviation from normal. This approach would also complement 'spotted anything unusual' campaigns.
- Increase the availability, accessibility and affordability (e.g., subsidy) of on-the-ground personnel who are skilled in record-keeping, and who can promote and assist with the adoption of record-keeping systems and procedures.
- Build the capacity (knowledge, skills, resources) of producers by embedding recording modules into existing nursery training programs and practical workshops.
- Consider strategies (e.g., financial and technical support – industry development officers) to promote and increase the uptake of NIASA accreditation and BioSecure HACCP certification.
- Promote the value of record-keeping in terms of better data for improved business decision-making. A real-life example and/or practical demonstration of this would be helpful.
- Consider strategies to improve and utilise records from the earliest stages of production through to the point of dispatch. Noting that dispatch is the point of the production process where almost all producers already inspect their plant material (because they have a strong market incentive/imperative to do so), this could be a feasible point for authorities and/or industry bodies to extract comprehensive industry data.
- Develop (or redesign) easier-to-use tools for pest identification and recording, and promote the uptake and usage of these systems.

5.1.3 Reporting

There appears to be a low rate of reporting of suspicious signs of pests in the production nursery industry, and while this may be a reflection of the fact that there is nothing to report, our interviews with stakeholders and survey data suggests that there may be other contributing factors. First and foremost, there appears to be quite a widespread fear of being investigated and quarantined, and the negative consequences this brings to the business (in terms of reputational and financial loss, loss of livelihood). This also extends to pest consultants working for chemical supply firms who may be able to identify HPPs/EPPs, but who also play a client support function. Some producers take steps to manage the problem themselves (e.g., isolate, test, identify problem, apply treatment) rather than report, and some may even not have the knowledge or expertise required to identify the risk and/or report it. We note that more than half of our survey respondents indicated that they themselves would formally report to the State NGI association or government department. The results from the interviews suggests that there are high-risk industry segments (e.g., non-members, backyarders, illegal importers, online sellers, market sellers) who are most likely to not report suspicious signs.

While this project is not tasked with considering changes to industry-government arrangements under the current Emergency Plant Pest Response Deed arrangements, many respondents indicated these arrangements can have a significant impact on producers' willingness to report. Thus a number of possible actions are included that reflect suggestions provided by respondents with regard to these arrangements that may help improve future reporting rates.

Possible actions:

- Better design of communications and engagement around emergency response, including of quarantine procedures, in order to enable continuous improvement of the system, minimise the fear of the consequences of reporting suspicious signs of a pest, and increase awareness of quarantine as a process that is ultimately beneficial for nursery businesses.
- Consider:
    - NGIA, with support of all EPPRD Parties, to work together to investigate options to promote reporting of suspect EPPs (i.e., reduce barriers to reporting) through mechanisms including:
        - expansion of the coverage of Owner Reimbursement Costs arrangements and the response phases they are available in – noting this process is currently underway via the EPPRD (NGIA pers. comm.)
        - implementing a plant biosecurity insurance scheme to cover all stages of the response process (e.g., during the entire quarantine period for a given property)
    - improved planning for HPPs/EPPs by the various parties involved in the pest categorisation and approval process to reduce the time taken to a response decision
    - better communication around the work involved in confirming the presence of a pest, so producers understand the length of time needed
    - improving state and territory arrangements to enable ongoing trade of unaffected stock during quarantine (i.e. partial quarantine) in a timely manner
    - provision of a technical support officer to provide on-the-ground practical training and support regarding emergency response and to maintain and improve the business.
- Where possible consider strategies (e.g., financial and technical support – industry development officers) to promote and increase the uptake of NIASA accreditation and BioSecure HACCP certification.
- Increase the availability, accessibility and affordability (e.g., subsidy) of on-the-ground personnel who are skilled in the identification of HPPs/EPPs.
- Provision of practical training on HPPs/EPPs and the detection/identification of such, obligations to report, subsequent quarantine procedures, related compensation schemes and any ability/flexibility to continue trade.

5.1.4 Producer segments

There are certain production nurseries that may require targeted assistance in building their biosecurity capacity. Both interview and survey data identified that lower-production value nurseries may lack capacity, presumably because they lack the ability to employ specialist staff to perform plant health surveillance. Some of these nurseries may also be remote, making it difficult for government staff to conduct visits.

Additionally, there were significant concerns raised by both stakeholders and producers regarding the many unregulated nursery producers in the market. Production nurseries surveyed reported they are concerned about so-called 'backyard operators', who they believe may be buying overseas plant starter material (seeds, cuttings) online and/or selling at markets. Producers consider that the identity and location of these operators are unknown, as they believe they are hidden in the supply chain, and therefore not noticed by government. As such, producers believe these backyard operators seem to be 'immune' from any biosecurity requirements, and it is believed by both industry body representatives and individual producers that these backyard operators are contributing to a critical pathway for pest transmission in the nursery industry.

Finally, we observed a significant portion of producers (45%) who know nothing or very little about BioSecure HACCP, and our typology also revealed a sub-group (43%) who could be considered to have a level of biosecurity capacity (as evidenced by their plant health monitoring, recording practices; skill; and interest) but have no desire to attain accreditation/certification in the future. This raises the question of what can be done to promote BioSecure HACCP certification (and its prerequisite, NIASA accreditation) to this group of producers who already have the requisite abilities and motivation to fulfil its requirements.

Possible actions:

- Consider articulating a value proposition and providing additional and/or outreach assistance to smaller, lower-production value, and remote nurseries who may be resource-constrained.
- Consider strategies to address the unregulated segments of the market (e.g., formal registration, licensing).
- Consider strategies (e.g., financial and technical support – industry development officers) to promote and increase the uptake of NIASA accreditation and BioSecure HACCP certification.

5.2 Building producers' motivation

In addition to supporting producers in, and providing them with the opportunities to build their knowledge, skills and abilities (including resources) to undertake plant health surveillance, it is important to foster their natural desire or motivation to do so. In fact, motivation is an essential element to any conscious behaviour change effort. While we have suggested that some of the barriers to engaging in monitoring, recording and reporting may be addressed through practical training, on-the-ground technical support, easier/simpler systems and processes, and financial support, a fundamental principle underlying these initiatives is that they (ideally) should help boost producer motivation as well (i.e., increase their perception that plant health surveillance is

important and worthwhile). There is some indication from our survey results that producers generally view plant inspections as highly important, but a certain sub-group (of around 50%) do not see recording as especially important. Additionally, from a threat perception point of view, we found that producers perceived the risk of an exotic pest incursion as quite low (~8% likely) in their nursery, but much higher across the wider industry (~48% likely) - suggesting that producers feel as though a pest incursion will occur to someone else in the industry, but not themselves.

Our interviewees suggested a range of factors that may enhance producer motivation, including: greater benefits (or avoided costs) and savings; the opportunity to be seen as a reputable 'professional' nursery manager; activities that are easy and fast to do, and compatible with existing procedures; a perception of risk (of pest incursion); and, a sense of doing the right thing (in terms of being responsible for following laws and regulations). Many of these aspects can be considered in the design and delivery of new initiatives or when revising current initiatives.

Possible actions:

- Consider how best to frame messages when communicating with producers, so that it accords with their personal interests, is relevant to them and gains their attention.
- Consider the 'keep it simple', ease, and compatibility principles when designing plant health surveillance systems. The less obstacles and difficulties that a producer encounters, the higher the prospects of uptake and usage.

5.3 Facilitating better partnerships

5.3.1 Shared responsibility and government liaison

Many interviewees expressed quite a strong negative sentiment regarding the nature of existing partnerships between producers, and industry and government. In particular, the concept of 'shared responsibility' tended to be viewed negatively, with producers making the assessment that government have disinvested in plant biosecurity (e.g., by reducing on-the-ground pest experts and extension officers) and shifted responsibility to industry – rather than truly modelling shared responsibility among all stakeholders (including government). In the eyes of stakeholders, as well as producers themselves, government tended to be viewed as assuming a distant, punitive and regulatory role rather than an engaged, supportive and facilitatory role. Stakeholders also saw government as lacking in knowledge of, and genuine concern for the nursery industry and growers' concerns. These factors may be contributing to a climate of cynicism and distrust, and hence a lack of co-operation with biosecurity initiatives. To improve the relationship between government, industry and producers, most interviewees saw the need for greater personal engagement with growers and a demonstrated commitment to providing substantive support for grower-led biosecurity efforts.

5.3.2 Accreditation across the supply chain

Another aspect related to partnerships was relationships across the supply chain. Some interviewees noted that some major end-use customers (such as large retailers and government organisations) do not require NIASA accreditation from their nursery suppliers, which reduces the

incentive for producers to gain such accreditation. However, the survey results also showed that almost half of plant material purchased by nursery producers does not have NIASA or similar best practice accreditation. The limited number of producers who hold NIASA accreditation may contribute to this problem, as purchasers face a situation of limited supply of accredited product, nevertheless this again points to the need to support initiatives that encourage producers to gain such accreditation.

Possible actions:

- Consider implementing a communication and engagement plan to develop genuine partnerships among producers, industry and government stakeholders (see Section 6).
- Increase the availability, accessibility and affordability (e.g., subsidy) of on-the-ground personnel, who are resourced to visit nurseries, skilled in plant health surveillance practices, and who can promote and assist producers with maintaining and enhancing their nursery's biosecurity capacity and resulting practices.
- Mechanisms to promote and support all participants in the nursery supply chain to encourage their suppliers to hold best management and biosecurity accreditation/ certification such as NIASA and Biosecure HACCP.

6 Communication & Engagement Plan

Communication and engagement is a key mechanism for working with growers to assess and manage biosecurity risks. Stakeholder engagement needs to occur across all scales, from the farm gate to policy development and implementation. It also needs to occur during all biosecurity operations, for effective stakeholder engagement requires time to build relationships, mutual learning and trust. Fostering a sense of shared responsibility for biosecurity through effective stakeholder engagement and communication is central to successful biosecurity surveillance efforts.

In terms of a communication and engagement plan it is important to consider the why, how and what elements of these activities.

Why engage? It is important that communication and engagement respond to the major concerns of key stakeholders. As outlined above, concerns reported by growers broadly focused on:

- Disincentives to report – due to impact on the business from biosecurity response
- Need for practical knowledge – there is a lack of ability to identify pests
- Resource constraints – biosecurity surveillance takes time and is costly

Thus, the individual benefits of surveillance, often unclear to the grower, need emphasis:

- Early detection and control – can improve production while reducing costs of infestation
- Better records – enable greater knowledge about the business to achieve efficiencies
- Improved reputation – can help gain premium markets/customers

How to engage? – The need to support a suite of appropriate stakeholder engagement strategies was highlighted. From this case-study analysis it was clear that:

- NGIA is critical as a broker of information and knowledge sharing– newsletters, information forums and technical workshops are highly valued by local growers
- On-ground technical support is a key aspect for local growers to undertake surveillance activities– investment in on-ground staff provides a two-way benefit for growers to understand key biosecurity threats and issues and government to understand grower concerns and motivations
- Messaging is important – Growers respond well to a clear description of risk and benefit to on-farm operations. Visual printable information is effective. Short alerts through existing phone / internet pathways for current threats is useful. Messages from technical experts is highly trusted

Who to engage?

- NGIA is a critical broker between government and industry. This is particularly important as networks between growers, even at a regional scale are often fairly weak
- Many local growers facing medium biosecurity risk have some capacity and with targeted engagement could be encouraged to undertake best practice biosecurity surveillance
- There are a few local growers who are not NGIA members and/or are disconnected from the grower surveillance and knowledge sharing system
- It is important to consider all participants involved in the industry supply chain – illegal importers still exist and large customer groups that don't require best practice accreditation from their suppliers still have some surveillance capacity issues that need to be addressed

It is also worth noting that the performance of existing engagement and communication strategies have not been evaluated. Existing communication and engagement are largely untested in terms of their efficacy and feedback of existing and new strategies are possible actions.

As Table 12 in this report highlights there is also a risk-capacity typology that emerges within a given industry group and this affects the way in which communication and engagement strategies could be targeted and prioritised. Table 13 below is a simplified version of Table 12.

Table 13 Typology of NGIA industry growers in terms of biosecurity risk and surveillance capacity

INDICATOR	PROFILE 1 variable capacity moderate risk	PROFILE 2 moderate-to-high capacity moderate risk	PROFILE 3 higher capacity higher risk
Biosecurity Capacity	n=105	n=92	n=16
Inspecting plants			
Inspecting imports			
Inspecting dispatches			
Recording			
Accreditation			
Intention to gain BioSecure HACCP			
Inspecting skill			
Detection skill			
Inspecting importance			
Recording importance			
Biosecurity Risk			
Production value			
Origin of imports			
Destination of exports			
Perceived risk of exotic pest incursion			

Colour codes for Biosecurity Capacity: low (red), medium (orange) or high (green)
Colour codes for Biosecurity Risk: low (green), medium (orange) or high (red)

Profile 1 growers have less capacity in recording and accreditation/certification and low motivation to engage with Biosecure HACCP. Yet their risk in terms of biosecurity appears to be fairly low. Communication and engagement strategies should focus on inspecting import activities and provide information about the risks facing export destinations.

For *Profile 2* growers, the risk is appears to be largely around accreditation/certification rather than poor recording practice. Growers in this profile are primed to shift to best practice grower-led surveillance profile if the benefits of Biosecure HACCP to their own operations can be communicated.

Profile 3 growers are usually bigger companies that have high production value – the risk is appears to be largely around value of their product and levels of importing and exporting rather than poor practice. Showcasing these best-practice growers could be beneficial to encourage other large-scale importers / exporters to improve their own surveillance efforts.

7 Next steps

This case-study research has provided an insight into one particular plant industry, however it is likely that many of the challenges associated with biosecurity surveillance, and possibly the solutions, are common to other plant industries. The aim of the next and final stage of this project (Milestone 6) is to draw on the findings from this case-study, together with those of previous stages of the project, to develop a 'roadmap' for how other plant industries can be supported in the development of grower-led plant health surveillance systems.

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Appendix A Email invitation for interview

A.1 Email text

Hi [first name of person],

My name is [full name of sender] from CSIRO. I am a part of a research team at CSIRO working on improving plant health surveillance in the production nursery industry. The aim of the study is to identify a set of solutions/strategies to encourage producers to engage in plant health surveillance and reporting (to avoid an exotic high priority pest incursion). This forms part of a broader research project, National grower-led surveillance systems: A method for developing effective grower-led surveillance systems for plant production industries in Australia, funded by the Department of Agriculture and Water Resources (DAWR). This project is part of the Australian Government's Agricultural Competitiveness White Paper, the government's plan for stronger farmers and a stronger economy.

I would like to invite you to participate in an interview to seek your views on issues surrounding plant health surveillance and reporting in the nursery and garden industry. Your participation would involve a telephone interview, of approximate 45 mins long, at a time that suits you. Dr Barton Loechel will be the research scientist conducting these interviews.

We are very keen to hear from some people involved in the Tasmanian sector of the industry. If you are unable to participate please consider nominating another person as Tasmania is the only state from which we have had no participants so far.

Please find attached an information sheet for further details.

I look forward to your response.

Yours sincerely,

[First name of sender]

A.2 Project Information Sheet

HEALTH & BIOSECURITY
www.csiro.au

Improving plant health surveillance in the nursery and garden industry: Research Information Sheet

The overarching aim of this project is to understand how plant health surveillance may be improved in the nursery and garden industry. Improved surveillance will assist producers to safeguard their livelihoods and increase productivity and competitiveness of the industry.

The Research

This project focuses on how to design and implement a plant health surveillance system that encourages nursery and garden producers (growers who produce and/or on sell plant stock) to engage in best practice plant health surveillance. It forms part of a broader project, *National grower-led surveillance system: A method for developing effective grower-led surveillance systems for plant production industries in Australia*, funded by the Department of Agriculture and Water Resources. This project is part of the Australian Government's Agricultural Competitiveness White Paper, the government's plan for stronger farmers and a stronger economy. The project aims to enhance plant health surveillance among the 39 plant production industries who are signatories to the Emergency Plant Pest Response Deed.

What is involved in this research?

To understand how the nursery and garden industry surveillance system can be improved we need input from a range of producers and stakeholders in the industry. Your participation will involve taking part in a face-to-face or telephone interview. The interview will take approx. 45 minutes and will be recorded to preserve the accuracy of information you provide. However, your information will be kept secure and confidential and will be de-identified in any publication from this study.

The researchers will seek your views on the following topics:

- Current state of the plant health surveillance system and on strategies and initiatives led by the Nursery and Garden Industry Australia intended to improve pest and disease surveillance
- Key challenges and barriers for plant pest and disease monitoring and reporting in the nursery and garden industry
- High risk segments or pathways for the introduction and spread of pest and disease within the industry
- Factors or approaches that could improve producer engagement and surveillance practices in the industry

It is important to remember that there are no right or wrong answers regarding the information you contribute to this research. We are only interested in your honest thoughts and personal opinions regarding biosecurity and surveillance activities.

Participation and withdrawal

Participation in this study is completely voluntary and you are free to withdraw at any time without prejudice or penalty. If you wish to withdraw, simply notify the researcher and you will be free to exit. If you do wish to withdraw after the interview has finished, simply notify the researchers listed overleaf (see *Research Team Contacts*) and your interview data will be destroyed. You may withdraw from this study at any time up until the point when the data is aggregated with other research data.

Risks

Aside from giving up your time, there are no foreseeable risks associated with participating in this project. You are free to omit answering any question(s). If you have any concerns about any aspects of the study, please contact Dr Cathy Robinson (*see Research Team Contacts*)

Confidentiality

All information collected will be anonymised using a coding system, so that there can be no direct association between your identity and the data you provide. The data will only be seen by members of our research team and will be stored in a secure area that is not accessible to any individuals other than the research team. Your information will only be used for research purposes.

How will my information be used?

The information you provide to us will be used to gain a greater understanding of the process of developing a grower-led surveillance system in the nursery and garden industry. This information will be used to prepare a case study report which will inform the broader project that seeks to assist development of a national approach to grower-led plant surveillance systems for other plant industries. The data may also be used to prepare scientific manuscripts for publication. Your personal information will not be identifiable at any stage of the writing process.

How can I find out more about this research?

This overall project is funded by the Department of Agriculture and Water Resources.

Please contact Dr Cathy Robinson from CSIRO for further information.

Ethical clearance and Contacts

This study has been cleared in accordance with the ethical review processes of CSIRO, within the guidelines of the National Statement on Ethical Conduct in Human Research. If you have any questions concerning your participation in the study feel free to contact the researchers involved.

Alternatively, any concerns or complaints about the conduct of the study can be raised with the CSIRO Ethics office on csshrec@csiro.au or (07) 3833 5693.

Research Team: Contact details

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Thank you for your help with this important research

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AT CSIRO WE SHAPE THE FUTURE
We do this by using science to solve real issues. Our research makes a difference to industry, people and the planet.

A.3 Consent Form

HEALTH & BIOSECURITY
www.csiro.au

Improving plant health surveillance in the nursery and garden industry: Research Consent Form

The aim of this project is to understand how plant health surveillance may be improved in the nursery and garden industry.

It forms part of a broader project, *National grower-led surveillance system: A method for developing effective grower-led surveillance systems for plant production industries in Australia*, funded by the Department of Agriculture and Water Resources. This project is part of the Australian Government's Agricultural Competitiveness White Paper, the government's plan for stronger farmers and a stronger economy.

Your involvement in this research is highly valued. Please review the information below and sign if you agree to participate in this research.

I acknowledge that:

- I have agreed to participate in this social research project and I am 18 years of age or older
- I understand my participation in the research will involve a 45 minute face-to-face or telephone interview
- I understand that the interview will be recorded for transcription and reference purposes to help ensure accuracy of the data
- I will not be personally identified with the information I provide and this data will be kept confidential and only seen by researchers involved in the research project
- I can obtain further information about the project from the research team at any time during the project (see accompanying Information Sheet for contact details)
- I understand that this study has been cleared in accordance with the ethical review processes of the Commonwealth Scientific and Industrial Research Organisation (CSIRO). I have been provided with contact details of the CSIRO Human Research Ethics office, where I can speak to an independent ethics officer if I have any concerns about the project.
- I understand that I am able to stop taking part in this study at any time without penalty and without giving an explanation for my withdrawal
- I understand that if I do withdraw from the study, any data I have provided prior to its aggregation with other research data will be removed from the study without penalty or explanation. Data that is removed will not be included in any further analyses
- I understand that I will not be paid directly for this research

Sign: _____ Date: _____

By providing my consent to participate in this research, I confirm that I have read and understood the accompanying Information Sheet and the contents of this Consent Form

Thank you for your participation

SOCIAL RESEARCH CONTACTS

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Appendix B Interview schedule

Introductory statement:

Hi _____thanks for agreeing to participate in this interview. My name is _____ from CSIRO, Australia's national science agency and I'm based in Brisbane.

The aim of this interview is to gain a better understanding of how the nursery and garden industry in Australia, specifically production nurseries, could improve their biosecurity surveillance. I will be interviewing a range of stakeholders – growers, industry professionals and topic experts – to improve our understanding of biosecurity surveillance in the industry and how it could be improved.

This series of interviews is part of a larger project being conducted by CSIRO for the Department of Agriculture and Water Resources, for which the aim is to improve surveillance for exotic pests and diseases in production nurseries. This project is part of the Australian Government's Agricultural Competitiveness White Paper, the government's plan for stronger farmers and a stronger economy.

This interview

The interview normally takes around 45-60 minutes to complete – but the total length can vary depending on how much detail you're willing to provide.

Have you been able to read the participant information sheet and consent form that was sent in the introductory email?

[If yes]:

Are you willing to participate?

Are you OK with the interview being recorded?

[If they haven't read the PIS & CF]:

I will be recording the interview, with your permission, so it can be transcribed and analysed afterwards. Your participation is entirely voluntary, and all information collected will be kept confidential as per CSIRO's research ethics protocol. Your identity and organisation will not be identifiable with any comments that you make. Interview information will be reported on a sector basis only (e.g. government, industry professional, researcher etc.) and will not be identifiable with an individual position, role or agency.

If you have any concerns or questions about the ethical aspects of this survey, please contact CSIRO Social Responsibility and Ethics: (07) 3833 5693 (email: csshrec@csiro.au).

Are you happy to participate?

(If not – could you suggest another person we could contact?)

Are you ok with the interview being recorded?

Do you have any questions before we start?

If all agreed and ready to proceed: "Great – let's begin!"

1. What is your organisation and your role in it?
2. How would you describe the current approach to developing a plant biosecurity system for the nursery production industry (in your jurisdiction or nationally)?
3. How would you describe the current plant health surveillance and reporting system of the nursery production industry (in your jurisdiction or nationally) with regards to the steps, initiatives and incentives involved and how well they are working?
4. In your view, what are the key challenges and barriers that impede monitoring and reporting plant pests and diseases in the nursery production industry?
5. What are the high risk segments or critical points within the industry for the introduction and spread of pests and diseases?
6. How would you characterise the current capacity of different grower segments to undertake surveillance for plant pests and diseases in a way that is likely to be effective? (i.e., do growers have the knowledge, skill and motivation to undertake surveillance?)
    a. Prompt: What currently affects producer motivation?
    b. Prompt: What might help increase it?
7. How would you characterise producers' readiness to report unusual signs of pests? Can you describe an example of when a producer did report unusual signs – what happened?
8. How would you characterise the current capacity of different segments of the nursery production industry to undertake surveillance for plant pests and diseases? (i.e., do different segments of the industry have different levels organisational capacity, network linkages, or legal or market drivers to undertake surveillance?)
9. What is your view on current strategies and initiatives led by producers, industries or government departments intended to improve pest surveillance?
    a. Prompt: What needs to be done to improve surveillance in the industry?
10. What things do you think could facilitate or enhance partnership among producers and other actors for an improved surveillance and reporting system?
11. Is there anything else you would like to share with us, anything that I have missed?

Appendix C Email invitation for online survey

Dear [name of person],

You may recall from our February, 2018 e-communications newsletter that CSIRO is conducting a case study on plant health surveillance in the nursery industry. It is recognised that the nursery industry plays a critical role in managing plant pests and diseases for Australia.

The aim of the study is to explore how surveillance and reporting may be improved in nurseries – to find out what challenges are being encountered and what supports may be required for producers.

CSIRO has already spoken to stakeholders in the industry and now needs to hear from producers.

Some of you may have already been contacted over the past week to participate in a telephone survey (CSIRO thanks you for participating!).

To ensure that everyone is given an opportunity to participate, the NGIA is now helping CSIRO distribute this same survey in online form.

So if you're keen to have your say about plant health surveillance and reporting, please click on the following link:
https://tinyurl.com/nurseries2018

The survey should take around 15 minutes to complete. **The survey will remain open for 1 week, closing at 5pm on Wednesday 18th April.**

If you'd like to know more about the study, please email PlantHealthResearch@csiro.au with your preferred contact details and a CSIRO researcher will make contact with you as soon as possible.

This project focuses on how to design and implement a plant health surveillance system that encourages nursery and garden producers (growers who produce and/or on sell plant stock) to engage in best practice plant health surveillance. It forms part of a broader project, *National grower-led surveillance system: A method for developing effective grower-led surveillance systems for plant production industries in Australia*, funded by the Department of Agriculture and Water Resources.

This project is part of the Australian Government's Agricultural Competitiveness White Paper, the government's plan for stronger farmers and a stronger economy. The project aims to enhance plant health surveillance among the 39 plant production industries who are signatories to the Emergency Plant Pest Response Deed.

The project has received ethical clearance from the CSIRO's ethics committee. You can be assured that your responses will remain private and anonymous.

All results will be aggregated together, and provided to participants at the conclusion of the study.

Thanks for taking part in this important research for our industry.

Best regards,
Peter Vaughan
NGIA CEO

Appendix D Survey questionnaire

Hello and thanks for agreeing to do this survey! We appreciate your time and value your answers.

This survey is being conducted by CSIRO and funded by the Department of Agriculture and Water Resources as part of the Agricultural Competitiveness White Paper – the government's plan for stronger farmers and a stronger economy.

The focus is on plant health monitoring. We'd like to know what will help production nurseries keep their plants free from pests and diseases.

First, can you tell me, is your nursery a production nursery?	0=no [terminate survey] 1=yes [proceed with survey]
And would you be the owner, manager or a staff member/someone who looks after the plants in the nursery?	0=no [ask for someone who is in charge of looking after the plants, else terminate the survey] 1=owner manager 2=manager (employed) 3=staff member

What is the postcode of your production nursery?	_____ [to be used to fulfil state quotas]

Thanks for that. Now, we'd just like to advise you that your participation is completely voluntary. Your responses will remain entirely anonymous, confidential and private. In the reporting of results, your responses will be grouped together with many other production nurseries. If there are any questions you don't wish to answer, that's totally fine, just let me know and we will skip to the next question.

It will take around 15 minutes to complete.

The survey has been reviewed and cleared by CSIRO's ethics committee. If you have any questions or concerns about the survey, I will provide you with the details of who to contact, and also how to receive feedback at the end of the survey.

Would you like to continue?

Thank you, let's get started then!

In this first section, we're interested to know about your current practices in the nursery. I'll read out a list of activities and as I read each one, please can you tell me how frequently your nursery undertakes that action.

1. How often does your nursery – as in your own nursery staff – inspect the plants and plant material in your nursery for signs of pests and diseases?	0=never 1=rarely 2=monthly 3=fortnightly 4=weekly 5=daily
2. How often does your nursery – as in your own nursery staff – inspect other vegetation elsewhere on the property for signs of pests and diseases?	0=never 1=rarely 2=monthly 3=fortnightly 4=weekly 5=daily
3. How often does your nursery get a local pest and disease expert to inspect plants and plant material for signs of pests and diseases?	0=never 1=rarely 2=every few months 3=monthly 4=fortnightly
4. What proportion of the plant material your nursery buys is from suppliers with NIASA accreditation or similar accreditation?	0% (none) to 100% (all)
5. How often does your nursery isolate and inspect newly imported plants and plant material before introducing them to the main nursery?	0=never 1=rarely 2=1 in every 6 or so imports 3=1 in every 3 or so imports 4=every import
6. How often does your nursery inspect plants and plant material for signs of pests and diseases before dispatching?	0=never 1=rarely 2=1 in every 6 or so dispatches 3=1 in every 3 or so dispatches 4=every dispatch
7. How often does your nursery formally record the results of any plant inspections that may be undertaken in the nursery?	0=never 1=rarely 2=sometimes 3=often 4=always
8. Is your nursery accredited under any of the following industry schemes? (please select all that apply/please just say yes or no as I read them out) • Nursery Industry Accreditation Scheme Australia (NIASA) • BioSecure HACCP • EcoHort • Quality Assurance (QA) Program e.g., ISO9000 • Other (please specify)	0=no 1=yes
9. How well does your nursery know BioSecure HACCP?	0=know nothing 1=know a little 2=know a moderate 3=know a lot
10. [branching if did not select say yes to BioSecure HACCP in Q8] Does your nursery intend to gain BioSecure HACCP accreditation?	0=no, never 1=sometime in the next few years 2=sometime later this year 3=currently in the process of applying
11. How frequently does your nursery make use of the following: • the Industry Biosecurity Plan for the Nursery Industry • the Biosecurity Manual for the Nursery Production Industry	0=never 1=rarely 2=sometimes

• the BioSecure HACCP Manual • the Nursery Production Farm Management System website www.nurseryproductionfms.com.au • the FarmBiosecurity website www.farmbiosecurity.com.au • the online electronic plant pest identification resource called Pest ID • any mobile phone apps that help you identify and report suspicious signs of pests and diseases	3=often

In this section, we're interested to know more about inspecting for signs of pests and diseases in your nursery.

12. Compared to other issues your nursery is dealing with in running the business, how important to your nursery is inspecting plants and plant material for signs of pests and diseases?	0=not at all important/ not a priority 1=low importance / low priority 2=moderate importance / medium priority 3=high importance / high priority
13. In your opinion, how technically skilled do you think your nursery staff are in inspecting plants and plant material for signs of pests and diseases?	0=below average skill 1=average skill 2=above average skill
14. What is the biggest challenge your nursery faces, in conducting regular inspections of plants and plant materials for signs of pests and diseases?	_____

In this section, we're interested to know more about record-keeping – that is, keeping formal records of the inspections undertaken in the nursery, looking for pests and diseases.

15. Compared to other issues your nursery is dealing with in running the business, how important to your nursery is formally recording all of the inspection activities undertaken to look for signs of pests and diseases?	0=not at all important/ not a priority 1=low importance / low priority 2=moderate importance / medium priority 3=high importance / high priority
16. What is the biggest challenge your nursery faces, in formally recording the results of inspections?	_____

In this section, we're interested to know what your nursery would do if staff found a strange or suspicious sign of a pest or disease – something that may indicate the presence of an exotic pest of disease (an exotic pest or disease is one that is NOT currently in Australia).

17. Firstly, if your nursery spotted something that looked a bit strange or suspicious – like a sign of an exotic pest or disease – what do you think your nursery would most likely do? (please select all that apply / please just say yes or no as I read out the list). Would your nursery… • contact a local pest and disease expert • contact a neighbour for advice • look up information on pests and diseases • report it to the state or national nursery and garden industry association • report it to the plant pest hotline • report it to the state Department of Primary Industry or Agriculture • just wait and see for a while • do nothing/wouldn't do anything • Would you do something else? (please specify)	0=no 1=yes _____
18. In your opinion, how would you rate the technical expertise of your nursery staff in making decisions about whether a strange or suspicious sign of a pest or disease actually requires further investigation?	0=below average expertise 1=average expertise 2=above average expertise
19. There are a number of reasons why nurseries might not formally report suspicious signs of pests or diseases to an authority. An authority might be the plant pest hotline, the Department of Primary Industry or Agriculture, a plant health consultant, or the Nursery and Garden Industry Association. Can you tell me what you think is the main reason why nurseries might not formally report something suspicious?	_____

Thinking now about exotic pests or diseases now – that is, pests and diseases that are NOT currently in Australia.

20. First can you tell me - how likely do you think it is that an exotic pest or disease incursion will happen in your nursery in the next 12 months?	0% (not at all likely, no chance of happening) 100% (it's certain, will definitely happen)
21. And using the same scale - how likely do you think it is that an exotic pest or disease incursion will happen in the nursery industry within the next 12 months?	0% (not at all likely, no chance of happening) 100% (it's certain, will definitely happen)
22. Reflecting now on what your nursery is currently doing to protect itself from exotic pests and diseases. Is there anything you can think of that industry could provide to you, which would help your nursery to improve its capacity to inspect plants and plant material for signs of pests and diseases, and/or to keep records of inspections?	_____

Thank you for answering all the survey questions. We now have just a few demographic questions to finish up with. This information will help us describe the overall sample of participants.

1. What is your nursery's main plant type?
   - Ornamental plants
   - Seedling stock
   - Forestry stock
   - Fruit and nut tree stock
   - Landscape stock
   - Plug and tube stock
   - Revegetation stock
   - Mine revegetation
   - Other (please specify)

2. What is your nursery's main horticultural market?
   - Retail greenlife (Bunnings, Aldi, Garden centres etc)
   - Domestic and/or commercial/government landscape
   - Interior-scapes/plant hire
   - Vegetable growers
   - Plantation timber
   - Orchardists (citrus, mango, avocado, apples, nuts etc.)
   - Cut flower
   - Revegetation (farmers, government, landcare etc.)
   - Mine site rehabilitation
   - Other (please specify)

3. What was the gross value of your production or trade in the financial year 2016-17?
   - Turnover up to $200,000 per year
   - Turnover between $200,000 and $500,000 per year
   - Turnover between $500,000 and $1,000,000 per year
   - Turnover between $1,000,000 and $2,500,000 per year
   - Turnover between $2,500,000 and $5,000,000 per year
   - Turnover between $5,000,000 and $10,000,000 per year
   - Turnover above $10,000,000 per year

4. What proportion of your nursery plants are:
   - Sold locally?
   - Sold elsewhere within your state?
   - Sold to other states in Australia?
   - Sold overseas?

5. What proportion of the plant materials your nursery buys is:
    - Purchased locally?
    - Purchased elsewhere within your state?
    - Purchased from other states in Australia?
    - Purchased from overseas?

6. How many full-time equivalent staff (including yourself) does your nursery employ?

    _____

7. What is your age group?
    - 18-24
    - 25-34
    - 35-44
    - 45-54
    - 55-64
    - 65 or over

8. What gender do you identify with?
    - Male
    - Female
    - Other

9. What is your highest level of education you have completed?
    - School education
    - Certificate
    - Advanced Diploma/Diploma
    - Bachelor degree
    - Graduate Diploma/Graduate Certificate
    - Postgraduate degree

You've now reached the end of the survey, but before I go, is there anything else you'd like to tell us about the prevention of pests and diseases in the production nursery industry?

_____

Thank you for participating! Would you like the details of the project team and the ethics manager? Would you like to know who to contact for feedback?

The project team can be contacted on PlantHealthResearch@csiro.au
The ethics manager can be contacted on Cathy.Pitkin@csiro.au or 07 3833 5693

Appendix E Socio-demographics of the sample

E.1 Role

	SAMPLE N	SAMPLE %
Owner Manager	159	74.65
Manager (employed)	48	22.54
Staff member	6	2.82
Total	213	100.00

E.2 Age

	SAMPLE N	SAMPLE %
18-24	1	0.47
25-34	14	6.57
35-44	35	16.43
45-54	60	28.17
55-64	71	33.33
65 or over	32	15.02
Total	213	100.00

E.3 Education

	SAMPLE N	SAMPLE %
School education	43	20.19
Certificate	43	20.19
Advanced Diploma/Diploma	50	23.47
Bachelor degree	55	25.82
Graduate Diploma/Graduate Certificate	7	3.29
Postgraduate Degree	14	6.57
Refused to answer	1	0.47
Total	213	100.00

E.4 Location of Business

	SAMPLE N	SAMPLE %	POPULATION % (AS AT 2014/2015)
NSW	49	23.00	21
VIC	77	36.15	36
QLD	58	27.23	27
WA	15	7.04	10
SA	10	4.69	5
TAS	3	1.41	<1

NT	1	0.47	<1
Total	213	100.00	100.00

Source: Population percentages were obtained from the Hort Innovation Nursery Fund 2016/17 Annual Report.

E.5 Plant Type

	SAMPLE N	SAMPLE %
Ornamental plants	103	48.36
Seeding stock	13	6.10
Forestry stock	5	2.35
Fruit and nut tree stock	13	6.10
Landscape stock	40	18.78
Plug and tube stock	14	6.57
Revegetation stock	14	6.57
Mine revegetation	1	0.47
Other	10	4.69
Total	213	100.00

E.6 Main Market

	SAMPLE N	SAMPLE %
Retail greenlife (Bunnings, Aldi, Garden centres etc.)	117	54.93
Domestic and/or commercial/government landscape	49	23.00
Interior-scapes/plant hire	2	0.94
Vegetable growers	7	3.29
Plantation timber	4	1.88
Orchardists (citrus, mango, avocado, apples, nuts etc.)	6	2.82
Cut flower	2	0.94
Revegetation (farmers, government, landcare etc.)	17	7.98
Mine site rehabilitation	1	0.47
Other	8	3.76
Total	213	100.00

E.7 Gross Value of Production

$ TURNOVER PER YEAR	SAMPLE N	SAMPLE %
up to $200,000	30	14.08
between $200,000 and $500,000	43	20.19
between $500,000 and $1,000,000	35	16.43
between $1,000,000 and $2,500,000	49	23.00
between $2,500,000 and $5,000,000	25	11.74
between $5,000,000 and $10,000,000	4	1.89
above $10,000,000	6	2.82
Refused to answer/no response	21	9.86
Total	213	100.00

E.8 Origin of imports and destination for exports

LOCATION	BOUGHT (IMPORTS)	SOLD (EXPORTS)
Locally	43.15	43.06
Elsewhere in state	25.37	35.17
Interstate	22.49	20.55
Overseas	4.93	1.21

Appendix F Indicators of biosecurity capacity and biosecurity risk

F.1 Biosecurity Capacity

F.1.1 Plant and Plant Material Inspections (in nursery)

SCORE	CRITERIA
0	Never
1	Rarely
2	Monthly
3	Fortnightly
4	Weekly
5	Daily

F.1.2 Imported Plant and Plant Material Inspections

SCORE	CRITERIA
0	Never
1	Rarely
2	1 in every 6 imports
3	1 in every 3 imports
4	Every import

F.1.3 Dispatched Plant and Plant Material Inspections

SCORE	CRITERIA
0	Never
1	Rarely
2	1 in every 6 dispatches
3	1 in every 3 dispatches
4	Every dispatch

F.1.4 Record-keeping

SCORE	CRITERIA
0	Never
1	Rarely
2	Sometimes

3	Often
4	Always

F.1.5 Accreditation Status

SCORE	CRITERIA
0	None
1	EcoHort, QA Program, Other
2	NIASA
3	BioSecure HACCP

F.1.6 Intention to gain BioSecure HACCP

SCORE	CRITERIA
0	No, never
1	Sometime in the next few years
2	Sometime later this year
3	Currently in the process of applying
4	Already with BioSecureHACCP

F.1.7 Perceived technical skill in inspections

SCORE	CRITERIA
0	Below average skill
1	Average skill
2	Above average skill

F.1.8 Perceived technical expertise in detection

SCORE	CRITERIA
0	Below average expertise
1	Average expertise
2	Above average expertise

F.1.9 Relative importance of inspecting

SCORE	CRITERIA
0	Not at all important/not a priority
1	Low importance/low priority
2	Moderate importance/medium priority
3	High importance/high priority

F.1.10 Relative importance of record-keeping

SCORE	CRITERIA
0	Not at all important/not a priority
1	Low importance/low priority
2	Moderate importance/medium priority
3	High importance/high priority

F.2 Biosecurity Risk

F.2.1 Value of Production

SCORE	CRITERIA
1	up to $200,000 per year
2	between $200,000 and $500,000
3	between $500,000 and $1,000,000
4	between $1,000,000 and $2,500,000
5	between $2,500,000 and $5,000,000
6	between $5,000,000 and $10,000,000
7	above $10,000,000

F.2.1 Origin of Imports

SCORE	CRITERIA
1	Imports only from local sources
2	Imports from local and/or intrastate
3	Imports from local, intrastate and/or interstate
4	Imports from local, intrastate, interstate and/or overseas

F.2.1 Destination for exports

SCORE	CRITERIA
1	Exports only to local destinations
2	Exports to local and/or intrastate
3	Exports to local, intrastate and/or interstate
4	Exports to local, intrastate, interstate and/or overseas

F.2.1 Perceived risk of pest incursion (in nursery)

SCORE	CRITERIA
0-100%	0% likelihood (not at all likely, no chance of happening) to 100% likelihood (it's certain, will definitely happen)

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